TEACHING THE TOOL OF THE TRADE: AN EXPLORATION OF TEACHERS' BELIEFS, KNOWLEDGE, AND PRACTICES ABOUT MAPS

A Dissertation

by

GILLIAN ACHESON

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2003

Major Subject: Geography

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December 2003

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ABSTRACT

Teaching the Tool of the Trade: An Exploration of
Teachers' Beliefs, Knowledge, and Practices About Maps. (December 2003)
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Chair of Advisory Committee: Dr. Sarah W. Bednarz

Maps are the integral tool of geography. The importance of maps to geographic literacy is reflected in the National Geography Standards (Geography Education Implementation Project 1994): the first essential element, the World in Spatial Terms, details the significance of map comprehension to spatial thinking. Despite that centrality, there is little research which tells us how maps are used in the classroom. This study considers Texas teachers' instructional practices with regards to maps. The following questions are addressed: (1) what are teachers' beliefs and knowledge about maps; (2) what are teachers' practices regarding their use; and, (3) to what extent do teachers understand the curricular requirements related to maps?

The study was conducted in two phases. During Phase I, a survey was completed by eighty-eight teacher-members of the Texas Alliance for Geographic Education. In Phase II, eleven teachers were selected from the pool of survey respondents for interviews and classroom observations. Data were analyzed using descriptive statistics and qualitative techniques. Analysis included evaluation of teachers' practices along a map skills continuum, which was adapted from National Assessment of Educational Progress' (NAEP) standards in geography, the National Geography Standards, and the state curriculum, the Texas Essential Knowledge and Skills (TEKS). The continuum evaluated teachers by grade (elementary, middle, or high school) and proficiency (basic, proficient, or advanced). Teachers in Phase II were representative of the grade and proficiency levels of the survey respondents.

Results indicate that map instruction focuses on learning cartographic terminology, performing basic map tasks, and identifying locations. The more advanced tasks illustrated in the continuum are largely absent. The teachers in this study generally had

a limited conceptualization of maps and their uses; that limited conceptualization constrained their practices *and* their understanding of the curricular requirements regarding map skills. Consequently, map instruction does not occur in the rich way conceptualized by the Standards, NAEP, or the TEKS. The implication is that teachers' conceptualization of maps must be improved. This goal could be accomplished by providing teachers with professional development experiences and curricular tools that will enhance their understanding of maps and their many uses.

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The results of this research could not have been obtained without the participation of eighty-eight Texas teachers. Teachers are extremely busy people; I am grateful to those eighty-eight teachers who took the time to tell me how they approach instruction about maps. Eleven of those eighty-eight teachers went a step further, and invited me into their classrooms. The brief time I spent with each educator confirmed for me that teaching is one of the most difficult professions. I have great respect for these eleven teachers' efforts, and I so appreciate their participation in this study. I must also thank the Texas Alliance for Geographic Education (TAGE), particularly Judy Behrens at Texas State University–San Marcos, who was instrumental in providing the TAGE database for this research. Marci Smith Deal kindly field tested the surveys for me with

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CHAPTER I
INTRODUCTION

Geography is concerned with the spatial relationships that exist between humans and their environments. Maps are an integral tool of the discipline. The influential geographer Carl Sauer (1956, 289) wrote: “The map speaks across the barriers of language; it is sometimes claimed as the language of geography. The conveying of ideas by means of maps is attributed to us as our common vocation and passion.” A map is both a means of organizing and communicating information.

Map literacy is considered important for all people, not just geographers (de Blij 1999; Geography Education Standards Project 1994; Monmonier 1993). A person who is proficient with maps (e.g., map literate) is able to (1) perform basic tasks essential for successful map reading (such as finding locations, interpreting symbols, orienting maps, and using scale to determine distance), and (2) use maps to answer a range of geographic questions such as where, what, how, when, and why (Geography Education Standards Project 1994, Golledge and Stimson 1997). While map literacy is considered an important component of geography and the social studies, little is known about instructional practice in this area.

The focus of this research was to understand how teachers in the state of Texas think about and develop map literacy among their students. Teacher practices are an important component of student learning. Teacher knowledge and beliefs are important parts of teacher practices. The goal of this study is to understand teachers’ beliefs, knowledge, and practices regarding map literacy. This research was conducted in two phases: (1) surveys distributed to teacher-members of the Texas Alliance for Geographic Education (TAGE); and (2) interviews and observations with a subset of survey respondents. Surveys were used to assess teacher beliefs, knowledge, and practices regarding map literacy. In addition to this baseline data, survey data were then used to select a subset of educators for in-depth interviews and observations. Both quantitative and qualitative methods were used. Quantitative measures provide general, descriptive data about teachers’ beliefs, knowledge, and practices. Qualitative methods

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Style and format follow *The Journal of Geography*.

provide a deeper understanding of these issues (Bogdan and Biklen 1992). Multiple methods (a survey, interviews, and observations) are used to ensure data trustworthiness through triangulation.

This chapter provides an overview of the research including the study's literature-based context, and its goals and methodology.

Context of the Study

At their most basic use, maps help us navigate through space, from our homes to the grocery store or from New Jersey to Texas. At a higher level, maps can inform us about the world in which we live—the physical lay of the land, the political boundaries, languages spoken, religions practiced, even the distribution of Internet connections. Map literacy is a significant component of geographic literacy specifically and of education generally. While maps are most often associated with geography, they are used throughout the social sciences (and among other disciplines) to illustrate phenomena such as battles waged, goods moved, or economic partnerships like the European Union. Outside of the classroom, maps are part of everyday life: they appear in newspapers, on television, in shopping malls, and amusement parks. To develop map literacy is to develop a life long skill, useful to anyone regardless of profession or socioeconomic status. The importance of map literacy cannot be stressed enough, but it is equally important to note that map literacy is not the same as geographic literacy. Maps are one tool of geography—an indispensable tool—but understanding maps and how to use them is only one component of geographic literacy.

Extensive research exists about how maps are understood and utilized by people of different race, ethnicity, gender, and age (see Blades and Spencer 1987, 1990; Boardman 1989; Bremner and Andreasen 1998; Downs and Liben 1991; Mealey, Cohen, and Jordan 1998; Ormrod et al., 1988; Trifonoff 1995; Wiegand and Stiell 1996). This research provides some indication of what children from a young age can do with maps, and consequently should inform curriculum and instruction. In order to set the context of this study, the following sections describe what students *can do* with maps (the research), what students *should do* with maps (the curriculum), and what students *do* with maps (instruction).

What Students Can Do with Maps—the Research

The majority of studies on map learning[1] examine people's ability to use a map for navigation. Fewer studies examine people's skills at using them for other purposes. The following research suggests what children can do and where the application of instruction might improve understanding and use.

Research indicates that children can use simple maps at a young age for way-finding purposes (Blades and Spencer 1987, 1990; Bluestone and Accredolo 1979; Presson 1982; Uttal and Wellman 1989). Aligned maps[2] are easier to use than rotated[3] ones, although ability to navigate using a map improves with age. There is also evidence that children know to rotate maps when faced with a turn in a path that they are following (Bremner and Andreasen 1998).

