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ICONIC AND SCHEMATIC MAPS: A COMPARATIVE STUDY

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ICONIC AND SCHEMATIC MAPS:
A COMPARATIVE STUDY

A Dissertation APPROVED FOR THE
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

BY:

DEDICATION

To my wife.
Faye Allison Foreman
for her love, for her sacrifice, and for her endurance.

To our children,
Allison, Erinn, Gretchen, Joshua, Caleb, and Liesl
for their patience with life.

To our grandchildren,
in hope that someday they will understand why.

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ABSTRACT

This study examines how the learning of geographic information is affected by the organization of information presented on maps. A pretest, posttest, and delayed test format determined if there is any significant difference in the scores of participants who learned from viewing iconic intervention maps of Africa and schematic intervention maps of Africa.

Participants in this study were fifth grade students in a midsize school district in a southwestern state. Participants were randomly assigned to one of four groups, two who viewed iconic intervention maps and two schematic intervention maps.

Participants, on the same day, were pretested, and posttested before and after viewing interventions. Two weeks later, participants were delay posttested with the same iconic map used for the pretest and posttest. Little advanced verbal instruction was given participants as to learning from iconic or schematic maps.

Results show that there was no significant difference in scores between those participants who viewed the iconic intervention maps and those participants who viewed the schematic intervention maps. All participants did learn, however, as postscore mean averages significantly exceeded prescore mean averages. Delayed posttest mean averages were lower than the postscore averages, but significantly higher than the pretest averages.

This held true for all four groups whether the participants viewed the iconic intervention maps or the schematic intervention maps.

One study finding is disappointing: that schematic maps do not promote greater map comprehension than do iconic maps. However, the study suggests that prior verbal instruction may have positive results for recalling map information.

This study is of value in that if there are further studies using iconic and schematic maps, as there was no significant difference without verbal instruction as to how to remember and recall from either format, if instruction were given, any significance could be attributed to that instruction.

CHAPTER 1

Many individuals in the United States, even when given place-names as cues, cannot correctly identify specified locations such as cities, rivers, or mountain ranges, on maps or globes (Duckson, 1988). Cognitive ability to understand, remember, and recall the features on a map differs by individuals. Such differences suggest a need to tailor maps to meet the needs of the map viewers. However, the use of the same map displays for different grade levels and purposes by publishers and text writers suggests a belief that all learners, regardless of age and basic visual knowledge, can understand and remember graphic representations with the same visual and cognitive clarity. This expectation is in conflict with research concerning how people visualize, remember, and recall information (Watt, 1988; Anderson, 1990). Modification of the visual and verbal organization of maps is one technique that may improve understanding map content.

The purpose of this study is to examine how the learning of geographic information is affected by the organization of the information on a map. More specifically, I compare differences in recall performance of geographic place-names for students who study a typical iconic map and students who study a map designed to emphasize the spatial relationships of the same area shown in the iconic map. In the remainder of this chapter, I describe and discuss the theoretical and empirical support for the initial presentation of geographical information in spatial relationship terms.

Chapter One is organized in the following way. First, I review the foundations for the study. The problem inherent to this study was generated by a concern for the inability of individuals to remember and recall information on maps. Possible reasons behind the difficulty of reading some maps is discussed. Then, I discuss the general organization of maps. Next, why cognitive and visual theories support different ways to represent mapped information. Then, as an alternative to general map organization, I suggest ways to represent mapped information to better assist learners as they visualize, remember, and recall such information. Chapter One concludes with a statement of purpose for the proposed study. In Chapter Two, the method section, I describe the plan for the proposed study. In Chapter Three I review the results of the study, and in Chapter Four I discuss implications drawn from the results.

Foundations for the Study

There are cognitive differences in individual ability to understand, remember, and recall the features on a map. Research has provided evidence of differences in map learning performance between good and poor learners (Thorndyke & Stasz, 1980); between age groups (Kosslyn, Pick & Fariello, 1974; Ottosson, 1988; Vosniadou & Brewer, 1992); by gender (Gilmartin & Patton, 1984; Gilmartin, 1986; Philippe & Schwartz, 1989); and by individual encoding strategies (Evans, 1980; Thorndyke & Stasz, 1980; Winn & Sutherland, 1989).

Duckson (1988) noted the inability of college level students to properly identify the locations of states in the United States. Hsu, Lackey and Foreman (1993) found that even when given place-names of locations on a map of the United States, college students were unable to satisfactorily identify and match the place-names to major mountain ranges, lakes, and rivers. Further, like college students, most high school students have poor geographic skills. It is apparent that when it comes to geography, one difficulty many individuals have is that they either do not recognize the names of places, or, they are not able to locate on a map the places that are named. Gritzner (1981) pointed out that for a fifty year period the subject of geography was absent from elementary school curricula. He implied that individuals cannot identify places because at some point they have not learned the names for places, or the location of those places. This further implies that there must be reasons why students cannot relate names and locations.

Maps, "...display in a concise symbolism both explicit information about object names, shapes, and locations, and implicit information about spatial relationships and distances among objects," (Thorndyke & Stasz, 1980, p. 137). In doing so, many maps use a variety of symbols and represent a considerable amount of information. When there is a variety of information being represented on a map nothing stands out more than anything else. A teacher's directive to, "Learn this map," does not help the viewer focus on anything particular, and, although all of the mapped information gets into the sensory memory, not all the information on the map is retained. Unless directed to seek specific information or relationships in a particular instance, much of the information represented may be lost to memory (Anderson, 1990). This suggests one reason why maps are not remembered. Often there is so much information represented on maps that they are cluttered, therefore, viewers have difficulty in focusing on specific information to remember.

Further, maps not only identify places and their locations, but imply a spatial relationship among those places (Gregg & Leinhardt, 1994). Some individuals find it difficult to relate to the spatial relationships shown on maps. Chiodo (1993) reported that preservice social study teachers who will be teaching geography had difficulty constructing proper sketch maps of the world. That is, the preservice teachers did not understand the spatial relationships particular to geography well enough to arrange parts of the world correctly. This, then, points to another possibility for poor geographic skills. There is a possibility that individuals are unable to recognize, or remember and recall the spatial relationships on maps. Such individuals are unable to place geographic experiences in their proper relationships one to another (Tversky, 1981).

Although maps represent viable and useful information, it seems that viewers often find difficulty in remembering and recalling map content. Maps may be designed in such a manner that it is difficult for the viewer to extract specific information from the clutter or for the viewer to place spatial relationships in their proper perspective (Carter, 1988). As a result viewers are perceived to have poor geographic skills.

Map Design and Content

The earth is quite large compared to an individual. It is almost impossible to study the earth without an aid. Maps have been developed as such an aid. They are used as a visual aid to portray the spatial relationships and the distribution of the physical environment, natural resources, and manmade features associated with the earth. Anything which can be observed on the face of the earth, tangible or otherwise, can be represented as a map (Robinson, 1963).

Maps are two dimensional representations of three dimensional space (Tversky, 1981). A three dimensional earth is represented in a two dimensional format. Such mapping generally falls into one of two types; iconic maps or schematic maps. To remember and recall mapped representations requires both visual and cognitive effort. To help the reader understand the difference between an iconic map and a schematic map designed to stress spatial relationships, and the visual and cognitive efforts required for each, a review of each type of map is in order.

Iconic Maps

An iconic map, compared to a schematic map, is a type of picture (See Appendix, figure 1). Such a map is not an image like a photograph, but is a representation organized with a measure of realism (Goodman, 1968). Cartographers, and others who design maps, communicate information in a spatial context (Macey, Greenberg, Weismantel & Carmack, 1988). They position lines, arrange symbols, use design elements, thicknesses, forms, hues, numbers and words as substitutes for that which has been observed (Bertin, 1983; Bullough, 1988). Efficiently designed maps assist the viewer in recognizing that which is being represented (Carter, 1988).

Some of the symbols used by cartographers are substitutes for natural features, some for manmade features (Robinson, 1963). A squiggly line substitutes for a river; a circle substitutes for a lake; a black line substitutes for a road. One can fish in the river represented by the squiggly line; swim in the lake represented by the circle; and drive on the road represented by a black line. As such, the substitutes represent real objects. However, cartographers also use other substitutes to represent that which is imaginary and more abstract: a arrow pointing north; a line for state boundaries or the equator; different sized dots; and sizes of type for different sized cities. In such cases one cannot walk outside and see an arrow pointing north, nor see an actual line between states or at the equator, or go to a city and see the representative dot size or type size.

Still, the natural and imaginary substitutes used by cartographers are recognizable and children as young as four and six years old can be taught to properly identify such representations (Ottosson, 1988). It seems, however, that when many such representations are organized in proximity, recognition of the individual parts, and remembering their individual locations and spatial relationships, becomes more difficult (Pufall & Shaw, 1973).

The organization of the representations on a map, however, is only a part of that which contributes to the clarity of the map. Maps, although often devised as a picture with a measure of realism, are not full size. As such, vast distances, considerable differences in elevation, and a myriad of observable geographic experiences are often scaled, that is shrunk, to fit on a page, perhaps two. For instance, on an 8 1/2 inch by 11 inch sized iconic United States map, it is less than 1/2 inch, _____, this far, from Oklahoma City, Oklahoma to Dallas, Texas. Those who have driven this 200 miles will attest that numerous towns large and small, several rivers, some mountains, and some open space are along the way.

However, it is impossible for a cartographer to take all features into consideration, and only a small portion of the available geographic experiences along the way can be represented. That which is represented is the remains of a selection process which may or may not include the features that are of interest to the viewer. If I have an interest in the Arbuckle Mountains, they may be included. However, if the map viewer is from Purcell and wanted to locate their town, most likely this city will not be included. Relationships are even more compressed on a two page world map where the 200 miles between Oklahoma City and Dallas is 1/8 of an inch, about this far, _. As such, it is almost impossible to represent any but the most obvious geographic experiences in such a given space. The scale, that is the distances between points on a given map, effects that which the cartographer can represent. As such, scale can be a weakness in map design when it effects the relationships of that which is being communicated to the viewer (Macey, Greenberg, Weismantel, & Carmack, 1988).

Distances between points, especially on large surface areas like world maps, are further exaggerated by the format, that is the projection, used to represent the curvature of the earth. On an iconic projection the transfer of size and distance from a curved surface to a flat one distorts that size and distance. Depending on the scale and the projection used by the cartographer, real distances, that is the spatial relationships between points on a map, can be disproportionately represented and visually very deceptive.

Thus, although iconic maps can be a representation of reality, depending on the complexity of the map, the scale of the map, and the projection used for that map, there can be many interpretations of that reality. Generally, it is such iconic maps that are used when determining that individuals have poor geographic skills.

Schematic Maps

Schematic maps, as opposed to iconic maps, are only obligated to resemble or be a general outline form of that which is being mapped (see Appendix, figure 1). Schematic maps, like iconic maps, use symbols as substitutes but the schematic symbols are not expected to be realistic in manner. That is, a river could be a line, but that line may not follow, or pretend to follow, the actual bed of the river. Schematic maps can show the same information as an iconic map and therefore can become quite complex.

Still, most schematic maps are drawn with the idea of showing relationships of locations, not the exact position of those locations.

For instance, if, on a schematic map of the area between Oklahoma City and Dallas, the cartographers wanted to show that there are mountains between the two cities, liberty could be taken to expand the distance between the two to allow for inclusion of the mountain range. As schematic maps are not held to a fixed scale, this would not be a problem. Oklahoma City would still be north of the mountains and Dallas to the south. If the cartographers wished to show where Purcell is in relation to the mountains, they could do so on a schematic map. Although liberty can be taken with the form in which something is drawn, or the scale, or the projection, the relationships between the places, that is, their relative locations to each other, will be correct.

So it is then, that maps use scale, projection, and the relationships between the places to communicate information about those places. If, individuals do not know the names of places, where places are, or the spatial relationships between places, they are excluded from that information which is transmitted by means of a map display. Some map presentations are easier to visualize, remember, and recall than others.

In this study I use both iconic and schematic maps with the fifth grade participants. Maps of Africa were used as it was judged that participants prior knowledge of such area maps would be minimal

Cognitive and Visual Theories

Most studies that have examined cognitive strategies pursuant to map learning have tried to describe how people solve problems in reading and how people use maps (Blades & Spencer, 1986). Research studies have used local maps like a campus (Howard & Kerst, 1981) or town (Thorndyke & Stasz, 1980), state maps (Duckson, 1988), maps of countries (Ormrod, J., Ormrod, R., & Wagner, 1988), and maps of the world (Chiodo, 1993; Vosniadou & Brewer, 1992; Metz, 1990; Drumheller, 1968). In common, these studies required participants to view maps, then remember, recall, and perhaps manipulate information from the maps they viewed. Such formats require that an individuals' cognitive functions and visual senses act in concert. I will first discuss current cognitive theories, then theories of perception, as concerns remembering and viewing of maps.

Cognitive Theories

There are several views of how memory works: Atkinson and Shiffrin (1968); Pylyshyn (1973); Pavio (1986); Anderson (1990); Mayer and Anderson (1991). The contemporary view, however, is that information is stored in memory in such a way that related pieces are associated, or connected, with one another (Anderson, 1990; Ormrod, 1990). That is, information that is received is stored in a format that somewhat segregates the information with similar information of type or content.

Information received for storage in memory has been encoded, or transformed, into representations that can be more permanently retained (Anderson, 1990). Such representations, perception-based representations and meaning-based representations, are both applicable to map viewing.

Perception-based representations are those encodings that retain much of the structure of the original perceptual experience. Anderson (1990) divided perception-based representations into two types, images and linear. Perception-based image representations apply directly to the viewing of maps as they preserve information about the visual properties of objects. As individuals perceive maps, they are representing the geographic symbolism and the spatial relationships. Perception-based representations retain such information in memory.

There may be two kinds of perceptual imagery, one involving visual properties and one involving spatial properties. That is, one perception for judgments (color, bigger, sizes), and one perception for rotation or the relationships of items one to another or in space (location, distance). Such imagery tends to be organized in a hierarchical structure where separate pieces of the structure then fit together to make the whole. In such a hierarchical structure, even large pieces of a whole picture may again be divided into smaller pieces. To mentally recompose a full picture, the different parts of the picture are pieced back together to solve whatever problem is in hand (Drumheller, 1968).

In memory, as each part in the hierarchical structure has its' own perceived spatial relationship, when parts are put back together distortions in relationship to the whole can arise. That is, the spatial position within one perception is correct, but when the parts are put together the perceived spatial relationship is incorrect. There is an often used example of such distortion: California is west of Nevada. As part of the perception of the United States, this is correct. It is often incorrectly concluded that San Diego, California, is west of Reno, Nevada. Such is one type of perceptive error, a vertical distortion (Tversky, 1981).

Perception-based linear representations, in contrast to image representations, apply to the sequence of events. Such representations apply to perceptual information that is stored in order. Such representations would include verbal information like words of a play, a sequence of names, or poetry. Linear representations might also apply to verbal and visual maps. For instance, a common sequential order is verbal directions: go west one block, turn at the church, the third house on the north side of the street. Further, if the learner, while viewing a map, memorized the information written on the map in a sequential order, the encoding could be considered linear.

Memory storage of such linear orders has limits. Linear items have their own hierarchical order. For instance, those items in the linear order that are toward the first, and toward the last items committed to memory, are more likely to be remembered in recall. Further, if items are in a linear order, it is often necessary to repeat the entire order to pick out any one part of the sequence. That is, if ten geographic items have been memorized, to remember the sixth item it might be necessary to repeat the first five.

Meaning-based representations, on the other hand, encode that which is significant at an abstract level. Such representations are selective and may omit unimportant perceptual details. One way for such information to be stored is as propositional representations. That is, as, "the smallest unit of knowledge that can stand as a separate assertion... the smallest unit about which it makes sense to make the judgment true or false (Anderson, 1990, p. 123). These small units of knowledge can be organized into networks, which in turn can make up representational concepts. The closer the concepts are in an organized network, the more supportive they are in assisting each other in recall. For instance: water - river - rapids - waterfall, relate to each other and one concept supports the other. On the other hand: yellow raincoat - Maid of the Mist - waterfall - rapids - river, seem to not be related. Still, if the reader has been to Niagara Falls, the sequence is correct. Yellow raincoats are worn by those who ride the boat, "Maid of the Mist," at the bottom of Niagara Falls, cut by the rapids, and by the Niagara River. Such divergence of supportive networks is indicative of associative cognition in that that which is already in the mind is the foundation for additional association.

Based on similar cognitive divergence, we each have expectations about certain things. Such expectations, that is abstract concepts, or schemas, are based on our knowledge. For most, the term "house" brings forth expectations of rooms of some type, walls, running water, inside plumbing, and people who live there. Many even conjure a visual picture of a white house with a picket fence similar those seen in basic picture book/readers. Such schemas can both influence what we expect from a situation, what we choose to encode about that situation, and what we recall of that situation (Anderson, 1990: Intraub & Hoffman, 1992).

At encoding, meaning-based representations contain both verbal and visual details. However, such details rapidly decay and only that which is meaningful remains. Thus, in meaning-based representations exact details of verbal input or of spatial relationships are not likely to be remembered. Still, visual information is more likely to be remembered than verbal information (Anderson, 1990). That is, if an individual views a map containing both spatial relationships and verbal items, they are more likely to remember the gist of the spatial relationships than they are the accompanying verbal information.

Maps, then, can be remembered as perception-based representations or as meaning-based representations. Neither, of itself, may suffice. In either case, mental images of maps can be misleading, not because of the way a map is drawn, but because of the way an individual stores the images in memory.

Thorndyke and Stasz (1980) found that the best map learners were those who could employ both image and written encoding in memorizing mapped information. That is, the best learning occurred when spatial locations were identifiable and when names were then given to those locations. For most efficient acquisition, then, maps should at least start with something familiar to those viewing them. Ottosson (1988) pointed out that learning of maps should start with spatial relationships that can be seen, or which are already known.

As memory is hierarchical in structure (Anderson, 1990), there is an advantage in starting with that which is already known. Arnheim (1969) noted that individuals can only deal with something that is already in the mind in some fashion. This being the case, the more information already in memory the greater the possibility that additional information will find existing relationships with which to associate. As memory capacity is unlimited

(Ormrod, 1990), the possibilities of such associations are also unlimited. It would seem, then, that an individual could remember everything that ever happened. This is not the case.

Some things in memory are more easily brought to mind than others. We respond quickly when ask our current address and phone number. However, the address of a previous residence may take a bit longer and the phone number we may not recall at all. Such cognitive processes are known as activation, and strength. "Activation controls the speed and reliability of access to the memories." "Strength determines the degree to which we can reactive old memories" (Anderson, 1990, p. 150). This is called by Anderson (1990) the two-concept theory of memory. That is, activation keeps information in a readily accessible state for present use, while strength makes that which has already been encoded available for activation. Those memories which are currently active, that is, those currently being used, are often referred to as working memory. Other memories that are not in current use, but have strength sufficient to allow for reactivation, are referred to as long-term memory (Anderson, 1990).

Working memory has a very high capacity for ongoing activity. For instance, we are always somewhat aware of the input from our senses. We taste, we hear, we feel, we smell, we see. We perceive these sensory inputs according to our backgrounds and our needs. We attune our senses to tasting the salt; or hearing the baby; or feeling the heat; or smelling the roses; or seeing a rock fall. A condiment for potatoes should be salt; a baby should cry; the summer should be hot; a rose should smell like a rose; a rock should fall. These expectations are based on past experiences. When such experiences happen as expected, the new sensory inputs have a perceived meaning and are easily assimilate into the hierarchical patterns of memory. In other words, the ongoing sensory input matches the strong memory codes which already exist.

However, sometimes an exact, or similar match, is not found in long-term memory for a sensory experience. If this new experience is to be remembered, then, "...it is critical ...that we process (the) information in a way that is conducive to setting up a long-term memory trace" (Anderson, 1995, p. 174).

Maintaining such meaningful processing of information is difficult as there are some limitations within working memory. For instance, although the capacity of working memory is high, working memory can only process a limited amount of information at a time. The limitation on processing is inscribed by the amount of that information. For instance, when learning from a map of the United States, one might be able to process five or six names with ease. On such a map, as activated from long-term memory, there is some familiarity with pronunciation, and perhaps even with the names themselves. However, when learning from a map of China, one might be fortunate to process only two or three names at a time. In the case of China, it takes more time to pronounce unfamiliar combinations of letters, and familiarity with names is limited. In both situations there is a frame of amount/time which is allocated for processing.

Information which is meaningfully processed is encoded and retained in long-term memory. Again, when information is encoded sufficiently for retention in long-term memory, it is incorporated in a hierarchical format and related to similar information already in memory, and to all information in memory by association.

In theory everything that has ever been encoded is still in memory. In reality, some information may be difficult to activate or on recall may vary from the original encoding. For instance, those recalling stories from the past may tell such stories in a format most favorable to the memory of the individual telling the story. Such alterations apply not only to verbal but to spatial memory. Spatial relationships are often interpreted to match that which we already have in long-term memory. Regularity and order is imposed and that which was slightly tilted is rotated and remembered as having been more lined up, more in concert with a frame of reference, or in a different position relative to the positions of other figures (Tversky, 1981).

Strength of information encoded can be enhanced when such information is verified by more than one input. Such strength reflects an increased input to long-term memory and, as there is association between hierarchical structures, a more elaborate network of representations evolves. The greater the network of representations for a bit of information, the more likely that on activation the information will be pulled back into working memory.

Such inference to recall can be extended to implicit and explicit information. For instance, an implicit description of a place and location of a city on a map of the United States is: The City of New Orleans is on the Mississippi River. This is true, but such information makes it difficult for the learner to place New Orleans in a spatial relationship. A more explicit verbal description is: The City of New Orleans is located near the mouth of the Mississippi River, the major river that flows from north to south in the mid-section of the United States, and empties into the Gulf of Mexico. This explicit description certainly allows the learner more advantage in encoding the spatial relationships and should enhance both finding and remembering The City of New Orleans. Even so, the description: The City of New Orleans is at 30.00° north latitude, 90.05° west longitude, is the most accurate and the most explicit. However, such a description presupposes prior knowledge, even expertise, of map reading.

Presumption of prior knowledge on the part of cartographers may be part of the reason some individuals have poor geographic skills. For instance, Drumheller (1968), and Vosniadou and Brewer (1992) pointed out that the ability to understand that the features drawn on maps represent physical relationships in the real world differs among individuals of the same age. Then, in addition to individual abilities, Kosslyn, Pick and Fariello (1974) noted that the cognitive ability to understand and remember spatial relationships also differs by age groups. Such different abilities among individuals and age groups suggests a need to tailor the complexity of map representations to be compatible with different knowledge levels.

However, an informal survey of textbooks approved for geography and social studies classes in grades K - 12 in a mid-western state, revealed that consideration for differing abilities is not the case. This author found a single map of North America being used in a social studies textbook, grades K - 6, and in two geography texts, grades 7 and 8, and grades 9 - 12. A similar map was being used in an atlas for beginning geography students in college. A further review of texts intended for use across age groups, showed that it is not uncommon to use the same map, or a similar map, for a variety of purposes. Use of the same maps for different ages, grade levels, and learning situations, suggests a belief that learners of all ages and background knowledge can encode graphic, spatial, and verbal representations with the same visual and cognitive clarity. Most iconic maps do not demonstrate an age group consciousness. As individuals and age groups learn differently, the expectation that everyone learns from maps in the same manner, as noted, is in conflict with research concerning encoding and memory (Anderson, 1990; Kosslyn, Pick & Fariello, 1974; Thorndyke & Stasz, 1980; Tversky, Kugelmass & Winter, 1991).

Most iconic maps display explicit information. That is, a dot represents a city. The size of the dot or the size of the print proclaiming the name of the city represents the population of the city. A name by a squiggly line indicates the name of the river represented. Texture or color represents depth of sea or height of mountains. It would seem, then, that from an iconic map presentation, there is much explicit information to be gleaned. Still, in each case, the learner is left to their own devices to determine how the city, the river, the mountains, are spatially related to each other, or to the other geographic representations on the map. This being the case, then, depending on the complexity of its' parts, some iconic presentations are easier to remember, and recall than others.

Still, the more explicit the information available to a learner about a geographic experience the more the learner is able to use mental elaborations, improve memory, and recall that information (Anderson, 1990). Compared to a description of just place and location, a description of a spatial relationship provides additional information for a learner. That is to say, learners who are verbally given more explicit information about the location of a geographic experience depicted on a map, and meaningfully process that information, will be more proficient in remembering that information or that geographic experience. This notion is supported by the research of Schwartz and Kulhavy (1981) who found that participants who had both viewed maps and read passages were better able to recall information than those who did not both types of information. So it is that in reading passages pertaining to that presented on a map, that the learner is in essence given an additional opportunity to rehearse and encode the information from the map.

It is noted, then, that the strength of memory traces comes not only from explicit information, but from duality of input. Thus, one way to improve the learning of iconic maps is to provide the learner with more opportunities to encode the information.

One of the questions about learning from maps is whether the learner has the ability to see and understand the mapped format, and the geographic expressions of the cartographer (Ottosson, 1988). As discussed, geographic experiences can be described verbally by place and location, but more explicitly by a verbal description of a geographic experiences' spatial relationships. Still, it would seem that such verbal expressions would need be at the entry level of the language spoken by that learner, not at the language level spoken by an expert. Likewise, for the best learning opportunity, it would seem that the visual presentation of the cartographer should be at the level of the learner, or, at least in a visual format which offers the greatest opportunity for rehearsal and encoding.

Perception

As vision is the sensory input for the cartographic portion of map comprehension, and there is a question concerning an appropriate learning format for mapped information, it is of value to review the visual process as it relates to maps. For purposes here I sketch an outline of how vision works, and a discuss Gestalt principals. These thoughts on vision and the previous comments on the cognitive processes, lay the foundation for comments on geographic representations.

Theories of visual imagery fit nicely with the associationistic views of memory. That is, visual imagery is not stored in long-term memory as a snapshot equivalency, but is processed and stored as perception based knowledge representations, or meaning-based knowledge representations (Ormrod, 1990). Perception is a means by which sensory input agrees with, or matches the completeness of, that which is already in memory (Watt, 1988). As such, that which is seen is not reality, but is a depiction of a representation of reality (Maceachren & Ganter, 1990). The mind sees what it will, and interprets and recognizes sensory input through the psychological process of perception (Ormrod, 1990). That is, what we see is what our mind tells us we see.

Vision

In its' simplest form, vision is the sense that allows us to interact with remote objects without having to have direct contact with them (Watt, 1988). The human eye is sensitive to light, a form of electromagnetic radiation made up of photons. As photons enter the eye through the pupil they are gathered on the inside back of the eye, the retina, by neural photoreceptor cells, rods and cones. These rods and cones contain photosensitive pigments that react to light.

As such, when light waves reach the rods and cones they are first converted into neural energy by photochemical processes and neural exchanges (Anderson, 1990). The results of this neural output is transmitted to the brain by the optic nerve which is attached to the back of the eye. The area around the optic nerve, the fovea, is the most sensitive to photic activity, so we see better in normal light when we shift out eyes to look directly at an object.

It is not possible for the eye to clearly focus on more than one point at a time as beyond about one degree either side of the fovea, clarity of vision begins to diminish. Further, as not all cones and rods activate at the same time, even when looking at a focused point, the eyes have a minute shifting movement, or saccades, to assure continual photic activity for processing.

When light waves travel further to reach the viewer, or where the contrasts of the luminance of objects being viewed is high, there is a peak and/or trough in the light wave. The neural processing of such variance in peaks and troughs of the light waves makes, edges, comers, and places where near objects and far objects meet very obvious. In the normal seeing process the peaks and troughs of light waves are modified, or smoothed, to eliminate extremes so that what we see is softer to our view. This ability to see both small and large objects and distinguish and separate the borders between and within them is visual acuity. Visual acuity allows viewers to distinguish between the parts of the maps they view.

However, Maceachren and Ganter (1990) pointed out that visualization, "seeing," is foremost an act of cognition. We do not look at something without a reason. So, when viewing a map, a leamer might already have in mind to seek particular information. That is, a leamer might already have a need and choose to focus on specific points on the map to satisfy that need. For instance, the leamer is ask to locate and color Oklahoma. If the learner already knows that in a spatial relationship Oklahoma is in the center of the United States, they focus there first. As such, the learner predetermines where they will look, and they choose the placement of their visual focus. This selection, or attention, is critical to learning. It is at the point of attention that visual acuity distinguishes and separates the objects attended as candidates for retention in long-term memory (Anderson, 1990; Ormrod, 1990). Without this separation, neural processes can not pass the information into memory.

One can visually select and isolate specific material, or a specific point. Such a single instant of perception is the most visually efficient in extracting information. So, when viewing a larger area, the construct which requires the minimum number of instances of perception to view that area, is the most efficient for learning. That is, attention and perception contribute to seeing by sorting out what the retinal image presents by determining what is, and what is not, important at the moment. Those items which are attended to are those which are more likely to be remembered.

Seeing, however, is not all optical in nature. Seeing is a psychological response to basic forms. Kanizsa (1979) commented, "One need not "think"; it is enough to "look." In seeing a judgment is already implicit" (p. 14). This implies that even in selecting what we want to look at, some determinations of what we will see have already been made. These determinations are based not only on what we choose to see, but on what the mind sorts out, the attentive process itself.

Still, as attention must be directed at something, there must be some preattentive processing prior to attention. These preattentive processes are considered to be those which occur early, are automatic, fast, and include texture segregation and grouping, as processing prerequisite to object identification (Mack, Tang, Tuma, Kahn, & Rock, 1992). The attentive and preattentive processes were the focus of recent experiments conducted by Mack et al.

In the experiments by Mack et al., students and colleagues viewed computer controlled displays with which, when briefly shown cross arrays of vertical and horizontal lines, they were to determine which of the arms of the cross were the longest. The cross arrays viewed were embedded in homogeneous texture patterns. As the trial began, a small fixation mark was shown at the center of the computer screen for 1496 ms., followed by a cross array for 200 ms. Participants were then given a forced-choice response as to which of the cross arrays, vertical or horizontal, was the longest. In this manner the participants attention was directed to the fixation mark and the vertical and horizontal cross arrays. This procedure was followed for three cross arrays. However, after the third cross array, the participants were also asked about the surrounding pattern.

Considering the processes of preattention, it would be expected that participants in the Mack et al. experiments would be able to identify the texture patterns surrounding the cross array as a preattentive function. However, "The single most significant outcome of these experiments (was) that there (was) no perception of either texture segregation or Gestalt grouping under conditions of inattention" (Mack et al., p. 498). That is, based on an ongoing pattern, participants seemingly bypassed part of the preattentive processes and attended directly to that which they anticipated would be expected.

Such a non-attentive process, however, would agree with the associationistic/hierarchical view of memory. In viewing the first array, the hierarchical structure of long-term memory would be searched, and the forced-choice response would be activated to working memory for a response. In the second array, the response means was already in working memory. As the response queries to the first and second arrays were the same, an implied pattern, a determination of what to attend to, that is, what to "see" first in the next array was already made. As such, preattentive processing was made, just at a different psychological level.