Research has further confirmed that children are able to derive information (beyond that for navigation tasks) from simple maps. One study found that children are able to understand simple maps that contain a limited number of elements; however, subjects were unable to integrate multiple elements into a "big picture" (Boardman 1989). Thematic maps have also been used with success: children as young as seven demonstrate ability to interpret simple symbols and subsequently, map information (Trifonoff 1995). Research by Wiegand and Stiell (1996) confirms Trifonoff's findings that children can interpret symbols, however as symbols become more complex, children have increasing difficulty identifying their meaning. For example, children were able to identify a pick and ax symbol (signifying mining activities) but were unable to interpret the meaning (Wiegand and Stiell 1996). Oftentimes, children are able to identify symbols long before they are able to interpret them (Gerber 1984).

Research suggests that children are able to use simple maps without any apparent instruction at a young age. These successes may offer support to the camp of researchers who believe that certain aspects of map learning are innate (Blaut 1997; Blaut and Stea 1974; Sowden et al., 1996). This map intuitiveness, however, seems to level off. Gregg (1997) found that fifth and seventh grade students had difficulty interpreting a map's meaning: either inferring too much about its color or reading something verbatim from the legend and not really understanding what the map meant. Many studies report the difficulties encountered by adult users in reading and interpreting maps. For example, research has found that the issues of rotation and

alignment continue to confound map users at the college age (Downs and Liben 1991; Mealey, Cohen, and Jordan 1998). It also would seem that interpreting abstract, geometric symbolization is a stumbling block for many adult map-users (Bronzaft, Dobrow, and O'Hanlon 1976; Muehrcke 1974).

What Students Should Be Able to Do with Maps – the Curriculum

For geography and the social studies in Texas, two sources guide the curriculum in the area of map literacy: The National Geography Standards, *Geography for Life* (Geography Education Standards Project 1994), and the state mandated curriculum, the Texas Essential Knowledge and Skills[4] (TEKS). It must be noted that map learning is a component of the National Geography Standards; within the TEKS, map learning, along with geography, is a component of the social studies curriculum. While the National Geography Standards offer benchmarks for geographic literacy, they do not dictate geography instruction in Texas (or any other state). However, the TEKS reflect many of the map skills identified in the National Geography Standards. This agreement should be expected: the geography strand of the social studies TEKS were modeled after *Geography for Life.* As a result, map skill-specific strands of the TEKS are found throughout the K-12 curriculum.

Geography for Life outlines the characteristics of geographic literacy using a framework comprised of six essential elements and eighteen standards. The "geographically informed person" understands: (1) the World in Spatial Terms, (2) Places and Regions, (3) Physical Systems, (4) Human Systems, (5) Environment and Society, and (6) the Uses of Geography. Each of these essential elements is broken down further into eighteen standards. Maps are an important tool for illustrating and understanding the six elements and their related eighteen standards. It is that first element, though, the World in Spatial Terms, which relates specifically to map literacy. This element includes three standards:

The geographically informed person knows and understands:

- How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

- How to use mental maps to organize information about people, places, and environments in a spatial context.
- How to analyze the spatial organization of people, places, and environments on Earth's surface.

This element, and its related three standards, requires students to use maps at all grade levels. At the completion of high school, students should be able to use and create maps in order to answer questions like where, what, why, and how. While maps are often used for the first question (where), the remaining three are equally significant. As the National Geography Standards note: "Geography studies the relationships between people, places, and environments by mapping information about them into a spatial context" (Geography Education Standards Project 1994, 34). Students must learn to use maps for information, analysis, and interpretation in order to achieve geographic literacy.

While the National Geography Standards offer guidelines of geographic literacy, including map literacy, the TEKS are law. They state what each student should know and be able to do at each grade level, from kindergarten to grade twelve, in all subject areas. Like the National Geography Standards, the TEKS seek to develop general knowledge and skills. The social studies component of the TEKS is comprised of eight domains: history, geography, economics, government, citizenship, culture, science-technology-society, and social studies skills. Within the social studies TEKS, map literacy falls primarily within the domain of geography and social studies skills. However, map literacy is required, and developed, within each of the eight domains at various points in the social studies curriculum [see Appendix A for a complete list]. Examples of the correspondence of the TEKS to the National Geography Standards is illustrated in Table 1.

In comparing the National Geography Standards to the TEKS, it would appear that the National Geography Standards suggest a more rigorous definition of map literacy. For example at the elementary level, Standard 3: How to analyze the spatial organization of people, places, and environments on Earth's surface, is essentially absent from the TEKS. *Geography for Life* guides the TEKS, but it does not define them. Again, the Standards are *guidelines*, the TEKS are *law*. For this reason, the

present study assumes that when map literacy is developed in Texas classrooms, the TEKS have greater influence than the Standards.

Teachers often make use of supplemental materials like textbooks and workbooks. Such materials provide practical classroom lessons that help teachers meet the goals of the curriculum. The textbook can be particularly important in determining what gets taught: often textbooks are used as the primary curricular guide (Smith and Girod 2003). However, reliance on textbooks for curriculum purposes can be problematic. First, textbooks are often criticized for superficiality, covering breadth and ignoring depth (Schmidt, McKnight, and Raizen 1997). Second, in the case of geography specifically, implementation of the Standards has been hindered by a "lack of supplemental materials and weak support from textbook providers" (Bednarz 2003a, 101). Supplemental materials should provide support to teachers. If they are unaligned with curricular objectives, though, they can hinder implementation.

Table 1. TEKS Correlation to Essential Element 1 of the National Geography Standards

Grade Level	National Geography Standards*	Sample TEKS Correlation**
Elementary (K-4)	Standard 1: Map Use	1.5: The student understands the purpose of maps and globes
	Standard 2: Mental Maps	2.6a: Identify major landforms and bodies of water, including continents and oceans, on maps and globes
	Standard 3: Analyze, interpret spatial patterns	[not evident]
Middle (5-8)	Standard 1: Map Use	5.6a: Apply geographic tools, including grid systems, legends, symbols, scales, and compass roses, to construct and interpret maps
	Standard 2: Mental Maps	6.4b: Identify and explain the geographic factors responsible for patterns of population in places and regions
	Standard 3: Analyze, interpret spatial patterns	8.11c: Analyze the effects of physical and human geographic factors on major historical and contemporary events in the United States
High (9-12)	Standard 1: Map Use	WH.12c: Interpret historical and contemporary maps to identify and explain geographic factors such as control of the Straits of Hormuz that have influenced people and events in the past
	Standard 2: Mental Maps	WG.22a: Design and draw appropriate maps and other graphics such as sketch maps...to present geographic information including geographic features, geographic distributions, and geographic relationships
	Standard 3: Analyze, interpret spatial patterns	G.4b: Analyze the economic significance to the United States of the location and geographic characteristics of selected places and regions such as oil fields in the Middle East.

(Geography Standards Project 1994; Texas Education Agency 1997) *Text of each standard is shortened due to space; **This list is not exhaustive. TEKS shown are at the performance level of selected grades and courses. Notation: Example for grades K–8, 2.6a represents second grade, standard 6, sub-point a; WG-World Geography, WH-World History, G-Government.