The visual sensory system, then, is a stimulus-driven process where information is received into memory from the optic array. As the physiology of the visual system is built into the human body, it cannot be changed by learning (Gagne, Briggs & Wagner, 1992). The seeing process is completed only when the viewer has cognitively encoded a full scene description of visible bodies, and the sizes, shapes, spatial relationships, motions, colors and markings of those bodies (Bruce & Green, 1990). Only when the viewer has an understanding of the relationships of objects in three-dimensional space is the visual cognitive process entirely successful (Watt, 1988).

To this end, as there are explicit verbal representations which facilitate encoding, there are also visual presentations which are more easily perceived by the sensory system. Some of these presentations are explained by Gestalt psychology.

Gestalt Principles

Gestalt theorists placed emphasis upon experience rather than data, on a world of objects not a world of sensations. Gestalt theory is correctly described as seeing "the properties of the whole (as not being) the result of a summation of those of the parts" (Kanizsa, 1979).

> "Gestalt psychologists had the singular insight that the ordinary and omnipresent segregation of the visual field into units or objects was not a logical consequence of the retinal stimulation. They understood that this was an achievement of the visual system and must be the consequence of processes which intervened between the registration of stimulation and perception" "The prevailing view today has much in common with the earlier Gestalt conception. Currently it also is believed that organization occurs earlier in the processing sequence, prior to the stage at

> which attention enters the process." These, "preattentive processes are identified as those which occur early, are automatic, fast, operate in parallel across the visual field, and underlie the perception of features which "pop-out," "are considered to be those basic to perception," and, "set up the potential candidates for subsequent attentional processing" (Mack, Tuma, & Kahn, 1992, pps. 475 - 476).

From a Gestalt viewpoint, vision is based on perceptions, organizational laws, which are innate to memory (Bower & Hilgard, 1981). These organizational laws are important in this study as they effect how maps are seen, and how information perceived from maps can be most efficiently encoded and recalled. That is, if maps are constructed in a manner that incorporates these organizational laws, attention can be directed or assisted, the number of instances of perception can be minimized, and learning efficiency improved.

Candidates for such organization, that is "good gestalts," are figures which are regular, simple, and stable. The term "pragnanz," which translates from German as "compact and significant," is the term given to such visual representations. Such representations reach the best balance possible in a given situation.

One instance is the figure-ground relationship (Bruce & Green, (1990). This relationship applies when viewing maps and is the visual tendency to distinguish between the figure in a field of view and the ground against with which it is seen. So, even when attending to a particular point of interest, a decision is made as to which is figure and which is ground. If there is ambiguity as to which is which, the map representation may be organized in memory one way one time, and another way the next time.

The law of proximity (Bruce & Green, 1990) suggests that those things that are close together in a scene will be visually grouped together. The closer the objects, the more likely they will be perceived as part of the same group (Bower & Hilgard, 1981). Also, features that are similar in shape, color, texture, etc., tend to be visually grouped together unless overridden by proximity factors (Bruce & Green, 1990). Learners who view maps that display parts in proximity, or which are similar, may well remember those parts as belonging to a group, or relate one part to another in recall. This certainly agrees with the notion that memory is hierarchical in structure, and that similar features, when encoded, are stored in proximity to each other (Anderson, 1990).

Good continuation, or common direction, is a visual organization which tends to preserve smooth continuity rather than yielding to abrupt changes (Bruce & Green, 1990). Similarly, the mind seeks organizations in which there are meaningful wholes. When there is minimal information, the mind seeks out possibilities and visually closes areas or completes incomplete figures (Bower & Hilgard, 1981; Biederman, Hilton & Hummel, 1991). A map can be organized to lead learners from one point to another by directing their visual tendencies.

The mind follows a law of simplicity, in that other things being equal, that which is viewed will be organized into simple, regular figures (Bower & Hilgard. 1981). In such organization, those things which appear to be moving together will be visually grouped together in common fate (Bruce & Green, 1990). Symbols and representations on maps are spatial in their relationships to each other. Still, that which we see is somewhat beyond our control. The preattentive effect of Gestalt principles is a psychological response to basic forms. Although learners use a variety of strategies in viewing map symbols and determining spatial relationships, the placement of instances of perception, the most visually efficient means of extracting information, is certainly influenced by the regularity, simplicity, and stability of that which is being viewed. When the number or distribution of representations on a map are such that preattention and attention cannot efficiently organize the material, drawing comparable information from long-term memory is hindered, and it is more difficult to tie the new material to that which already exists.

Based on research, there are visual organizations that will facilitate the preattentive effect. The most easy of these organizational pattems to represent, are vertical and horizontal orientations (Tversky, 1981). These orientations are quite simple and familiar, so preattention and attention has less mental cost (Bertin, 1983). Further, as these are familiar patterns, these orientations are easier to process and encode as examples are readily available in memory for activation to working memory. This allows for more meaningful encoding.

Further preference for line orientation was demonstrated in a Tversky (1981) experiment on alignment. In the experiment, Tversky evaluated sketches of Palo Alto, California, as made by forty-five students at a major west coast university. The direction of the major thoroughfare of the city, El Camino Real, is 45-50° relative to east-west, yet participants invariably drew this major artery right to left in concert with the frame of the paper. Moreover all participants drew a major 60° intersection as a 90° intersection, and thirty-five of the participants sketched a 115° intersection as a 90° intersection. In a related version of this task, one-hundred-two participants were given a sheet of paper showing the major thoroughfare and were asked to draw lines indicating eight major streets relative to the direction of the thoroughfare. Participants drew the streets which were 60° and 115° intersections to the thoroughfare at angles whose median response was 90°. Such recall by participants certainly demonstrates an affinity for vertical and horizontal orientation.

Imbedded within the discussion of orientations, Tversky (1981) touched on other characteristics of spatial organizations in mapping: that there is superior visual acuity for displays that are either vertical or horizontal; that there are levels of hierarchical grouping within spatial organization; that there is a visual concept of wholeness for a structure; that one feature can act as a visual anchor for a larger spatial area. Each of these concepts are compatible with findings of others (Watt, 1988; Eastman, 1985; Bertin, 1983; Thorndyke & Stasz, 1980). That is to say, that not only when items are vertical or horizontal in orientation, but when similar items are in some way segregated, or are noted to be part of a group relationship, they are also more susceptible to preattention.

Thorndyke and Stasz (1980) further noted that single items on a map, like a major road or a river, can be oriented by relating it to the particular spatial patterns in which it is a part. For example, a learner might note that the river is vertical between the road and the left hand edge of the map. Such preattention leads to activation. This notion agrees with Bertin's (1983) assessment that the arrangement of the components attended in an instance of perception affects encoding, and that in differentiation the eye naturally moves to the construction in which it risks the least confusion.

McNamara (1986) agreed with these organizational observations and further expanded the principle to suggest that learners encode spatial relationships not as just small bits but as complete scenes, that is in groups or chunks. Bower and Hilgard (1981) pointed out that such groups of information tend to behave as all-or-none units in recall.

Eastman (1985) agreed with the chunk concept but called such organization and visual relationships clusters. Eastman's (1985) investigation of memory retention of map features compliments Tversky (1981) and indicated that data is retained as hierarchical regionalized groups. Eastman (1985) used five maps, each depicting the same location and names for twenty-four fictitious cities. The importance of the cities was distinguished on different maps by either the identification of major and minor cities, by the addition of county boundaries and color; by road connections; or by classification of both cities and roads into major and minor types. Fifty volunteer geography students from within the geography department of a major university were randomly assigned to five groups, each group then being exposed to one of the five experimental maps.

Participants examined their map for two minutes, completed a thirty second mathematical task to help erase the contents of the working memory, and were tested for recall of both the names of the cities by making a sequential list, and for the location of each city by positioning it on a free recall drawing. The process was repeated until all twenty-four cities could be recalled and located. After complete city recall and city positioning was completed, separated by direction tests, subjects were required to list the city names two further times. Learning efficiency was determined by the number of two minute exposures required to learn all the cities, and by the accuracy of the relative positioning of the cities on the map subjects reproduced from memory. For each participant a similarity matrix was constructed for the recall lists.

From these data, Eastman determined that there was a high similarity of recall lists, a similarity which would be expected if the participants learned by clustering or partitioning city names. Eastman found that participants organized groups of smaller clusters into a hierarchy of larger groups. And, in contrast to participants viewing maps without county boundaries and road connections, participants viewing maps with county boundaries and road connections tended to follow the clustering suggested by the regional inclusion.

Some research points to organizational groups other than just the Gestalt perceptions of pragnanz. One such organization, one which seems to strongly affect grouping, is common region. In the principal of common region, as suggested by Palmer (1992), "...elements will be perceived as grouped together if they are located within a common region of space, i. e., if they lie within a connected, homogeneously colored or textured region or within an enclosed contour" (p. 438). This principal, with "all else being equal," often overcomes the Gestalt principles of proximity, similarity, and closure. For instance, when viewed, a series of equally spaced dots seem to pair off in groups. Any two adjacent dots can be seen as a group. However, if same size circles are drawn around pairs of dots, then, visually, the dots are limited to that grouping by common region.

Common region is not preattentive, but occurs in the visual process after depth perception has taken place (Palmer, 1992). Common region is a different kind of grouping from that which is usually considered a Gestalt principle. Common region is an extrinsic grouping effect, most others are intrinsic. "That is, grouping by common region requires reference to something other than the elements that are grouped - namely, their "belonging" to a region - whereas classical groupings factors work just on the intrinsic relations among the elements themselves" (Palmer, 1992, p. 446). Common region, then, might be considered a special kind of chunk (McNamara, 1986), or cluster (Eastman, 1985).

Observations such as these give credence to the notion that some spatial organizations are more mentally efficient for encoding, transfer, and recall from long-term memory than are others. Such organizations include those which are vertical and horizontal; those which are chunked; and those which are framed in some manner. These findings certainly agree with the Gestalt principles.

Pilot Study

Further credence of the effects of spatial organization is reflected in a pilot study (Foreman, 1994). Participants were forty-five undergraduates enrolled in the education program at a major southwestern university. The study concerned map designs using spatial relationships agreeing with Gestalt principles, and the recall of geographic features.

The pilot study used maps of Africa; a pretest; iconic and schematic intervention maps; and, a post test. The pretest had two parts: (1) each participant, on an iconic outline map, was instructed to draw in as many geographic features as they could; then, (2) each participant, on a duplicate iconic map, was instructed to draw in as many geographic features as they could from a side list of twenty geographic place-names. As an intervention, participants were randomly assigned to study either an iconic map, or a schematic map stimulus, both of which showed the geographic locations of, and named the locations for the twenty places on the side list on the pretest map. After viewing the interventions, to break concentration, participants worked math problems for five minutes. The posttest repeated the same format as the pretest, except that participants were also given a map which showed both the side list of twenty geographic place-names and all of the twenty geographic locations. Again, participants were to identify the locations from the side list.

Pretest and posttest maps were graded on a forty point system, two points for each correct answer, no penalty for incorrect answers. Of major interest was a comparison of the posttest scores of those participants who studied the schematic intervention map, against those participants who studied the iconic intervention map. The means were as follows: posttest outline map; schematic 27.25, iconic 23.73; posttest outline map with names, schematic 33.90, iconic 28.73; and, posttest outline map with names and features, schematic 36.82, iconic 32.87. In each case the posttest scores of those participants who studied the schematic intervention map were higher than those who studied the iconic intervention map. All such findings agree with the discussion of Gestalt principles, and with the associative and hierarchical views of memory and recall.

Overview of Planned Study

The implications of the pilot study precipitated an interest for further inquiry into schematic and iconic mapping. The design of the pilot study also laid a foundation from which further testing materials could be developed.

Many individuals in the United States find it difficult to effectively understand the information displayed on maps. Although there are differences in map learning performance (Thorndyke & Stasz, 1980; Vosniadou & Brewer, 1992; Philippe & Schwartz, 1989; Winn & Sutherland, 1989), it is the design of maps which often inhibits that which the cartographer believes they are communicating (Macey, Greenberg, Weismantel & Carmack, 1988). Maps are often designed with little thought for clarity (Carter, 1988); are cluttered (Pufall & Shaw, 1973); not user, age, or viewer specific (Ottosson, 1988); and are but poor reflections of the spatial relationships being represented. As such, these map designs hinder, rather than assist, a learner in remembering and recalling information. Often such designs are not in accord with what is known about cognitive and visual abilities, that is, memory and perception, when it comes to viewing maps (Peterson, 1987).

Memory is associationistic and hierarchical (Anderson, 1990; Ormrod, 1990). Therefore, that which is already in memory is the foundation for further association (Arnheim, 1969). That which is familiar, be it in long-term memory as perception-based representations, or meaning-based representations, has sufficient strength to be activated into working memory to effect meaningful processing of incoming sensory information (Anderson, 1990). Maps are often designed using combinations of verbal information, visual symbols, and spatial relationships. To interpret this information, viewers call upon that which is already encoded, and hierarchically stored in long-term memory.

Therefore, in the learning process, depending on what is available for activation from long-term memory, some incoming sensory information is more easily meaningfully processed than others. When we "see", for instance, perception, the means by which points of interest are cognitively selected from visual sensory information for further attention (Watt, 1988; Macheachren & Ganter, 1990), is reflective of that which we have already retained in long-term memory. That which is attended is a candidate for encoding and retention (Anderson, 1990; Ormrod, 1990), and that which is attended, and meaningfully processed, is encoded in long-term memory with strength sufficient for recall.

Attention must be directed at something. Therefore, there is a process whereby placement of attention is determined, a preattentive/non-attentive process (Mack, Tang, Tuma, Kahn & Rock, 1992). In this process there are some visual spatial representations which are more easily perceived than others. Such representations, as explained by Gestalt psychology, include those which are vertical and horizontal (Tversky, 1981); those which are chunked (Eastman, 1985; McNamara, 1986); and those which are framed in some manner (Thorndyke & Stasz; Palmer, 1992).

Therefore, whether encoding is perceptual based or meaning based, upon sensory input, information is activated from long-term memory to working memory for comparison, to be contrasted, sorted, and meaningfully processed. Information of sufficient strength is encoded and stored. As such, the cognitive abilities and ages of the viewers (Anderson, 1990; Ottosson, 1988): the symbols, expressions, and terms used by the cartographer (Ottosson, 1988); and the visual clarity of the spatial relationships (Kosslyn, Pick & Fariello, 1974; Tversky, 1981); need be taken into consideration for successful map design. Maps, if effectively designed, communicate to the viewer both explicit and implicit information in such a manner that the mapped information can be encoded in long-term memory, and efficiently recalled for viewer use.

Tversky (1981) suggested that other than iconic map designs might be more efficient, and noted that a schematic format for some maps might be more appropriate for learning. After considering the cognitive and visual aspects of both iconic map design and schematic map design, it was determined to use a schematic map format.

In the results of the pilot, there was an indication of higher recall of geographic features by participants who studied a map designed with spatial relationships agreeing with Gestalt principles, compared to those who studied an iconic map. However, in the pilot, little comparison was made of participants' progress, if any, from pretest through posttest, to determine if the higher means for those who viewed the schematic map intervention was reflective of more learning. In the pilot, in both the pretest and posttest, participants were required to view and respond to several different maps. This seemed to confuse the issues at hand. Therefore, it was determined that in future study designs, to facilitate ease of comparison, the same identical map would be used for both pretest and posttest.

Also, in the pilot, there was no method to determine what results would be reflected after a delay of time. It was determined, therefore, that a delayed test, one following the same format as the pretest and posttest, would be part of a future design, and that the same pretest-posttest map would be used in the delayed test.

Africa was used as the map of choice in the pilot study as it was judged that prior knowledge of that continent would be low across participants. A low mean score on the pilot pretest outline map without names, 0.69 out of forty, verified this judgment. It was determined, therefore, that a map of Africa would be used in further study designs as, if this same degree of knowledge held for others, prior knowledge would not interfere with the results.