What Students Do with Maps – Instruction

Little research in effective instructional methods for developing map skills has been conducted, and the absence has been noted (Bednarz 1995; Downs 1995; Saku 1992). Only a handful of studies provide some clue about what "works." For example, map and globe skills (e.g., shape of the earth, the globe as a model for the earth, directions, earth-sun relationships, and scale) have been taught successfully to four and five year old children (Atkins 1981). Instruction also has proved useful in improving seventh grade students' world cognitive map (Chiodo 1997). Students receiving experimental instruction over the course of a week improved significantly more than students receiving "traditional" instruction (which is described as independently studying maps with no direct instruction). A third study found that teaching college students basic cartographic terminology as well as how to read a topographic map for only twenty minutes resulted in superior performance as compared to a no-instruction group (Saku 1992). In another study, Gregg (1999) compared two instructional methods in teaching seventh grade students about maps. One group of students learned map skills by constructing maps; the other group learned map skills through traditional map reading activities. Gregg found that all students learned, regardless of instructional model, but students who constructed their own maps learned more.

Most studies (Atkins 1981; Chiodo 1997; Gregg 1999; Saku 1992) have found that some instruction is better than no instruction. Still more research has suggested that map use and understanding can be improved with instruction (Downs and Liben 1991; Gregg and Leinhardt 1994; Matthews 1992). However, it is unclear how map skills are currently taught.

Teacher Beliefs, Knowledge, and Practices

It is commonly noted that teacher knowledge and practice are significant determinants of student achievement (Cochran-Smith 2003, Wayne and Youngs 2003), but understanding teachers' beliefs is equally important. Teacher beliefs impact practices in the classroom (Handal and Lauvas 1987; Munby 1984). For example, Smith and Shepard (1988) found that teachers' beliefs about school readiness generally influenced their decisions to promote or retain kindergartners. The complex interaction of beliefs and practices is termed *practical theory*, defined as "a person's private,

integrated but ever-changing system of knowledge, experience and values which is relevant to teaching practice at any particular time" (Handal and Lauvas 1987, 9). Beliefs are, of course, not the sole determinant of practice; the educational and social context also influence practice (Smith and Shepard 1988). For example, the curriculum goals established by the school, or state, may override beliefs and modify practice. Nonetheless, they are considered an important determinant of teacher practice. For example, it is argued that they impact curricular implementation: "When implementing a significant curricular, organizational, or instructional change...teachers' belief systems can be ignored only at the innovator's peril" (Clark and Peterson 1986, 291). Teachers may adopt a new curriculum, for instance, but they modify it according to what they believe, as well as to work around gaps in their own knowledge.

Teachers' practices and subsequently their knowledge and beliefs are essential to understanding student knowledge. Research has shown that many teachers view themselves as purveyors of knowledge, controlling what students learn (Clark and Peterson 1986; Jetton 1994; Rearden 1998), despite research which advocates student-centered teaching (Good and Brophy 1997). Furthermore, "students' ability to determine instructional importance is dependent upon the teacher's subject-matter knowledge and pedagogical knowledge" (Jetton 1994, 80).

Pedagogical knowledge is knowing how to teach. Knowing how to teach includes the ability to motivate students to learn, to manage the classroom, and to develop and utilize appropriate curriculum materials (Sternberg and Horvath 1995, 11). Content knowledge is the domain-specific knowledge needed to teach a particular course such as human geography. Pedagogical content knowledge is the understanding and implementation of effective teaching practices in a particular subject. To be an effective teacher, one must possess knowledge in each of the three domains (Garnet and Tobin 1988; Rearden 1998; Shulman 1986a, b).

Teacher Preparation

Related to teacher beliefs, knowledge, and practices is teacher preparation. Teacher preparation is often cited as the key to educational reform (Cochran-Smith 2003, Smith and Girod 2003) as well as the culprit of educational failures (Bednarz 2003a; Gregg 2001, Whisenant 2002). For geography in particular, limited understanding of the discipline by K-12 educators has been a recurring problem. For example, Gregg (2001) examined the content knowledge of pre-service elementary teachers in Alabama; she considered their preparedness and subsequent ability to teach fourth grade students about rivers (an important element of elementary geography). She found that geographic concepts were often over-simplified and erroneous information was either presented to students, or went unchallenged when offered by students. For example, one pre-service teacher told students that the Nile ends in a waterfall. Whisenant (2002, 94) considered the effects of Texas teachers' conceptualization of geography on curricular emphasis. She found that teachers who have a partial or limited conceptualization of geography tend to "select course content that is less complex regardless of the grade level taught." Like Gregg, Whisenant concludes that geography teachers have a shallow conceptualization of the discipline at both the elementary and secondary levels. She believes this limited view may be related to pre-service preparation. Given that social studies is a composite of many disciplines, deep content knowledge can be difficult to acquire. Wilson, Weller and Cole (1998) note that preservice social studies teachers in Colorado often take only one or two college courses in a content area such as geography. This one course accounts for their sole preparation to teach a particular subject. In Texas, specific course requirements for teacher preparation are established by state approved programs.[5] At Texas A&M University, for example, pre-service elementary and middle school generalist teachers typically take one or two geography courses while pre-service secondary social studies teachers take approximately thirty hours of social science courses. While these examples are particular to geography, other disciplines face similar problems. Finding ways to develop pedagogical knowledge, deep understanding of content, and effective ways to teach that content is a challenging task—one that has yet to be adequately remedied.

Summary

In summary, research suggests the following. Maps are integral to geographic literacy, as well as social studies education. Simple maps are easily understood by students as young as four years of age. However, as map complexity increases, comprehension decreases. There are a limited number of studies that describe the state of "typical" map instruction. We have no comprehensive account of teachers' beliefs, knowledge, and practices regarding map literacy. If maps are an integral part of geographic literacy and the social studies, we must understand teachers' instructional practices so that their effectiveness can be measured. Understanding teachers' practices means understanding their beliefs and knowledge. Beliefs and knowledge are significant because they impact teacher practices. If a teacher does not think map skills are important, then she likely will not teach them, even in spite of a state-mandated curriculum. Further, if a teacher lacks adequate knowledge about maps and map skills, then too her practices will be limited.

Purpose of the Study

This study seeks to understand teachers' beliefs, practices, and knowledge regarding maps. Specifically, the following research questions are addressed:

(1a) What are teachers' beliefs about map literacy; and,

(1b) What knowledge about map literacy do teachers possess?

(2) What are teachers' practices, that is what, when, and how is map literacy currently taught in geography/social studies courses?

(3) To what extent do teachers understand the curricular requirements about map literacy?

Beliefs are what an individual holds to be true (Smith and Shepard 1988, 308). *Teacher knowledge* is defined by Shulman (1986a, b) along four domains: pedagogical knowledge, content knowledge, pedagogical content knowledge, and curricular knowledge. Pedagogical knowledge is knowing how to teach, content knowledge is the subject-specific knowledge needed to teach a particular course, and pedagogical content knowledge is knowing how to teach a particular course, like geography. Curricular knowledge includes an understanding of one's subject at a particular grade

level, as well as the *vertical* and *lateral* curricula. The vertical curriculum is the content of a subject at different grade levels; the lateral curriculum is the content of other courses being taken by the student at the same time. *Practices* are actions taken (Smith and Shepard 1988, 309).

Methodology

Due to the goals of this study, multiple data collection methods (qualitative and quantitative measures) are used. Quantitative measures provide general, baseline data about teachers' beliefs, knowledge, and practices, while qualitative methods provide a deeper understanding of these issues (Bogdan and Biklen 1992). This study is meant to provide descriptive, baseline data upon which further research can build; the methodologies employed support this goal.