It was also noted in the pilot that when participants had access to place-names as a foundation from which to make choices, their scores were higher, and, when participants had geographic features to which they could attach place-names, their scores were higher. The authors' interest is in the effect, if any, of iconic or schematic intervention maps. As the design of further studies is to be centered around intervention maps, not participants knowledge of names or ability to draw in geographic locations, it was determined to maintain a level field on the pretest, posttest, and delay test map by giving participants names from which choices could be made, and by having geographic features already drawn on the map.

Further, in the pilot study there were twenty place-names as cues, and twenty geographic places to be identified. This availed those who might guess at answers by having a corresponding number of names, and the number of places. Therefore, to discourage such guessing, it was determined that in future designs, there would be more place-names than geographic places to name.

Both of these decisions were also based on practical geographic application. That is, when an individual is trying to locate a place on a map, they usually have a name in hand, and are usually looking at a map with geographic features. It was determined that similar circumstances in a study would simulate practical application.

Although there was little apparent preknowledge of the geography of Africa by the students in the pilot study, by the time they reach college most have had some contact with formal geographic instruction. It was determined that the participants in any further study would be from a group of younger students, preferably young enough that they would not as yet have had formal geographic instruction. It was recognized, however, that any participants should be old enough to cognitively understand the spatial relationships designed in the study (Anderson, 1990). In the area where the study was conducted, geography becomes a curricular requirement in the 6th grade. Therefore, it was determined that students in the 10 - 12 age group, that is 5th grade classes, be requested to participate.

Purpose of the Study

It seems from the above that maps which stress the spatial relationships that are more easily perceived, should be more easily remembered and recalled. Therefore, in the learning from maps, if both verbal cues are given, and the spatial relationships on the maps are more easily perceived, the duality of the verbal and spatial relationships should facilitate strength of encoding, and increase activation and recall. Such a notion does agree with Anderson's (1990) two-concept theory for memory and recall.

Therefore, the purpose of the proposed study was to examine how the learning of geographic information is affected by the organization of the information on a map. Specifically, I compared differences in recall performance for participants who studied a typical iconic map of an area, and participants who studied a schematic map of the same area. Further, within these groups, I compared the performance for participants who studied iconic or schematic maps designed to emphasize chunks or clusters.

Chapter 2

Method

This chapter describes the methods used in this study. The chapter is in four sections. First the participants are described. Then the design of the study is discussed, and the materials used in the study are outlined. The hypotheses and analysis of data are considered, and finally the procedures used in the study are presented.

Participants

Participants in this study were selected from students in fifth grade classes in a mid-size school district in a southwestern state. Approval for the study was received from the independent school district and five teachers in three different elementary schools volunteered their students as participants. Participants had parental permission, and each student agreed to take part in the study.

The participants had some prior knowledge of geography having had social studies in the classroom. However, in the area where the study was conducted, geography is not a curricular requirement until the sixth grade. Therefore, fifth grade students were chosen as they had not as yet had a formal geography class as part of the school district's curriculum. Still, such students were considered old enough to cognitively understand the spatial relationships designed in the study.

Design

The study was a four by three repeated measures design. The twenty responses in the pretest, posttest, and delayed posttest were each graded in the same manner: correct answers counted as one point, twenty points maximum; and, incorrect answers did not receive any points. There were three scores, pretest, posttest, and delayed posttest, for each participant. The efforts of each participant were tracked by matching numbers as preassigned to the pretests, posttests, and delayed posttests by the administrator.

The design was such that each participant was pretested, posttested, and delayed posttested with the same administrator generated iconic map of Africa. After the pretest, one of four intervention maps of Africa was randomly assigned to each participant. After viewing the intervention maps, to disrupt the learning process, each participant filled out a brief personal questionnaire. The posttest was then administered. Two weeks later, a delayed posttest was administered.

Map Interventions

Five basic maps of Africa were designed for the study, three iconic maps, and two schematic maps. One iconic outline map of Africa was used for the pretest, posttest, and delayed posttest. On this basic iconic outline map, only twenty selected items, major geographic features or major cities, were drawn. These selected features or cities were not identified, but beside each feature or city was a line on which a response could be written. At the bottom of the map, in alphabetical order, were a list of thirty names from which the participant could choose the correct name for each of the twenty unidentified features or cities. At the top of the map were directions to the participants (see Appendix, figure 2).

To pretest a participant's knowledge of African geography, each participant was given a basic iconic map and directed to select from the list of thirty names the correct names for the features or cities, and to write that name on the line provided next to the feature. After the pretest, participants were given intervention maps.

The intervention maps were developed as learning tools. There were four different intervention maps, two iconic, and two schematic. Each of the intervention maps correctly identified, by name, the geographic features and major cities requested of the participants on the basic iconic map, that is, the iconic pretest map.

The first intervention map was a copy of the basic iconic map. That is, a map with the same twenty selected features or cities. However, the names were not at the bottom of the page, nor were there lines for those names. Instead, the names for each selected feature or city were placed on the map to identify the feature or city. The participants who received this map intervention were directed to study and learn from it the names and locations of the selected geographic features in Africa (see Appendix, figure 3).

The second intervention map was the same as the first: an iconic map; twenty selected features or cities; no names at the bottom of the page or lines for those names; each feature or city correctly identified. In addition, however, two imaginary lines, 0° latitude (the equator), and 20° longitude, were drawn on the map. This latitude and longitude crossed Africa east/west (horizontally), and north/south (vertically), and divided the map into four sections. The participants who received this map intervention were directed to study and learn from it the names and locations of the selected geographic features in Africa (see Appendix, figure 4).

The third intervention map was a schematic representation of the basic iconic map, that is, the pretest map. This African map was the same size east/west (horizontally), and north/south (vertically), as the basic iconic map, but was a schematic design. That is, it was a schematic map with the same twenty selected features or cities. However, there were not names at the bottom of the page nor lines for those names. Instead, the names of each selected feature or city were placed to correctly identify the feature. The participants who received this map intervention were directed to study and learn from it the names and locations of the selected geographic features in Africa (see Appendix, figure 5).

The fourth intervention map was the same as the third: a schematic map; twenty selected features or cities; no names at the bottom of the page or lines for those names; each feature or city correctly identified. In addition, however, two imaginary lines, 0° latitude (the equator) and 20° longitude, were drawn on the map. This latitude and longitude crossed east/west (horizontally), and north/south (vertically), and divided the map into four sections. The participants who received this map intervention were directed to study and learn from it the names and locations of the selected geographic features in Africa (see Appendix, figure 6).

As schematic mapping might have been unfamiliar to the participants, a visual/verbal explanation was included as part of the schematic learning intervention. Two such transition sheets were designed to illustrate the difference in viewing that which the participants normally use, that is iconic maps, and viewing schematic maps. The verbal portion of the transition sheets only explained what was on the sheet, iconic to schematic mapping, and did not give advantage to the schematic viewers. One transition sheet accompanied each schematic intervention map.

On the first 8 1/2 inch by 11 inch transition sheet were three illustrations. To the left hand side of the sheet was an iconic outline map of Africa. In the center of the same sheet was an iconic outline map of Africa, overlayed by the outline of the schematic map of Africa. To the right side of the sheet was the outline of the schematic map of Africa. At the bottom of the page was an explanation that directed the participants to look first to their left at the Africa outline map; then look to the center at the iconic/schematic map; then to look to the right at the schematic map (see Appendix, figure 7). The directions explained to the participants that they were now to view a map where Africa was represented by the schematic map on their right. This transition sheet accompanied the third intervention.

On the second 8 1/2 inch by 11 inch transition sheet was three illustrations. To the left hand side of the sheet was an iconic outline map of Africa. In the center of the same sheet was an iconic outline map of Africa, overlayed by the outline of the schematic map of Africa. To the right side of the sheet was the outline of the schematic map of Africa. In addition, however, two imaginary lines, 0° latitude (the equator) and 20° longitude, were drawn on each of the three maps on the transition sheet. This latitude and longitude crossed east/west (horizontally), and north/south (vertically).

At the bottom of the page was an explanation that directed the participants to look first to their left at the Africa outline map; then look to the center at the iconic/schematic map; then to look to the right at the schematic map (see Appendix, figure 8). The directions explained to the participants that they were now to view a map where Africa was represented by the schematic map on their right. This transition sheet accompanied the fourth intervention.

After participants viewed the intervention maps they were requested to fill out a student questionnaire (see Appendix, figure 9). This questionnaire had two purposes: (1) it provided the administrator with basic biographical information about the participant, and, (2) it broke up any memory processes which participants might have used to remember names and locations of the twenty unidentified features.

The posttest map was identical to the pretest map (see Appendix). Further, the delayed posttest map two weeks later was likewise identical to the pretest map (see Appendix).

Such a design allowed the administrator to determine the participants prior knowledge of African geography, to have the participants learn information from four different interventions, and to compare short term and long term recall of the selected African geographic features by intervention types.

Materials

The problem which generated an interest in spatial relationships on maps came from iconic maps in a real world situation. As such, for this study, it was determined that an iconic map of an existing geographic area be used as a base for the study, not a map of a fictitious environment, or an artificial map. It was determined that for convenience, and to give a definitive outline to that which was mapped, a continent would be used. A continent was simple and there was no visual ambiguity as to where the mapped area ended.

The maps used in this study were administrator-generated using computer drawing programs. The outline of the continent and the content of the iconic maps were drawn as accurately as possible. The location of features on the schematic map were as accurate as a schematic drawing permits. All of the maps were single sided, on 8 1/2 inch by 11 inch pages of paper. There was no color on any of the maps. All maps, iconic and schematic, were placed in the same positions relative to the page. The same font and type size were used on all maps for participant instructions, and for all geographic features. Location of place-names relative to each geographic feature were consistent on all the iconic and schematic study maps. That is, if the name of a river was placed north of a river on the iconic study map, the name, in the same type size and font, was placed north of the same river on the schematic study map.

The African continent was chosen for this study. In a previous study (Hsu, Lackey, and Foreman, 1993) it was determined that the closer an individual lives to a commonly-known geographic feature, the more likely he/she will be to know the name of that feature. Although the current study dealt with fifth grade children, it was thought necessary to avoid the possibility of any previous personal experience. As such, prior to selecting a continent and Africa, the United States was ruled out for the study.

Those items selected for representation on the African map were taken from among many possible regional and national geographic features and cities. Selection was made based on the importance of the feature, and in a manner which attempted to avoid visual clutter. The equator was selected as the east/west dividing line of the continent. The equator seemed the most logical line to assist students to relate the position of Africa to the other continents of the world.

As noted, the study consisted of a pretest, four interventions, a posttest, and a delayed posttest.

Hypothesis and Analysis

There were three scores for each participant, the pretest score, the posttest score, and delayed posttest score. There was a possible score of 100 points for each test, for each participant. Scores were compiled in three ways. First, the pretest scores, posttest scores, and delayed posttest scores were each compiled separately. Secondly, the pretest, posttest, and delayed posttest scores were divided as resulting from either iconic or schematic interventions. Scores were then divided as to whether the participants learned from the iconic and schematic interventions with longitudes and latitudes, or from the iconic and schematic interventions without longitudes and latitudes. From these scores, there were certain expectations for the results of the study. Based on theory and previous research, several hypotheses were made.

Hypothesis 1

Participants posttest scores, without concern for intervention type, will be significantly higher than the participants pretest scores. Part of the design was to find a geographic area of which there was little prior knowledge. If the design meets expectations, and pretest scores indicate little prior knowledge, then any learning from the interventions should increase scores significantly.

Hypothesis 2

Posttest scores of participants who learned from the two schematic interventions will be significantly higher than the posttest scores of the participants who learned from the two iconic interventions. This will hold true, if, as anticipated, the schematic interventions facilitates encoding and recall.

Hypothesis 3

Participants delayed posttest scores, without concern for the type of intervention, will be significantly higher than the participants pretest scores, but lower than the posttest scores. Although there was a cognitive break between the learning interventions and the posttest to disrupt memory, that which was encoded in long-term memory was more readily available for activation and recall after a short period of time, the posttest, than a longer period of time, the delayed posttest. Still, as there was little prior knowledge, activation at any point should recall more information than was previously available.

Hypothesis 4

Delayed posttest scores for participants who learned from the schematic interventions will be significantly higher than the delayed posttest scores of the participants who learned from the iconic interventions. Again, this will hold true, if, as anticipated, the design of the schematic interventions facilitates encoding and recall.

Hypothesis 5

The correct responses of the participants who learned from the iconic and schematic interventions with longitudes and latitudes will be more clustered in their relationships than those participants who did not learn from the iconic and schematic interventions with longitudes and latitudes. Both iconic and schematic interventions were designed showing one longitude and one latitude. Such horizontal and vertical lines will divide the maps into four sections. It is anticipated that such divisions will encourage clustering of materials to be learned.

As the study used four interventions, that is, four methods for teaching information on maps, repeated measures analysis of variance was used to evaluate the first four hypotheses. Hypothesis five was evaluated through an analysis of frequencies.

If these hypotheses are correct, there will be an indication, at least for the participants in this study, that simplification of graphic materials, in this case maps, could have an influence on encoding, and on short term and long term recall of information.

Procedure

The design of the study, and of the study materials, allows for simplicity in administration. For the participant, written instructions accompanied each step of the study. The administrator voiced very few additional instructions.

Each participant received parental/guardian consent to participate in the study. Further, after introduction of the administrator, as the first step in the procedure, each participant signed a consent form. Pretests, posttests, and delayed posttests were numbered as sets to match the student consent form and the questionnaire. This assured participant identity and continuity of the study components. Study sets were marked as to which intervention the participant received. The study sets were then randomly ordered prior to being distributed to the participants.

Participants were requested to do their own work prior to passing out the pretest. The pretest to determine participants knowledge of African geography were handed out by the administrator. One pretest, that is, the basic iconic map (see Appendix), was placed face down in front of each participant. Participants were asked to turn over the pretest and follow the instructions. The administrator read the instructions out loud as the participants followed. After participants were given time to complete the pretests, they were gathered by the administrator.

As the administrator gathered the pretests, an intervention matching that random ordered study set was placed face down in front of each participant. The participants had seven minutes to study and learn the interventions. The administrator announced this time limit when the participants, as one, were asked to turn the interventions over to begin. As the interventions were different because of the transition sheets, the administrator did not read the instructions but permitted the participants to read and follow accordingly. After seven minutes the participants were asked to turn their interventions face down. The administrator collected the interventions and gave each participant a student questionnaire to be completed.

After participants were given time to complete the questionnaire, they were gathered by the administrator. The posttests which matched numbers with the participants pretest and questionnaire were then handed out, face down, by the administrator. As one, participants turned over the posttest and began. After participants were given time to complete the posttest, they were gathered by the administrator.

After a two week delay, the administrator returned to do the delayed posttest. Delayed posttests which matched numbers with the participants pretest, questionnaire, and posttest, were matched to participants using the numbers on the student questionnaires. Again, this assured continuity for grading, matched each participant to the correct intervention type, and provided security for each individual.

Chapter 3

Results

The purpose of this study is to examine how the learning of geographic information is affected by the organization of the information presented on a map. The study is designed to determine what the participants knew about a mapped area, use different visual presentations to teach about the mapped area, then determine any different levels of learning. More specifically, the study compared the differences in the results in recall performance for participants who studied an iconic map of an area, and those who studied a schematic map designed to emphasize the spatial relationships of that same area. This chapter describes the results of this study. The chapter has three sections. First, the participants are discussed. Then, the design of the study is briefly outlined. Finally, the results are discussed and compared to each hypothesis.

Participants

A total of 67 participants took part in the study, 27 females and 40 males. The participants were divided into four groups. In group 1 there were 19 participants, 12 female and 7 male. In group 2 there were 11 participants, 4 female and 7 male. In group 3 there were 18 participants, 6 female and 12 male. In group 4 there were 19 participants , 5 female and 14 male.

Each group was assigned to one of the four intervention maps: group 1 to map 1; group 2 to map 2; group 3 to map 3; and, group 4 to map 4. Map 1 and map 2 were both iconic maps, and map 3 and map 4 were both schematic maps. As hypothesis 2 and hypothesis 4 concern the relationship between the iconic maps (map 1 and map 2) and the schematic maps (map 3 and map 4), the number of participants and the data from group 1 and group 2 were combined as an iconic maps group, and the number of participants and the data from group 3 and group 4 were combined as a schematic maps group.

Except for group 2, the numbers of participants in the groups were nearly equally. Since there were fewer participants in group 2, the number of participants for the combined group in which group 2 was included was also affected. As such the iconic map group had 30 participants (16 female and 14 male), while the schematic map blended had 37 participants (11 female and 26 male).

The Design

The study was a 4 by 3 repeated measures design. Participants were pretest, posttest, and delayed posttest with the same iconic map. Four intervention maps were randomly ordered and distributed among participants. Participants were to respond to twenty items on each of the testing maps. The responses on the pretest, posttest, and delayed posttest maps were graded in the same manner: a correct answer counted as one point, and an incorrect answer did not receive any points. As such, there were three scores for each of the participants, a pretest score, a posttest score, and a delayed posttest score (Appendix, figure 10, figure 11, figure 12, figure 13).

Main Results

The means and Standard Deviations for the full design are shown in Table 1. A repeated measures ANOVA was used to determine whether there was a main effect for map treatment group, across all the four map groups, a main effect for tests over time (i.e., pretest, posttest, delay posttest), and an interaction of map treatment and tests over time. The analysis showed that there was no effect for treatment effect, $F(3, 63) = 1.50$, $p. = .224$. A significant main effect of tests over time was found, $F(2, 126) = 258.84$, $p. = <.0001$. Finally, the analysis showed no interaction of map treatment and test over time, approximate $F(6, 126) = .43$, $p. = .85$. In the remainder of this section I will present the analyses that addressed each of the five hypothesis.

Hypothesis 1

Results support hypothesis 1 that participants' posttest scores, without concern for intervention type, whether map 1, map 2, map 3, or map 4, will be significantly higher than the participants' pretest scores. A statistically significant difference was found for the mean of combined posttest scores collapsed across groups compared to the mean of combined pretest scores collapsed across groups, $t\ (66) = 18.581$, $p < .05$. As can be seen from Table 1, the posttest scores were considerably higher than the pretest scores.

Based on the mean pretest score, results indicate that prior to learning from the different intervention maps, participants were able to correctly identify only 6 percent (mean 1.209) of the twenty selected geographic locations in the mapped area. Such a low mean is indicative that the participants had low prior knowledge of the mapped area. However, after studying the iconic and schematic interventions, the combined posttest score results indicate that participants were able to correctly identify almost 64 percent (mean 12.761) of the twenty selected geographic locations.

Hypothesis 2 and Hypothesis 4

The results do not support either hypothesis 2 or hypothesis 4 that posttest scores of participants who learn from the two schematic map interventions will be significantly higher than the posttest scores of the participants who learn from the two iconic interventions. The pretest, posttest, and delayed posttest data of the iconic maps combined group, and the pretest, posttest, and delayed posttest data of the schematic maps combined group were compared using a repeated measures ANOVA. In addition to there being no main effect for the map treatment (2 groups), $F\ (1, 65) = 1.88$, $p. = .816$, there was also no interaction of map treatment and tests over time, $F\ (2, 130) = .07$, $p. = .93$. This absence of an interaction shows that the two groups did not differ on the tests over the three different times.

Table 1

Means and Standard Deviations for Group 1, Group 2, Group 3, Group 4 as a Function of Pretest, Posttest, and Delayed Posttest

	Pretest		Posttest		Delayed Posttest	
Group 1 (Iconic)	Mean	1.368	Mean	13.842	Mean	10.842
	SD	1.300	SD	4.413	SD	4.682
Group 2 (Iconic)	Mean	0.364	Mean	10.455	Mean	7.727
	SD	0.674	SD	5.958	SD	5.179
Group 3 (Schematic)	Mean	1.444	Mean	13.222	Mean	9.667
	SD	1.580	SD	4.930	SD	5.190
Group 4 (Schematic)	Mean	1.316	Mean	12.579	Mean	9.474
	SD	1.529	SD	4.574	SD	4.742

Table 2

Means and Standard Deviations for Iconic Maps Group 1 and Group 2, and for Schematic Maps Group 3 and Group 4 as a Function of Pretest, Posttest, and Delayed Posttest

	Pretest		Posttest		Delayed Posttest	
Iconic						
	Mean	1.000	Mean	12.600	Mean	9.700
	SD	1.203	SD	5.203	SD	5.018
Schematic						
	Mean	1.378	Mean	12.892	Mean	9.568
	SD	1.534	SD	4.695	SD	4.896

Hypothesis 3

The data supports hypothesis 3 that participants delayed posttest scores, without concern for the type of intervention, will be significantly higher than the participants pretest scores, but significantly lower than the posttest scores. A statistically significant difference was found for the mean of the combined delayed posttest scores collapsed across treatments, compared to the mean of the combined pretest scores collapsed across treatments, $t\ (66) = 13.485$, $p. < .05$. Also, a statistically significant difference was found for the mean of the combined posttest scores collapsed across treatments, compared to the mean of the combined delayed posttest scores collapsed across treatments, $t\ (66) = 3.691$, $p < .05$. As can be seen from Table 1, the posttest scores were considerably higher than the pretest scores, and the delayed posttest scores were higher than the pretest scores, but lower than the posttest scores.

As there was a two week break between testing, there was some forgetting by the time the participants were ask to complete the delayed posttest of the mapped area. Based on the combined mean delayed posttest scores results indicate that after the two week delay participants could identify 48 percent (mean 9.627) of the selected locations. That is, the participants' posttest scores tested significantly higher shortly after viewing the interventions compared to the scores for the delayed posttest scores two weeks later. As such, the data supports the hypothesis in that the delayed posttest scores are significantly higher than pretest scores, and posttest scores are significantly higher than delayed posttest scores.

Hypothesis 5

The pattern of correct answers as distributed among the Northwest (NW), Northeast (NE), Southwest (SW), and Southeast (SE) quadrants of the interventions maps does not support hypothesis 5 that the correct responses of the participants who learned from the iconic and schematic interventions with longitudes and latitudes will be more clustered in their relationships than those participants who did not learn from the iconic and schematic interventions with longitudes and latitudes.

Visual observation of the numbers of correct answers in the quadrant areas delineated by the longitude and latitude drawn on map 2 and on map 4 were used to determine clustering. First, each of the twenty geographic features were identified by how many of the 67 participants got that feature correct. This was done for pretest (range 17), posttest (range 36), and delayed posttest (range 45) (Appendix, figure 14). The geographic features were then divided by directions into four areas: NW, NE, SW, and SE (Appendix, figure 15). The numbers correct for map 1, an iconic map, and map 3, a schematic map, were combined, and the numbers correct for map 2, an iconic map, and map 4, a schematic map, were combined. Correct answers were determined by maps and quadrants. With the exception of one quadrant, the SW, the average number of correct answers for the iconic map group 1 and the schematic map group 3, those maps without longitudes and latitudes, were higher than the average number of correct answers for the iconic map group 2 and the schematic map group 4, those maps with longitudes and latitudes (Appendix, figure 16).

Although some geographic features were more easily identified by the participants than others. The longitudes and latitudes on the maps, whether an iconic map or a schematic map, did not visually aid the participants in clustering and correctly identifying geographic features.

Comments

The results of this study support two of the five proposed hypotheses. Because there was no significant difference between the iconic map test scores and the schematic map test scores, one might expect that it would make no difference for learners of this age group as to whether they are taught using iconic or schematic maps. Further, the results do not support the idea that the use of vertical and horizontal lines assist visual clustering.

However, the results do support the notion that if participants learn hitherto unknown geographic features, their immediate knowledge will significantly increase, but that such learning will decrease after a period of time.

Chapter 4

Discussion

The hypotheses for the study concern three areas: the comparison of scores between iconic interventions and schematic interventions, that is, visual differences; the encoding and recall of the names of geographic features over time; and, the clustering of geographic features in encoding for recall. These areas are discussed in view of the study results.

Iconic and Schematic Maps

One of the more important and disappointing findings is that the data did not support a significant variable between the scores of the participants learning from the schematic maps and the scores of the participants learning from the iconic maps, hypothesis 2 and hypothesis 4. However these results should not be attributed to lack of geographic ability on the part of the participants. One might say that without instructing participants how to encode information using schematic forms of intervention, the results of the study are not unexpected. Indeed, part of the failure to find any significance may be accounted for by the design of the study. By design, however, minimal verbal instruction or exposure to schematic form was given to the participants.

The study interventions required participants to visually recognize either iconic or schematic forms and affix names to points of predetermine spatial relationships. That is they had to read a map. Participants who viewed the schematic map interventions, group 3 and group 4, were expected to encode new information without receiving instructions how to do so. These participants had to recognize spatial relationships, learn from the schematic maps, and transfer the information back to an iconic map. That is, they were confronted "cold turkey" with a new mapping process and were still expected to learn.

The most recent approximation of schematic maps available in memory as reference was the iconic map just viewed in the pretesting process. Participants viewing the schematic maps may have reverted to encoding using the iconic map form. That is, when viewing the schematic maps, the new information was not held in memory as a schematic form, a form that was unfamiliar, but was encoded from the schematic form back to an iconic form. This would have made the encoding process for the schematic maps more difficult rather than simplifying the visual process as was expected.

On the other hand, any participants with prior knowledge of schematic form would have approximations of schematic forms in memory. Had the administrator given extensive verbal instructions about schematic forms, perhaps given some practice using the new mapping format, knowledge of schematic form would have been encoded and accessible in memory. As such, participants viewing the schematic intervention maps could have incorporated the new information to that form and the results of the study may have been different.

Had verbal instruction been given, or practice allowed, any significant difference between learning from iconic interventions or schematic interventions might then be attributed to those instructions rather than to the visual and cognitive encoding of the intervention differences. As the administrator did not give instructions, and there was no significant difference between iconic and schematic interventions, further testing can be done with at least some assurance that participants learned equally well from iconic interventions and from schematic interventions.

Results indicate that when simpler schematic forms are viewed, there is not a visual default to the simple schematic form as being superior to one iconic. It was expected that the more complex iconic maps could be schematically drawn using simplified representations and symbols and that these simplified representations would be mentally and visually easier for the participants to cognitively encode, remember, and recall. Although a new form may be simple, it must be supported by some prior knowledge. The data did not support the idea that schematic simplicity had visual and cognitive advantages. On the other hand, the data did not support the idea that iconic mapping was superior to schematic mapping.

Geographic Features

The reason for discussing the geographic features is to point out that these findings reinforce the notion supported by hypothesis 2 and hypothesis

4 that neither the iconic map intervention nor the schematic map intervention had an advantage for encoding and recall.

Although there was little knowledge of Africa prior to the interventions, a lack of knowledge did not interfere with the expected learning pattern. Those participants who viewed the iconic interventions and those who viewed the schematic interventions both learned equally well over time.

The data when testing for differences in learning the names and locations of geographic features over time supported hypothesis 1 and hypothesis 3. That is, immediately after learning from the four interventions, recall of spatial relationships and correct identification of geographic locations was significantly higher when compared to pretest and posttest. Further, the delayed posttest was significantly higher than the pretest.

Hypothesis 5 anticipated that clusters of geographic features in the quadrants would be easier for the participants to encode and recall. The vertical and horizontal lines on map 2 and map 4, nor their anticipated use, was explained to the participants. Although some features were more often identified correctly than others, the visual presence of lines did not favor the iconic or schematic interventions.

Participants

The ages and curricular status of the participants will briefly be discussed to affirm that the study results were not unduly influenced by unusual factors associated with the participants.

The 5th grade was chosen for the study as the curriculum of the host school district had yet to require a formal geography class of this grade level. As such the participants should not have been prejudiced by other geography class instruction concerning, however, by this age the students should have been taught some social studies skills.

Social studies would have exposed them to basic information about maps. This is important to the study in that the participants understood the concept that the iconic form was not just a picture but was related to a real place with a shape similar to the map. There was preknowledge of these basic skills and they did not have to be taught the participants prior to conducting the study. Without understanding the iconic map, it would have been very difficult for the participants to grasp even the idea of a schematic representation.

Manipulations in this study were somewhat dependent on the participants being able to understand the basic concepts of space and visual relationships. As such, those in the participating group should have been old enough to understand the concepts presented in the study. That is, those participating in the study should be in a concrete operational stage of development. The average age of the 67 participants was approximately 10 years 9 1/2 months (10.791).

Until tested, it is not known if the results of the study would have been different with another class level or age group. It is suggested, however, that this group had sufficient map knowledge and mental development to not conflict with the intent of the study.

Limitations of the Study

There are some limitations inherent within the data collected by this study. As the participants were primarily fifth graders in a mid-sized southwestern school district, it is understood that generalization to other groups is limited.

Visual examination of maps was necessary for participation in the study, however, as there was no color on the maps, color blindness was not a concern. There were those whose vision restricted participation, and the researcher excused anyone with visual restrictions.

The findings in the study are the result of participants examinations of information on maps and the transfer of that learned knowledge. There are possibilities that participants had some prior knowledge of the geographic information presented. Africa was selected for mapping to compensate for this possibility. Africa would generally be considered outside the area of familiarity for most elementary school participants in the United States. The researcher excluded data gathered from any participant known or declared to have personal knowledge of the area as a result of birth or residency.

Implications for Future Research

Maps assist us in understanding our position in relationship to the rest of the world. Maps provide a means by which we can determine our location, and our spatial relationship. There is value in being able to properly understand such relationships. Being able to read maps is an advantage in learning social, historic, and economic information. As such, if there are different ways of teaching students about maps, and how to use maps, these areas should be explored.

Above all, it seems, the results of this study indicate that there is more than one way for information on maps to be cognitively encoded, recalled, and transferred. This insight into iconic and schematic mapping might open a door for a classroom instructor to apply new methods of teaching maps to students.