The research is conducted in two stages: a mail survey, and teacher interviews with classroom observations. The survey, developed by this researcher, was used to address the three research questions of this study, and to identify participants for the second phase of research. Survey data were analyzed in two ways: (1) descriptive statistics, and (2) qualitative analysis. In the second phase of research, eleven geography/social studies teachers were interviewed and observed to garner a deeper understanding of teacher beliefs, practices, and knowledge regarding map literacy. Data from the second phase of research were analyzed using grounded theory techniques of coding and theme identification (Miles and Huberman 1994).

Assumptions

This study involves several assumptions:

b. Educators will answer the surveys honestly and in enough detail for meaningful analysis to occur;
c. Educators will provide answers to interview questions that accurately represent their beliefs and knowledge.
d. Maps are used, and consequently taught to some degree, within geography and social studies at each grade, from kindergarten to twelfth.

Limitations of the Study

This study faces several limitations, which will be considered when analyzing and discussing the results.

a. The study is limited in its subject selection. The sample was purposefully selected from a pool of teachers involved in a professional geographic organization in Texas. Teachers who responded to the survey self-selected themselves for participation, and volunteered to participate in the second phase of this research.
b. This study considers only Texas teachers' beliefs, knowledge, and practices regarding map literacy, potentially limiting the generalizability of the findings. The limitation in generalizability may be particularly true in Texas due to the state mandated curriculum which prescribes topics and skills that may be not be applicable to other states.
c. The study is initial. Ascertaining teachers' pedagogical and content knowledge regarding map literacy, and how they put those theories into practice is one piece of the geographic literacy puzzle. Future research will need to assess the effectiveness of teachers' instructional methods, develop models of map instruction, and test the effectiveness of such models.
d. Data collected are largely self-reported. Self-reports may not accurately capture teacher practices. Criticism of self-report data stems from respondents telling researchers what they want to hear or trying to make themselves sound better than they are, which suggests that the findings may represent a best-case scenario.

Conclusion

The organization of this dissertation is as follows: Chapter II considers the literature about map learning, instruction practices relating to maps, and a review of the complex interplay between teacher beliefs, knowledge, and practices. The methodology employed for this study, including a description of the sample, is discussed in Chapter III. Data analysis and findings are described in Chapter IV; discussion, implications, and paths for future research are considered in the concluding section, Chapter V.

CHAPTER II
LITERATURE REVIEW

Introduction

Three questions guide this research:

(1a) What are teachers' beliefs about map literacy; and,

(1b) What knowledge about map literacy do teachers possess?

(2) What are teachers' practices, that is what, when, and how is map literacy currently taught in geography/social studies courses?

(3) To what extent do teachers understand the curricular requirements about map literacy?

This literature review considers research pertinent to each of the three research questions. Three areas are relevant: (1) research considering map literacy, defined previously as the ability to perform basic tasks essential for successful map reading (such as finding locations, interpreting symbols, orienting maps, and using scale to determine distance), and use of maps to answer a range of geographic questions such as where, what, how, when, and why; (2) research about teacher beliefs, knowledge, and practices; and, (3) curricular issues.

Maps contain a variety of information, displayed in a variety of ways. The development of map literacy includes learning *about* maps, as well as learning *with* maps. Learning *about* maps involves reading, interpreting, and producing maps; learning *with* maps occurs when maps are used to learn geographic concepts and relationships (Acheson and Bednarz 2003). For this reason, a consideration of what maps are and how maps are constructed is pertinent to this study. Research pertaining to map literacy is plentiful, particularly in the area of way-finding. Literature in this section reviews what students can (and cannot) do with maps. Consequently, these studies should influence curriculum and instruction. While considerable research informs us about the ease, as well as the difficulties, in using maps, few studies have considered the role of instruction in developing map literacy. The small number of studies that do exist complete this first section.

Equally abundant is research about teacher beliefs, knowledge, and practices. This research does not deal with map literacy specifically, but it does provide a general

picture of how teacher characteristics affect student achievement. Finally, the curriculum is an important component of how map literacy is developed. The National Geography Standards, *Geography for Life*, and the state mandated curriculum standards, the Texas Essential Knowledge and Skills (TEKS) are the significant guides. Other factors, too, influence the curriculum in the area of map literacy; support materials like textbooks and workbooks affect the way map skills are taught, as do state-wide assessments which *should* (but may not) align with the curriculum, and/or might result in the over-emphasis of some content and the de-emphasis of other. And, curricular choices made by teachers are an important component of curriculum implementation.

Teacher beliefs, knowledge, and practices and curricular issues are clearly related and even overlap. Research in the area of map learning is often conducted independent of any classroom issues. A summary at the end of this chapter links these three areas of research.

Map Literacy

Maps

A map is a spatial representation of the environment (Muehrcke and Muehrcke 1998). A map represents a territory in any number of ways: topographically, as a street plan or a floor plan, or schematically (e.g., a map of the London Tube network) (Winn 1991). Maps are broadly divided into mental (or, cognitive)[6] and cartographic maps. While this study is concerned primarily with cartographic maps, it is worthwhile to consider mental maps. Our very first maps are mental, and it is clear that mental maps influence and are influenced by cartographic maps.

Mental Maps

The construction of a mental map is defined as “the way of acquiring and storing essential information, of being able to use it, to decide where to go, and how to get there” (Downs and Stea 1977, 7). Generally, cognitive maps develop through experience in an environment, meaning that the view is acquired from the ground-level while cartographic maps provide an overhead view. However, a cognitive map can also develop from studying and using cartographic maps. This development allows us to store picture-like images of spatial information not acquired from direct experience.

These cognitive maps differ from those acquired from direct experience (MacEachren 1995).

Mental mapping begins at a young age, some researchers even suggest that it may be innate (Blaut and Stea 1974). Cox (1991) supports this suggestion with research findings that indicate internal maps are present during infancy. Cognitive mapping is fundamentally related to geography: people behave in space based on their environmental knowledge (MacEachren 1995). Environmental knowledge is acquired in a segmented fashion—bits and pieces are acquired over time to produce a larger, more detailed picture. While the information is acquired in segments, research suggests that too much segmentation can interfere with knowledge building (MacEachren 1995, 251). However early cognitive mapping begins, research has shown that it improves with age and practice, suggesting an opportunity for instruction.

Cartographic Maps

Cartographic maps, that is, flat representations of the spherical earth, are created with elements such as projection, scale, and symbolic representation in mind. While all maps contain distortion, cartographic maps should contain less than a mental map. In addition, they are designed for use by more than the individual who is creating them and are considered *more* accurate and *less* idiosyncratic than the average mental map. This bird's eye view, represented by a cartographic map, is created through a series of abstractions (e.g., selection, classification, simplification, exaggeration, and symbolization) that result in a two dimensional representation of a three-dimensional environment.

Cartographic maps are complex and difficult for many people, across age groups, to understand fully. All people develop some sort of internal map that aids in way-finding, however map use is a skill—one that not everyone develops. Research has shown that preschool children are adept at following routes from a simple map (Blades and Spencer 1987, 1990; Bremner and Andreasen 1998), however understanding the layers of information contained within a map is far more complex. Despite the complexity contained within maps, errors made by map users are usually a result of the user not understanding basic mapping principles (Muehrcke 1974). Cartographers suggest that

comprehension of scale, projection, and symbols are necessary for full comprehension (Monmonier 1993, 1996; Muechreke and Muechreke 1998).

Scale

Scale communicates the degree of reduction which can be stated as a ratio (e.g., 1:12,000), a verbal statement (e.g., one inch represents one mile), or as a bar graph. The scale determines the degree of detail included in the map and it allows one to measure distance between points. A ratio scale such as the one above states that one of some unit is equal to 12,000 of the same unit. For example, one inch on the map equals 12,000 inches on the ground. Verbal statements allow for easier measurement by converting the distance unit on a map into distance terms more useful if trying, for example, to plan a walk, bike ride, or car trip. Graphic scales are also easy ways to measure distances on large scale maps. They are useful when the map is enlarged or reduced because “the simple bar scale typically portrays a series of conveniently rounded distances appropriate to the map’s function and the area covered” (Monmonier 1996, 7). However, estimating distance using a graphic scale on a world map should be done with caution: scale varies widely in a map that must compress large portions of a three-dimensional surface into a two-dimensional representation, potentially resulting in grossly inaccurate measurements (Monmonier 1993, 31). Scale is not always an easy concept to master, however for many tasks, it must be understood if the map is to be accurately interpreted and analyzed.

Projection

A map represents the three-dimensional earth on a flat, two-dimensional piece of paper. This mathematical transformation is *projection* (Monmonier 1993, 21). Projection distorts area, shape, direction, and scale to varying degrees. A cartographer, depending on her goals, can choose to have less distortion in some aspects and greater in others. Because projection can vary the appearance of the same area of land, it is important for instructors to choose maps wisely. One option is to choose a map that is most appropriate for the topic being studied. For example, if studying South America, a cylindrical projection is most appropriate because it offers less distortion for equatorial areas (Monmonier 1993). Another option is to include a variety of different projections

so that students are aware of how maps distort reality. Too often mental maps are based on one, or maybe two, different projections, leading to common errors such as believing that Greenland is substantially larger than Mexico, when in fact they are roughly the same size.

Symbols

Once a cartographer chooses which phenomena she wishes to represent, information is portrayed through symbols. Text can be used but it often clutters up limited space and symbols allow for faster processing of information (Monmonier 1993, 57). Symbols are used to show location, direction, distance, movement, process, and correlation; points, lines, and areas used to represent such phenomena are further differentiated through "visual resources" like shape, size, pattern, and color; pattern can be further differentiated into arrangement, texture, and orientation while color can be broken down into hue, value (lightness and darkness), and intensity (Foote and Crum 1999; Muehrcke and Muehrcke 1998, 82). How symbols are depicted will also depend on map scale, pattern complexity, and the user-audience (Muehrcke and Muehrcke 1998).

As is evident to even the cursory map user, symbols can vary widely from map to map. The two most common categories of symbols are pictographic and geometric (Muehrcke and Muehrcke 1998). Pictographic symbols mimic the reality they represent. For example, a picture of a house on a map would represent a house in reality. Pictographic symbols are meant to be easily interpretable and have more flexibility than photographic symbols (pictures of reality in aerial photos which are limited in size depending on the scale of the photo-map) since they can be drawn at whatever size the cartographer chooses. They are limited though in three ways: (1) they can only represent tangible features, (2) most pictographic symbols are obscure enough to require reading the legend (see Wiegand and Stiell 1996 as example), and (3) pictographic maps are expensive to produce (Muehrcke and Muehrcke 1998, 81).

Geometric symbols can be used to avoid the pitfalls of using pictographic ones. While there is some convention in their use, usually geometric symbols will vary from map to map. Maps with geometric symbols are not as popular among children or novice map readers, but they are the most common type of map (Muehrcke and Muehrcke

1998). Perhaps their greatest advantage, abstract symbols allow the cartographer to depict intangible features like disease or population. However, how to choose a symbol to depict an intangible feature is one of the most difficult aspects of using geometric symbols. Geometric symbols generally require that the map user read the legend carefully.

In interpreting map symbols, the user must deal with visual and conceptual complexity. Visual complexity deals with identifying the symbol. Geometric symbols are less visually complex than pictographic symbols since they can be used in greater density and smaller size without compromising legibility (Muehrcke and Muehrcke 1998, 83). However, pictographic symbols are less conceptually complex than geometric ones.

Symbols are used to simplify information on a map. If chosen carefully, symbols can "make" the map (Monmonier 1993). However, the complexity involved in deciding what to represent and how to represent it makes symbol interpretation far from intuitive. Symbol notation significantly impacts how it is perceived, processed, and learned (Winn 1991, 216). Map readers must examine a map carefully (which includes reading the legend or any annotated text) in order to interpret the information properly.

Learning from Maps

Learning from maps is a unique task, different from learning other representations like graphs, charts, and diagrams (Winn 1991). Maps represent real space in realistic ways. Using a map requires a unique set of skills whereby users must integrate conceptual and spatial information, which is presented simultaneously (Thorndyke and Stasz 1980, 138). The majority of studies about map learning examine the ability to use a map for navigation. Fewer studies examine people's skills at using maps for other purposes. Research tends to focus on two age groups: young children (under 10) and college-age adults. This focus makes it difficult to see longitudinal change, or lack there of, in map understanding. The lack of documented progress could be attributable to (1) a lack of longitudinal studies, (2) the small number of studies with intervening age groups, or (3) limited use and instruction. The following research suggests what map users can do and where the application of instruction might improve understanding and use.

It is of note that many studies form their assumptions and select samples based on the work of Piaget. Piaget's research suggests that children's understanding of space and consequently maps is cognitively-bound, and consequently age-determined. The use of Piaget's theories has caused great debates in geographic education, with supporters of Piaget being labeled as "can't-ists" by those who believe the age-restrictions ignore children's innate spatial abilities and geographical curiosity (see, for example: *The Mapping Abilities of Young Children: Children Can* (Blaut 1997) and, the reply to Blaut by Liben and Downs (1997) *Can-ism and Can'tianism: A Straw Child*).

Using Maps for Navigation Purposes

A number of studies have examined the ability of young children to use maps for navigation. These studies have been particularly interested in the issues of rotation and alignment. A rotated map is turned so that it does not "line up" with reality while an aligned map is oriented in relation to the space it represents. Based on this research, it would appear that young children can use maps for navigation at a young age. For example, Bluestone and Accredolo (1979) found that children, age five, could use a simple, vertically-drawn map containing iconic symbols to navigate through space. Younger children, ages three and four, had more difficulty using the maps quickly and accurately. All subjects had difficulty with rotation, but most were able to interpret the symbols correctly. Their research was corroborated by Presson (1982) who found that second graders outperformed kindergartners in a navigation task; again, both groups had difficulty with rotation. Additional studies (Blades and Spencer 1987, 1990; Bremner and Andreasen 1998) have documented the abilities of young children to use simple maps for way-finding. From these studies, we know that (1) children as young as three can use *simple* maps for navigation, (2) ability to do so improves with age, and (3) knowing when to rotate a map is a significant stumbling block in navigation tasks. Such navigation tasks require that children understand the symbolic nature of a map, see the relationship between the map and the environment it represents, locate one's self on the map, and then plan a route (Blades and Spencer 1987). Unsuccessful navigators seem to face two problems, according to Blades and Spencer (1987): (1) they did not see the relationship between the map and reality; or, (2) they did not use the map to find their way.