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APPENDIX

Iconic and Schematic Maps of Africa

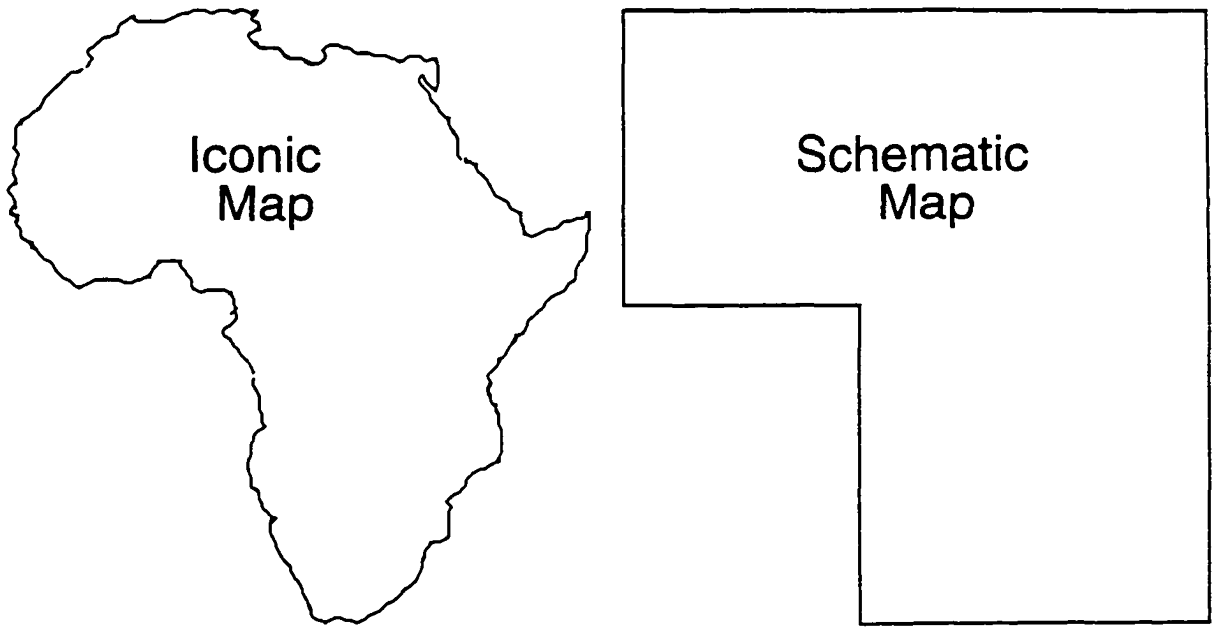
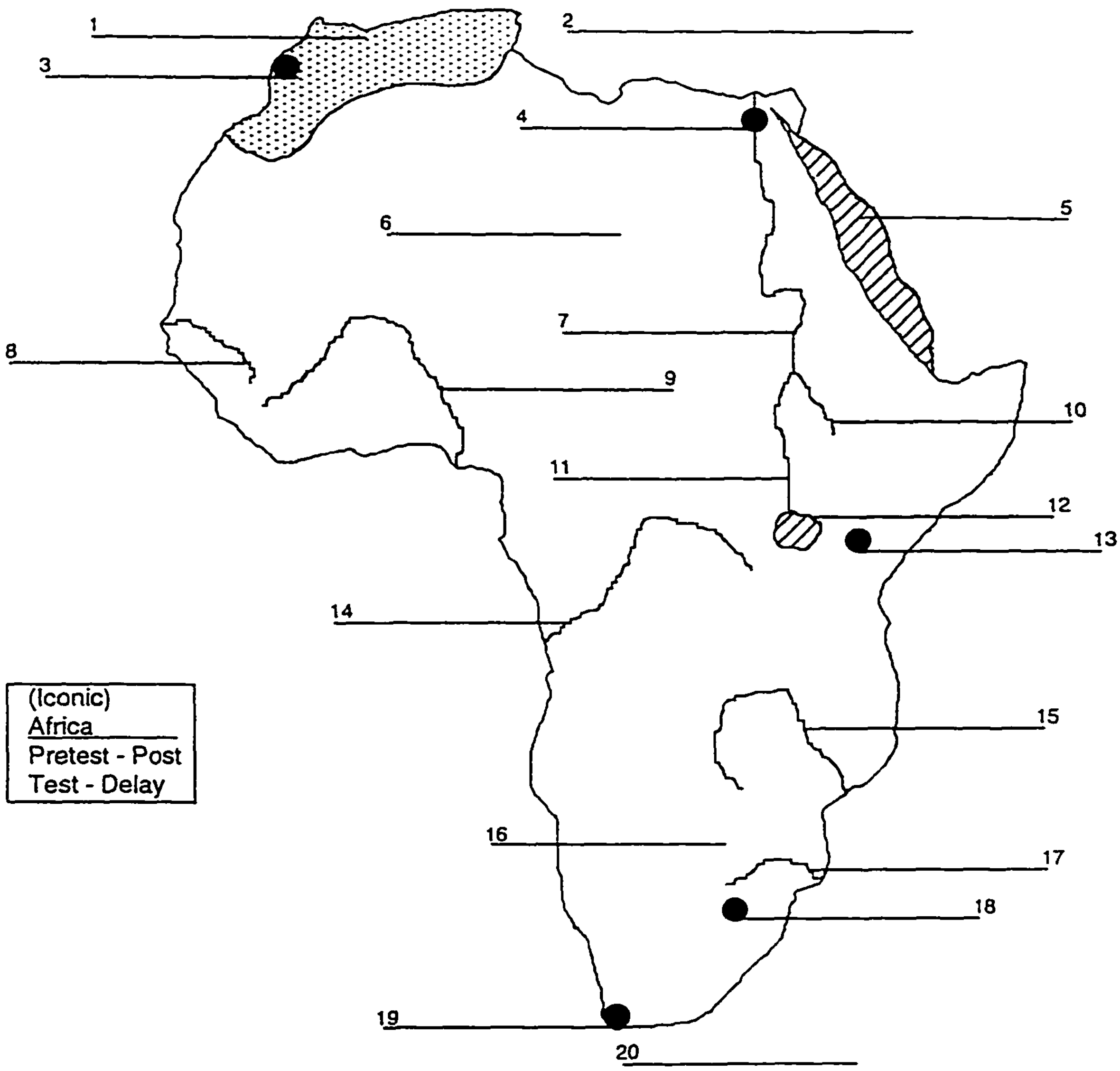


figure 1

On this map there are lines for the names of twenty places: cities, deserts, lakes, mountains, or rivers. You might know some of these places. If you do, write the name of the place on the line. At the bottom of this page are some names you might use.

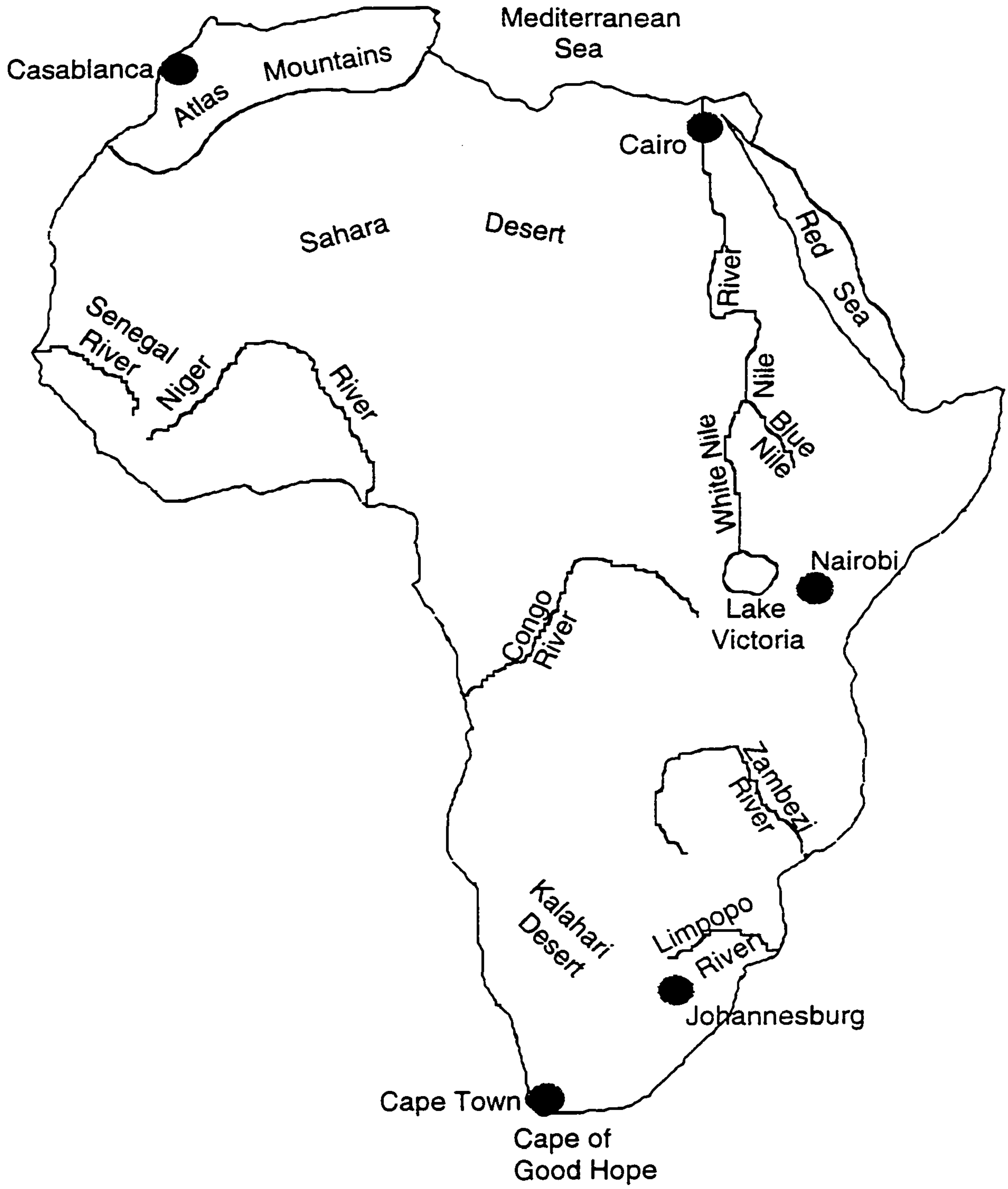


Ahmar Mountains	Cape of Good Hope	Johannesburg	Nairobi	Red Sea
Alexandria	Cape Town	Kalahari Desert	Niger River	Sahara Desert
Atlas Mountains	Cape Verde	Lake Chad	Nile River	Senegal River
Black Sea	Casablanca	Lake Victoria	Nubian Desert	Volta River
Blue Nile	Congo River	Limpopo River	Orange River	White Nile
Cairo	Gambia River	Mediterranean Sea	Pretoria	Zambezi River

Map %80 of original size.

figure 2

This map shows the names of all the cities, deserts, lakes, mountains, and rivers you just saw on the other map. Study and learn the names and locations on this map now. You will be asked about them again.



(Iconic)
Africa
Intervention

figure 3

This map shows the names of all the cities, deserts, lakes, mountains, and rivers you just saw on the other map. Study and learn the names and locations on this map now. You will be asked about them again.

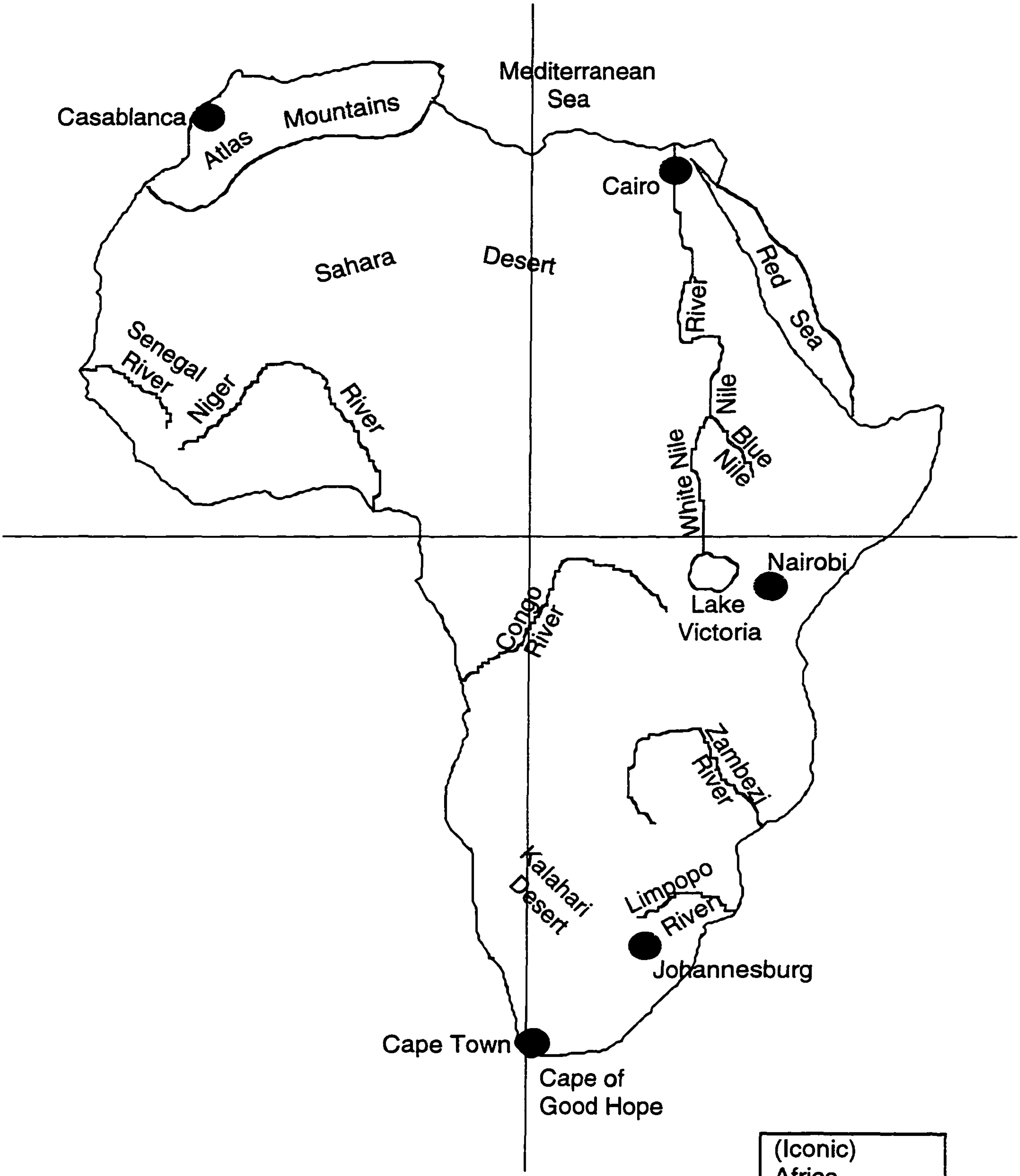
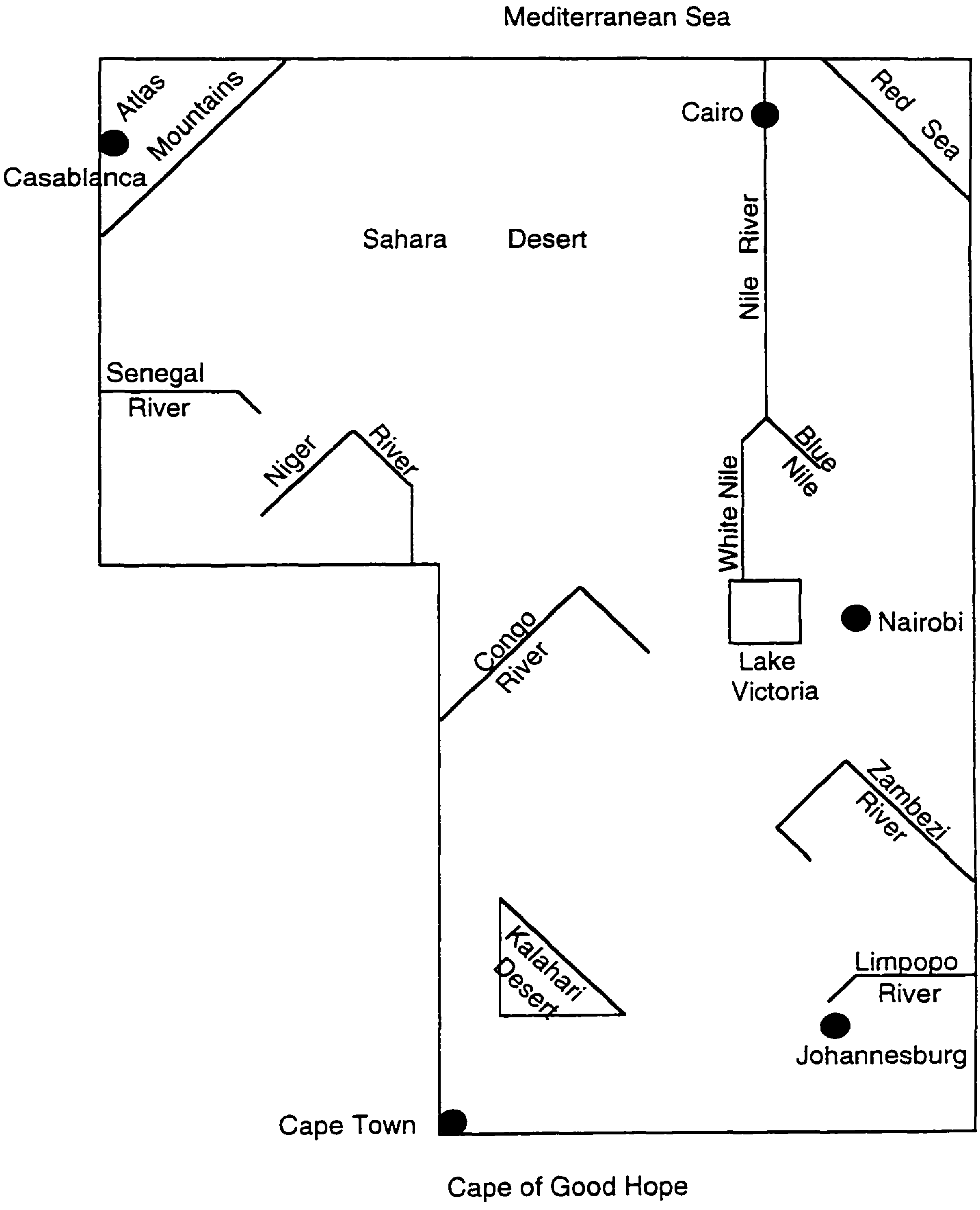


figure 4

(Iconic)
Africa
Intervention

This map shows the names of all the cities, deserts, lakes, mountains, and rivers you just saw on the other map. Study and learn the names and locations on this map now. You will be asked about them again.