Beyond the issues of rotation and alignment, research has considered the differences between using a map for navigation versus experiential knowledge. The opportunity to study a map prior to way-finding results in more successful navigation than learning a route by physically traveling along it (Uttal and Wellman 1989). Children (ages four through seven), who had studied a map prior to following a particular route, gained initial information from the map and, consequently, were able to learn the route faster. A second experiment examined how using a map while in-route might aid performance: subjects who used a map while in route were no more successful than subjects who studied the map ahead of time. The participants were not given any instruction on how to use maps but young children were still able to do so.

In each of the above noted studies, the simplicity of the map used is stressed by the authors. The maps used contained one simple layer of information. It, of course, makes sense to use simple maps with young children who have limited reading abilities, vocabularies, and experiences, but what happens when complexity increases? What happens when a multi-layered map is used? Research has not addressed navigation tasks with more complex maps, or with older children. The studies described below show that adults have difficulty using maps for navigation. The gap between young children using simple maps and adults using less simple maps is wide, and worthy of attention.

Two studies (Bartram 1980; Bronzaft, Dobrow, and O'Hanlon 1976) suggest that map complexity affects navigational abilities. In both cases, college students were given the task of using transportation maps to plan the best route from Point A to Point B. In the first study, Bronzaft, Dobrow, and O'Hanlon (1976) had college students (n = 20) find their way through the New York subway system: subjects were given one token, a list of stations to visit, and a map on which to base their route. Overall, subjects were unsuccessful in their task. A number of map reading errors can be identified: inadequate use of the legend (only seven subjects used the legend, six of whom consulted it just once), inability to correctly interpret map symbols (e.g., a cluster of dots represents a transfer point), and an unwillingness to rely and use map information (indirect routes were taken in order to avoid getting lost).

The authors believe that the subway map—which was the actual New York City subway map available at the time of this study—was poor, and there is evidence to

suggest that the type of map used for navigation is an important predictor of successful way-finding (Bartram 1980). For example, college students using a schematic map to identify the most efficient bus route in London were more successful than those using a road map. It is suggested that the schematic map was easier to use because it provided task-specific information and omitted superfluous information. The task at hand is important; as the author notes, if a bus rider needed additional information, such as the closest bus stop to a particular address, then the schematic map would be useless.

These two studies suggest (1) the importance of selecting a map that is appropriate to the specific task of the user, and (2) that as task complexity increases, map complexity should decrease. Matching the task to the map makes sense, given that maps show limited, selective information about the area they represent. Even the most detailed map contains only selected information. What these two studies do not address is the map reading ability of their subjects. Bronzaft, Dobrow, and O'Hanlon (1976) suggest that the subway map was poor, however, it might also be that the subjects are poor map readers, especially given that most did not use the legend and had difficulty interpreting a cluster of dots. These studies certainly point to the problems of navigating with either a poor map or poor map-reading abilities.

Beyond Navigation: Understanding Other Types of Map Information

Studies in this section consider a variety of topics: symbol interpretation (Abel and Kulhavy 1986; Gerber 1984; Mealey, Cohen, and Jordan 1998; Trifonoff 1995; Wiegand and Stiehl 1996), map construction (Bausmith and Leinhardt 1998; Leinhardt, Stainton, and Bausmith 1998; Wiegand 2002), overall map design (Miller 1982) and general map interpretation (Boardman 1989; Gregg 1997; Ormrod et al., 1988; Thorndyke and Stasz 1980). What this disparate group of research shares in common is a focus on maps for purposes other than navigation. Since finding one's way is only one part of map literacy, these studies provide important data about how people understand, interpret, and utilize maps in ways other than navigation.

From a limited number of studies, it can be surmised that symbol interpretation can be a difficult task for both children and adults. Interpreting a symbol requires two general steps: identification, followed by comprehension. Comprehension, is the more complex step, according to Gerber (1984), requiring the reader to recognize the symbol within its context, outside its context, and then understanding its meaning. In a study of children, ages eight to fifteen, Gerber found that children were able to identify a symbol long before they were able to interpret it. Success in interpretation was directly related to age: older subjects were better able to identify the meaning of symbols. Similar findings occurred in a study of children's ability to interpret symbols in picture atlases. For example, the ability to accurately identify represented economic activities ranged widely from correctly identifying cereal crops to literally and incorrectly interpreting a drill and pickaxe symbol as tools rather than identifying it as mining activities (Wiegand and Stiehl 1996, 21). It is suggested that symbol interpretation follows a "loose" hierarchy: (1) children are able to correctly identify the symbol but do not understand the meaning; (2) a literal misinterpretation is made (e.g., a picture of a coat is interpreted as someone leaving their coat there); (3) the metaphor is misapplied; (4) the metaphor is partially understood; and (5) the metaphor is correctly applied (Wiegand and Stiehl 1996, 22). While understanding symbolization can be difficult, students have also successfully interpreted thematic maps (Trifonoff 1995). Second graders examined simple maps at three scales (neighborhood, city, and national) with symbolization that varied by color, intensity of color (e.g., shades of gray), size, and shape. Students successfully interpreted the maps regardless of symbolization. These studies suggest the

importance of map selection based on students' abilities. Age of the map user as well as individual differences will affect a user's ability to accurately interpret symbolization.

It is noteworthy that interpretation of symbols is not just a stumbling block for children. Bronzaft, Dobrow, and O'Hanlon (1976) noted that college students misinterpreted symbols, and Mealey, Cohen, and Jordan (1998) found that map users have difficulty matching the symbols on a map to reality, particularly if the map is rotated. The more abstract the symbol is, the greater difficulty subjects seem to have interpreting it. Furthermore, research suggests that adults remember map information more easily when symbolization is pictographic rather than geometric (Kulhavy, Schwartz, and Shaha 1983).

Not surprisingly, research has found that the overall design of a map impacts a students' ability to use it effectively. Miller (1982) studied students' (grades four through six) ability to use a map that was illustrated four different ways. Variations in font size, graduated symbols, and a missing compass-rose affected students' performance on a variety of tasks. Maps can be made more comprehensible for children by using clear, unambiguous symbols and an appropriate scale and title (Winn 1987).

Constructing maps is considered an important component of map literacy. Through the construction of maps, it is expected that students will gain a better understanding of cartographic principles. Consequently, students should be able to better interpret maps (Bausmith and Leinhardt 1998). For example, Wiegand and Stiehl (1996, 23) report that children generally accepted the differences between maps based on their erroneous conception of how maps are made: cartographers design maps from their first-hand experiences visiting the places they are representing. When students understand the process of selection and symbolization, they might be better able to understand, for example, why a red line was used to represent a toll road and blue line, a river. Research suggests that students who construct maps are better able to make connections between map elements (such as the connection between scale, latitude and longitude, and size of land masses) and improve map reasoning skills (Bausmith and Leinhardt 1998; Leinhardt, Stainton, and Bausmith 1998). In addition, it seems that students who collaboratively engage in map making help clarify each other's reasoning and understanding of cartographic processes (Wiegand 2002). Research in this area is

limited by (1) a small sample size (Bausmith and Leinhardt 1998); and, (2) its initial nature (Wiegand 2002). It is the same old song: more research is needed.

Research suggests that for most people, map interpretation is a difficult task. Often, people have a difficult time visualizing a three-dimensional area based on a two-dimensional map. For example, Boardman (1989) finds that adolescent students have a difficult time interpreting contour maps. Boardman's subjects are not alone: Livni and Bar (2001) note that children as well as teachers encounter problems in interpreting topographic maps. Gregg (1997), in a study of fifth and seventh grade students' ability to pose (and answer) questions about maps, found that misinterpretation was common. For example, students seemed unable to infer the meaning of the legend on a map showing the American alligator's habitat, had difficulty accurately calculating distance from the map's scale, and misinterpreted the legend. Interestingly, she found that students' were unable to see beyond the map basics (location, distance, direction).