(Schematic)
Africa
Intervention

figure 5

This map shows the names of all the cities, deserts, lakes, mountains, and rivers you just saw on the other map. Study and learn the names and locations on this map now. You will be asked about them again.

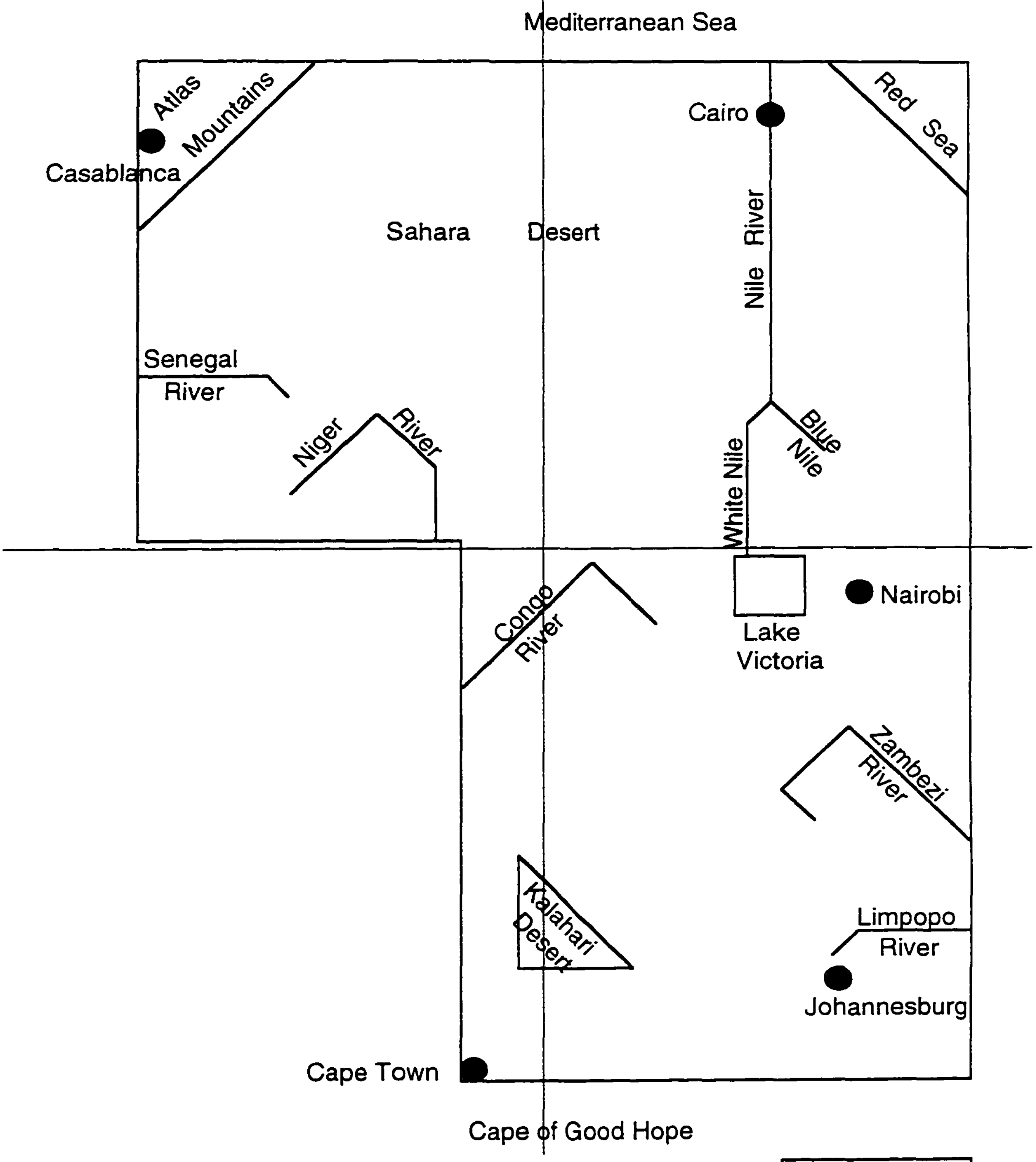
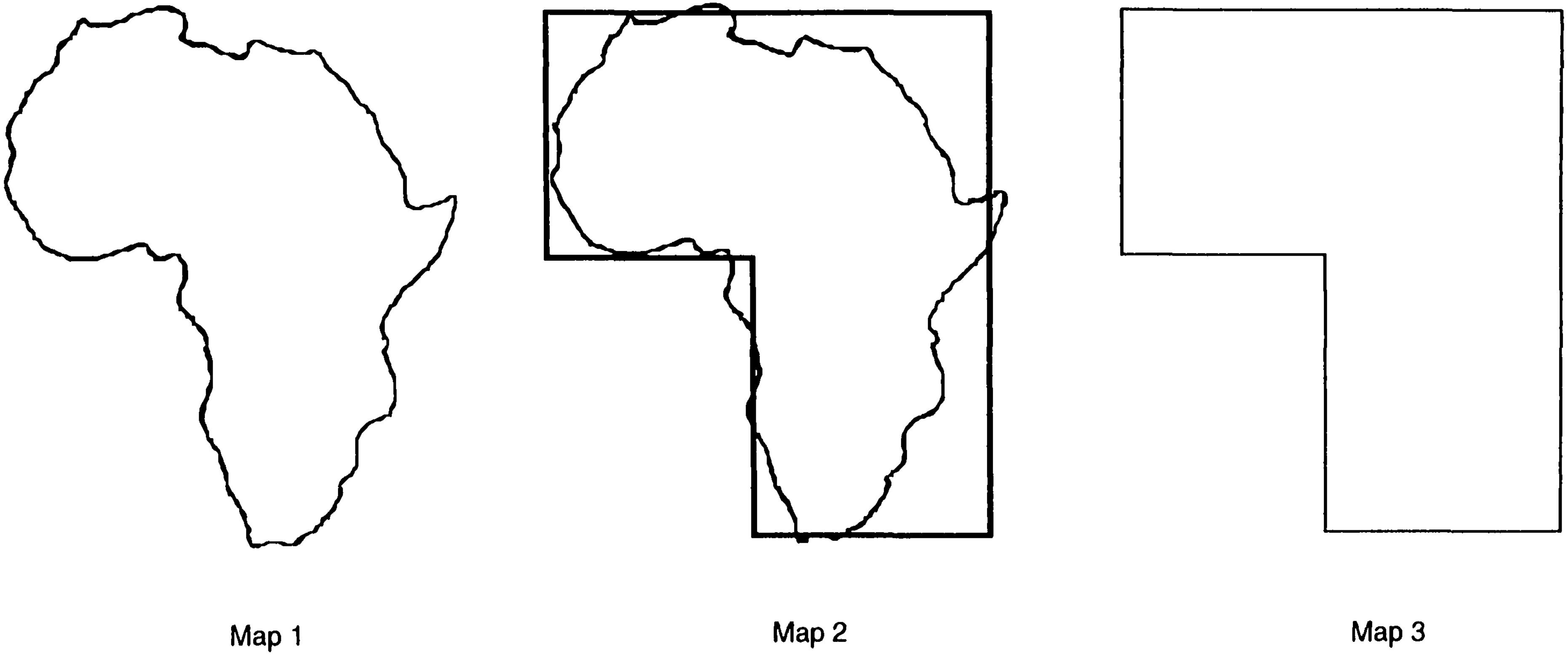


figure 6

AFRICA

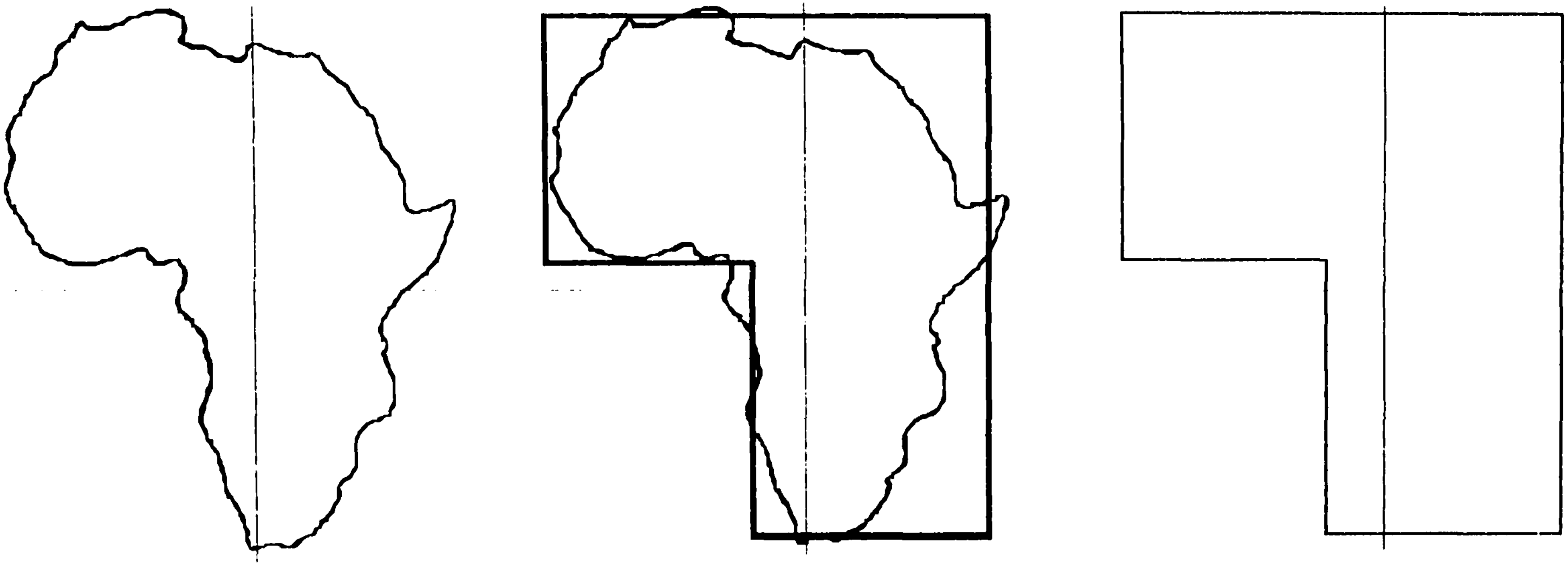


You have just named places on a map of Africa that looks like Map 1. Map 2 is just like Map 1 but there is a shape drawn around the outside. Pretend that this new shape is a map of Africa. You will learn names of places on a map of Africa which looks like Map 3. Now, turn the page.

figure 7

Transition
Africa

AFRICA



Map 1 Map 2 Map 3

You have just named places on a map of Africa that looks like Map 1. Map 2 is just like Map 1 but there is a shape drawn around the outside. Pretend that this new shape is a map of Africa. You will learn names of places on a map of Africa which looks like Map 3. Now turn the page.

figure 8

Transition+
Africa

- MAPS -
Student Questionnaire

Date: ______________________________

Write Your Name: ____

Print Your Name: ____

What is your phone number?: ____

Gender: Male: __________ Female: __________

How old are you?: ____

Your Parents or Guardian's Name: __________________________________

The Name of Your School: ____

Your Grade: ____

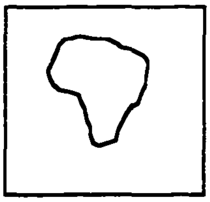
Your Teacher's Name: ____

The next page is the same as the first map. Please try your very best remember the names and locations of the places you have learned. Thank you for helping me.

figure 9

Iconic Map 1 Group 1
by Mean and Standard Deviation for Pretest,
Posttest, and Delayed Posttest;
by Participant for
Gender, Pretest Correct, Posttest Correct,
and Delayed Posttest Correct

Map 1



19 -12F/7M

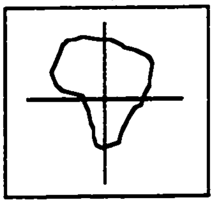
	Pretest	Posttest	Delayed Posttest
Mean	1.368	13.842	10.842
Median	2.0	15.0	10.0
SD	1.300	4.413	4.682
Min.	0	6	3
Max.	4	20	20
Range	4	14	17

Group 1 Participant	Gender (19 - 12F/7M)	Pretest Correct	Posttest Correct	Delayed Posttest Correct
1	M	0	15	6
2	F	1	16	14
3	F	0	18	16
4	F	0	16	10
5	F	2	18	14
6	F	3	14	10
7	F	2	15	16
8	F	2	14	15
9	F	0	13	10
10	M	0	6	5
11	M	0	7	6
12	M	2	7	5
13	M	2	13	9
14	F	0	6	3
15	M	3	19	17
16	F	2	18	10
17	M	2	15	13
18	F	2	15	8
19	F	4	20	20

figure 10

Iconic Map 2 Group 2
by Mean and Standard Deviation for Pretest,
Posttest, and Delayed Posttest;
by Participant for
Gender, Pretest Correct, Posttest Correct,
and Delayed Posttest Correct

Map 2



Mean	0.364
Median	0.0
SD	0.674
Min.	0
Max.	2
Range	2

Mean	10.455
Median	9.0
SD	5.956
Min.	1
Max.	20
Range	19

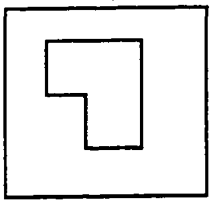
Mean	7.727
Median	6.0
SD	5.179
Min.	1
Max.	17
Range	16

Group 2 Participant	Gender (11 - 4F/7M)	Pretest Correct	Posttest Correct	Delayed Posttest Correct
1	F	0	11	3
2	M	0	7	7
3	M	0	7	4
4	F	0	14	7
5	M	1	20	17
6	F	0	7	6
7	M	1	19	16
8	F	0	10	6
9	M	2	15	12
10	M	0	5	6
11	M	0	1	2

figure 11

Iconic Map 3 Group 3
by Mean and Standard Deviation for Pretest,
Posttest, and Delayed Posttest;
by Participant for
Gender, Pretest Correct, Posttest Correct,
and Delayed Posttest Correct