It has been a finding of many studies that practice improves map use. It might also be that some individuals possess expertise in map reading: Ormrod et al., (1988) found that geographers had superior memory of a map as compared to sociologists and educational psychologists. Furthermore, when confronted with an illogical map (e.g., rivers originated in flat lands and ended in mountains, railroad tracks avoided towns in which they logically would have stopped), only geographers expressed frustration about the lack of spatial logic in the map. The authors conclude that

> The results from both studies are consistent with our hypothesis that true map experts are likely to apply principles and theories of spatial arrangements to the learning of a map. The principles that geographers apply...will presumably allow them to organize map information in ways that other groups cannot (Ormrod et al., 1988, 431).

Other studies (Anderson and Leinhardt 2002; Thorndyke and Stasz 1980; Underwood 1981) have examined the differences between experienced and novice map users. In one study, subjects were given the task of studying a map and then drawing the map from memory (Thorndyke and Stasz 1980). Experienced map users (defined as those who used maps regularly in their jobs) had varying success, leading the authors to note that "if familiarity with maps were the critical variable, then all experienced users should have performed well" (156). Instead, the authors found that successful learners developed a learning strategy to deal with the task's lack of

structure; this strategy included focusing systematically on sections of the map, encoding both spatial and verbal information, and being self-aware and self-evaluative of their learning, so that they could adjust their map study according to their own strengths and weaknesses (171). Research by Underwood (1981) suggests that these skills can be the result of instruction; in a comparison of female geography students, ages fifteen and seventeen, those students who had taken more geography courses fared better at reading topographic maps than those who had taken fewer classes. It is of note that the authors evaluated the visual-spatial ability of study participants, and higher abilities did not translate into improved reading of the contour map. This finding suggests that “controlled experience” (i.e., instruction) can compensate for limited innate ability. More recently, Anderson and Leinhardt (2002) found that expert map users, in this case tenured geography professors, exhibited superior abilities in a map task. Furthermore, experts could be distinguished from non-experts based on the reasoning used to complete the task successfully: experts either knew how to solve the problems or were able to generate accurate solutions. In addition, experts used a visualization strategy that allowed them to picture the three-dimensional earth from the two-dimensional map used in the study.

The research of Ormrod et al., (1988) suggests that geographers apparently understand that maps have certain logical properties while novices are unaware of them. Research by Thorndyke and Stasz (1980) suggests that expertise in memory for maps is more than just regular use. Research by Mealey, Cohen, and Jordan (1988) also suggests that regular use does not translate to ease of use. Further research distinguishing experts from regular users from novices would benefit instruction. Practice can certainly improve map user’s abilities but it would not seem to make them experts, which raises the question: Is expertise a result of instruction, a natural predisposition, or developed through regular exposure to maps?

Instruction in Map Learning

Little research in effective instructional methods has been conducted. The limited nature of research has been noted (Bednarz 1995; Downs 1995; Saku 1992). Many instructional strategies exist on how to teach map skills (see, for example, Forsyth 1988; Hawkins 2003; Krech 1999; Levstik 1985; Muessig 1985; Taketa 1996). Lesson plans such as these could possibly be effective, however without a theoretical basis or investigation of their methods, there is no way of determining their utility. Only a handful of studies provide some clue about what "works." The following studies, discussed in chronological order, examine various aspects of map learning (e.g., type of map best suited for information recall; map construction; projection, rotation, and alignment; instruction on topographical maps) reflecting the broadness of the topic.

In the often-cited "Introducing Basic Map and Globe Concepts to Young Children," Atkins (1981) examines whether four and five year old children can be taught about maps and globes. An experimental group received instruction while a control group received none. Her sample was small (n = 22). Half of the sample received a four-week instructional unit, teaching "basic concepts" which included such topics as shape of the earth, the globe as a model for the earth, directions, earth-sun relationships, and scale (231). Pre- and post-tests were administered to both the experimental and control groups but the test itself was not included, making it difficult to know what was tested. From her analysis, it is clear that the experimental group's performance was superior to that of the control groups. She did re-test the group a year later, finding that the experimental group performed significantly better than they had on the initial pre-test and still significantly out-performed the control group, suggesting they had retained some of the instruction. Atkins study showed that young children can be taught map skills and retain some of what they learned.

In "Map Use Teaching and Experience" Saku (1992) studies sophomore geography and psychology undergraduates' ability to use topographic maps. His question was two-fold: is instruction in map interpretation helpful and is there a difference in the ability of students with geographic training versus those without? Saku provides a sound theoretical framework, examining understanding of cartographic vocabulary and studies of map learning.

As noted, Saku chose geography and psychology majors in attempt to compare those with map experience versus those without. He assumes that psychology students have had little to no map training or experience and that geography students have had training in reading topographic maps. These are big assumptions to make. It is possible that the psychology students have had some type of formal experience with maps, either through school or possibly through outside activities such as scouting. It is also possible that the geography students have not had experience with topographic maps.

He designed his study to assess levels of map task competency. In Level I, map users are able to distinguish between basic symbols on a map. For example, a user would be able to identify that a dot on a map represents a town. A Level II user is able to incorporate Level I abilities and recognize spatial patterns. Level III users are able to garner information from maps and make decisions based on the information conveyed in them. By this level, users understand symbol-referent relationships. In this study, participants were given a topographic map and series of questions which addressed these three levels of map competency.

Geography students generally out-performed psychology students and instruction resulted in greater ability than no instruction. Saku finds that a short instructional unit about reading and interpreting maps improves student performance. The instruction lasted only twenty minutes. Like Atkins, Saku found that some instruction is better than none.

Chiodo (1997) studies how seventh grade students' world cognitive maps can be improved through instruction. Two classes for a total of forty-four students participated in this study. One class served as the control group while the other received a week's worth of instruction on cognitive mapping.

The control group received "traditional" instruction in developing their mental map which entailed independently studying maps, atlases, and globes with no particular, direct instruction. Chiodo instructed the experimental group on basic shapes of the continents, reference lines, visualization through a puzzle activity, and by drawing maps of individual continents. The protocol group performed better (statistically significant) than the control group.

He, like Atkins (1981) and Saku (1992), has shown that some instruction is better than none. Chiodo notes that his protocol lesson was compared to a traditional method

that really entailed little instruction. To determine the effectiveness of his lesson, he believes it must be compared to other, more direct-types of instruction.

Gregg (1999) investigates the map reading and interpreting skills of two groups of seventh graders. Two models of instruction were employed. One group of students learned map skills by constructing maps; the other group learned map skills through traditional map reading activities. Students were given pre- and post-tests, and a subset of the sample was interviewed in order to understand better what was learned. Interview data supported test results. Gregg found that all students learned, regardless of instructional model, but students who constructed their own maps learned more. Symbols and latitude and longitude were understood better than scale by all students, regardless of instructional method. Gregg's study offers further support to the idea that instruction in map skills benefits students' understanding. This research offers an important comparison in teaching methods as well. Other studies have compared instructional methods to no-instruction; with this study, some insight about what works better is provided.