Map 3



13 -6F/12M

Mean	1.444
Median	1.0
SD	1.580
Min.	0
Max.	5
Range	5

Mean	13.222
Median	13.5
SD	4.930
Min.	4
Max.	20
Range	16

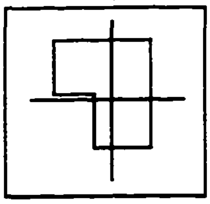
Mean	9.667
Median	9.0
SD	5.190
Min.	3
Max.	19
Range	16

Group 3 Participant	Gender (18 - 6F/12M)	Pretest Correct	Posttest Correct	Delayed Posttest Correct
1	M	1	10	15
2	F	2	16	12
3	F	1	13	8
4	M	4	19	17
5	F	0	4	3
6	M	2	13	5
7	M	0	6	3
8	M	3	14	7
9	F	0	13	8
10	M	0	10	5
11	M	0	15	8
12	F	0	5	2
13	M	2	19	15
14	M	3	15	12
15	M	4	20	20
16	M	4	14	11
17	M	1	16	12
18	F	1	18	19

figure 12

Iconic Map 4 Group 4
by Mean and Standard Deviation for Pretest,
Posttest, and Delayed Posttest;
by Participant for
Gender, Pretest Correct, Posttest Correct,
and Delayed Posttest Correct

Map 4



Mean	1.316
Median	1.0
SD	1.529
Min.	0
Max.	4
Range	4

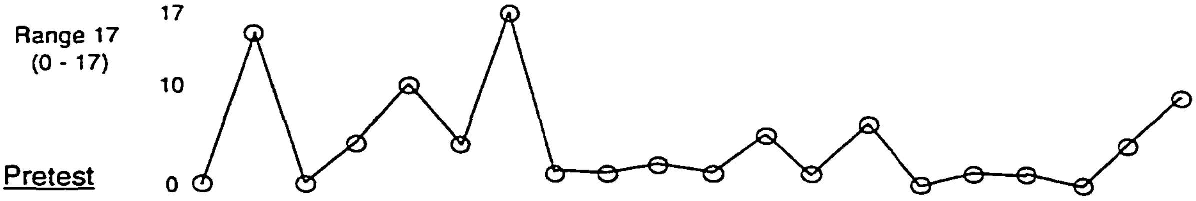
Mean	12.579
Median	13.0
SD	4.574
Min.	3
Max.	20
Range	17

Mean	9.474
Median	8.5
SD	4.742
Min.	1
Max.	20
Range	19

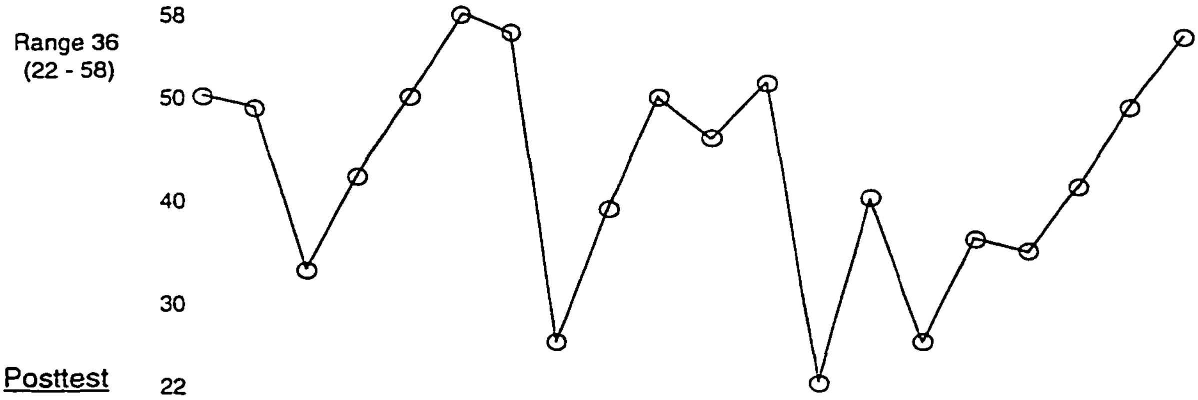
Group 4 Participant	Gender (19 - 5F/14M)	Pretest Correct	Posttest Correct	Delayed Posttest Correct
1	M	3	7	6
2	M	4	13	12
3	M	1	18	17
4	F	0	3	1
5	M	5	13	14
6	F	1	13	9
7	F	0	12	6
8	F	0	14	6
9	M	0	7	5
10	F	0	12	7
11	M	0	11	9
12	M	1	12	7
13	M	0	6	7
14	M	2	14	9
15	M	1	13	8
16	M	3	18	13
17	M	1	20	20
18	M	3	20	15
19	M	0	13	8

figure 13

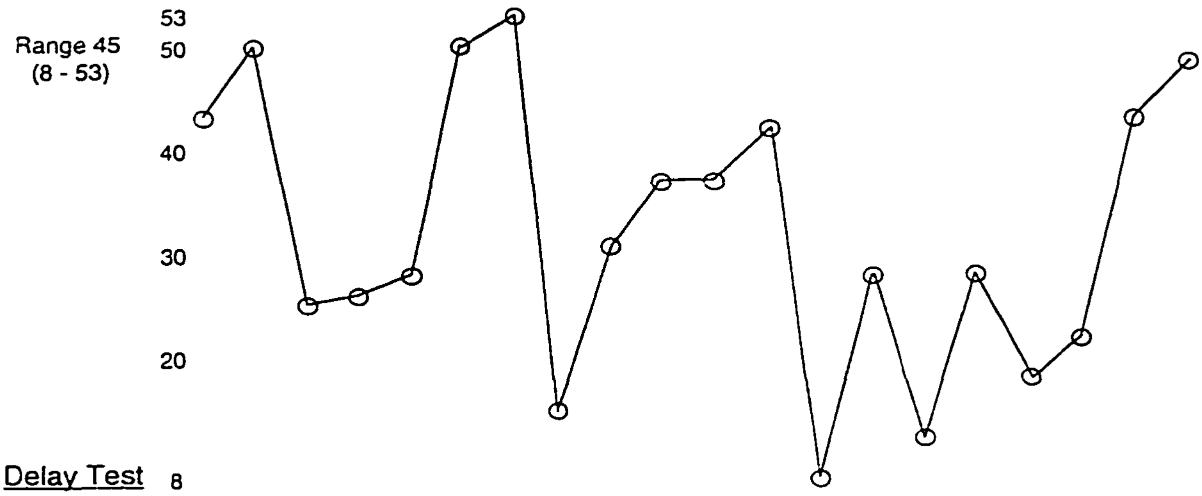
Geographic Features Correct
Groups 1, 2, 3, 4 - Pretest - Posttest - Delayed Test



Map Feature#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Correct of 67	0	15	0	4	10	4	17	1	1	2	1	5	1	6	0	1	1	0	4	9



Map Feature#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Correct of 67	50	49	33	42	50	58	56	26	39	50	46	51	22	40	26	36	35	41	49	56



Map Feature#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Correct of 67	43	50	25	26	28	50	53	15	31	37	37	42	8	28	12	28	18	22	43	49

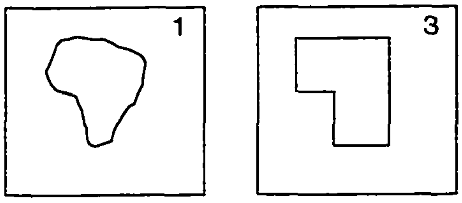
figure 14

Geographic Features by Area

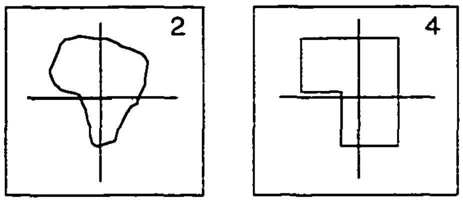
Participants

Study Group
67 participicpnats
27 Female
40 Male

No Guide Lines



Guide Lines



Northwest (NW)	Northeast (NE)
1 Atlas Mountains	2 Mediterranean Sea
3 Casablanca	4 Cario
6 Sahara Desert	5 Red Sea
8 Senegal River	7 Nile River
9 Niger River	10 Blue Nile
	11 White Nile
Southwest (SW)	**Southeast (NE)**
14 Congo River	12 Lake Vistoria
16 Kalahari Desert	13 Nariobi
19 Cape Town	15 Zambezi River
	17 Limpopo River
	18 Johannesburg
	20 Cape of Good Hope

figure 15

Map Interventions - Pretest, Posttest, Delayed Test -
Quadrant Averages Compared by
1 & 3 Blended and 2 & 4 Blended:
Geographic Features for NW, NE, SW, SE

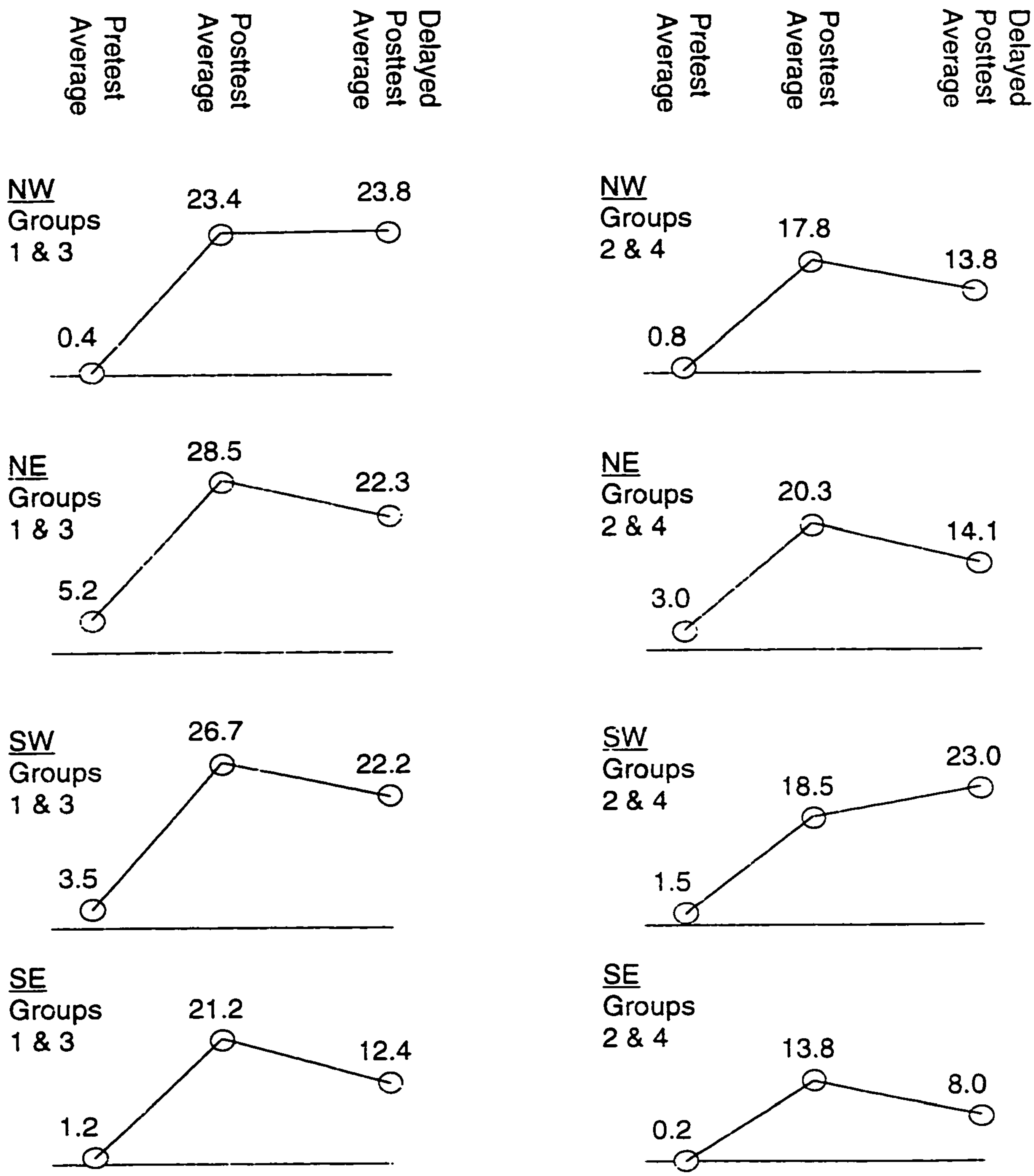
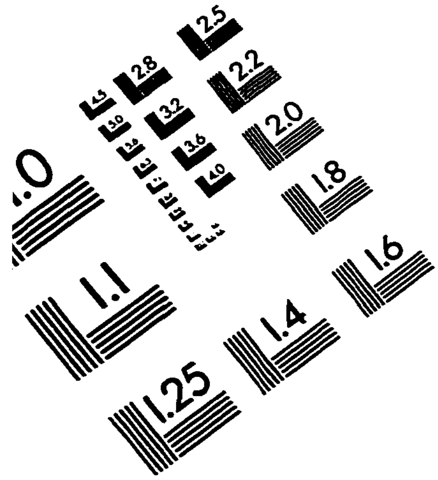
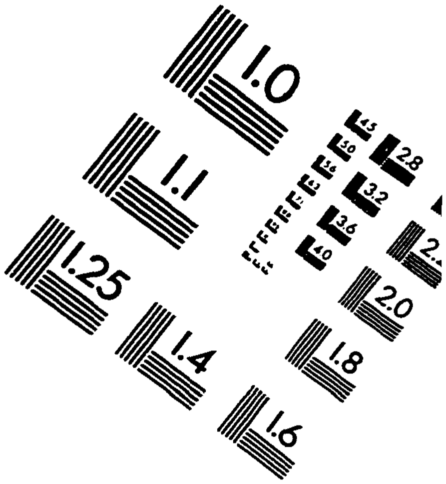
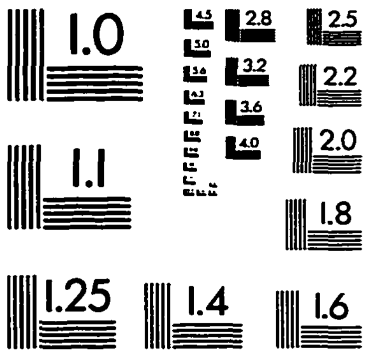


figure 16

IMAGE EVALUATION TEST TARGET (QA-3)

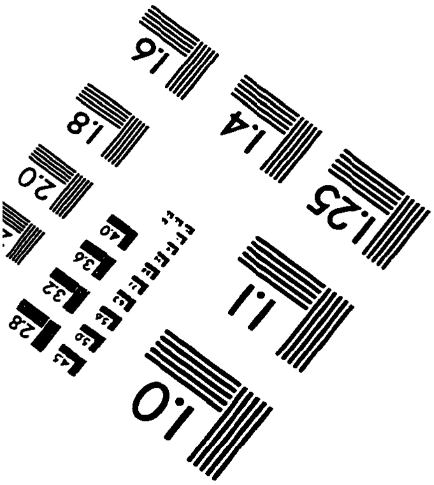


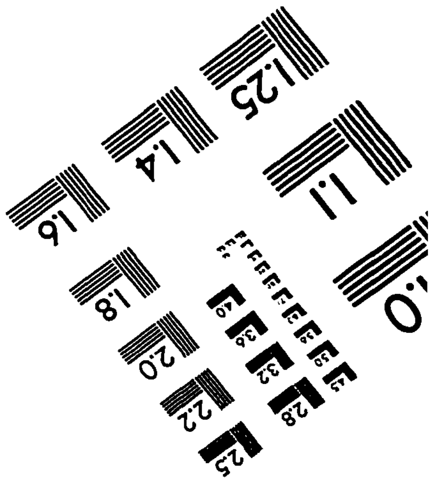




150mm

6"





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