Livni and Bar (2001) provide further insight as to how instruction can benefit students' physical map reading and comprehension abilities. In this study, the authors developed a series of map reading lessons for grade four students in Israel. Two surveys found that both Israeli students and teachers have difficulty successfully interpreting and using topographical maps—a necessary skill according to the mandated curriculum. The lessons sought to build on students' existing abilities, provide a student-centered learning environment, and develop understanding of spatial concepts. In a controlled teaching experiment, it was found that an experimental group had mastered the concept of a vertical viewpoint, allowing them to determine elevation from a topographic map. The authors note that (1) they assumed the map skills of fourth grade students prior to the experiment were essentially non-existent, and that (2) the control group received "conventional" instruction. Their assumption that students possessed few map skills is based on previous research which found that map skills were not being taught in Israeli elementary schools. Livni and Bar do not provide any description of the traditional instruction that the control group received. Inclusion of these materials would have been helpful in order to compare the two types of instruction implemented.

Both theoretical and empirical studies indicate that instruction improves map literacy (Atkins 1981; Boardman 1989; Chiodo 1997; Downs and Liben 1991; Gregg and Leinhardt 1994; Gregg 1999; Livni and Bar 2001; Matthews 1992; Saku 1992). The conclusion of Atkins (1981), Chiodo (1997), Saku (1992), and Livni and Bar (2001) is that *some* instruction is better than *none*; the implication is that prior to their studies, map skills were not taught in the classrooms in which they conducted research. These studies point to a significant gap in the literature: the quantity, quality, and duration of "typical" map skills instruction is unknown. The literature reviewed in these sections indicates that beyond simplified maps, users of all ages encounter problems in navigation and interpretation of maps, especially when complexity increases; skill in reading and interpreting maps improves with practice and instruction; and, the content, duration, and timing of map skills instruction is unknown.

Teacher Beliefs, Knowledge and Practices

Research Questions 1 and 2 of the present study consider the role of teacher beliefs, knowledge, and practices in developing map literacy. The role of teachers in learning outcomes cannot be diminished; as Theodore Sizer noted: "in reality, it all comes down to the teachers" (Delbanco 2002, 64). This section considers the interrelated topics of beliefs, knowledge, and practices in teaching. Little research exists to this date that examines the beliefs, knowledge, and practices of geography/social studies teachers. Only one study addresses teacher knowledge in the area of map learning specifically (Giannangelo and Frazee 1977). However, extensive educational research considers beliefs, knowledge, and practices in other content areas.

Teacher Beliefs and Practices

Understanding teachers' beliefs is important, considering that teacher beliefs impact practices in the classroom (Handal and Lauvas 1987; Munby 1984). For example, Smith and Shepard (1988) found that teachers' beliefs about school readiness generally influenced their decisions to promote or retain kindergartners. Beliefs consequently influence practice, and the complex interaction of beliefs and practices is termed *practical theory*, defined as "a person's private, integrated but ever-changing system of knowledge, experience and values which is relevant to teaching practice at any particular time" (Handal and Lauvas 1987, 9). Beliefs are of course not the sole determinant of practice; the educational and social context also influence practice (Smith and Shepard 1988). For example, the curriculum goals established by the school may override beliefs and modify practice. However, beliefs are considered an important determinant of teacher practice: studies have found that many teachers view themselves as purveyors of knowledge, controlling what students learn (Clark and Peterson 1986; Jetton 1994; Rearden 1998) despite research which advocates student-centered teaching (Good and Brophy 1997). Research clearly indicates that teachers' beliefs affect how they manage the classroom and structure learning opportunities.

Teacher Knowledge and Practices

Instructional practice is heavily influenced by teacher knowledge; this statement is true regardless of subject or grade (Brophy 1991). Extensive research examines the knowledge base of teachers. Shulman (1986a, b) identifies two domains within teacher knowledge: pedagogical knowledge and content knowledge. Both are necessary for effective teaching to occur. Pedagogical knowledge is knowing how to teach. Knowing how to teach includes the ability to motivate students to learn, to manage the classroom, and to develop and utilize appropriate curriculum materials (Sternberg and Horvath 1995, 11). Many studies (Brophy and Evertson 1976; Flanders 1970; Stallings 1975), conducted particularly during the 1970s, found a strong link between classroom management and student achievement.[7] Teachers must possess pedagogical knowledge, but content knowledge is equally important.

The domain of content knowledge is further delineated by Shulman (1986a, b) into three categories: subject-matter content knowledge, pedagogical content knowledge,

and curricular knowledge. Subject-matter content knowledge, herein referred to as *content knowledge*, is the domain-specific knowledge needed to teach a particular course such as human geography. Pedagogical content knowledge is the understanding and implementation of effective teaching practices in a particular subject. In other words, teachers know the subject that they are teaching and effective ways to teach it. For example, pedagogical content knowledge in geography and the social studies might include knowing how to most effectively teach longitude and latitude. Curricular knowledge is "the pharmacopeia from which the teacher draws those tools of teaching that present or exemplify particular content and remediate or evaluate the adequacy of student accomplishments" (Shulman 1986a, 10). Curricular knowledge includes an understanding of the content of a subject at different grade levels (the *vertical* curriculum) and the ability to relate course content to that of other courses being taken by the student at that time (the *lateral* curriculum) (Shulman 1986a, 10).

To be an effective teacher, one must possess knowledge in each domain (Garnet and Tobin 1988; Rearden 1998; Shulman 1986a, b). Exemplary teachers possess all four types of knowledge. Teaching philosophies can and do differ, but effective teachers know *what to do* and *why to do it* (Handal and Lauvas 1987, 20). Echoing this finding, in their study of exemplary chemistry teachers, Garnet and Tobin (1988, 11) found that "pedagogical knowledge and pedagogical content knowledge are the...determining steps in the equation for effective...teaching." While Garnet and Tobin emphasize the need for both types of knowledge, they believe that deficiencies in pedagogical content knowledge can be moderated through planning; deficiencies in content knowledge are more difficult to remedy. Lee (1995) echos their finding, and reports the consequences that occur when a teacher has limited content knowledge. In a case study of a middle school science teacher who, by her own admission, was unprepared to teach science, Lee finds the teacher using strict classroom management, teaching from the textbook, and independent seat-work to compensate for her limited content knowledge. Lack of content knowledge might mean that the discipline gets under-taught and/or is given cursory treatment (Gudmundsdottir and Shulman 1987).

In addition to pedagogical and content knowledge, teachers also must understand the linkages between pedagogy and the specific content they are teaching. As Gudmundsdottir and Shulman (1987, 60) write "pedagogical content knowledge is both

built with and builds upon content knowledge, general pedagogical knowledge, and knowledge of learners." Although teacher preparation programs tend to require coursework in pedagogy and content, research has shown that there is little connection made between pedagogy and content courses for pre-service teachers (National Center for Research on Teacher Learning 1992).

Content Knowledge in Geography

The limitations of teacher knowledge in particular subjects have been well-reported. This section focuses specifically on the literature relating to geography teacher knowledge. Teachers' knowledge in the area of map literacy is most likely to be developed in geography. No discipline uses maps more than geography (geology perhaps uses them in equal abundance). If teachers are to develop a rich understanding of the ways that maps can be used to understand geographic concepts and think like a social scientist, then literature relating specifically to the knowledge base of geography teachers is relevant to this study. Thus far, limited attention has been given to this area. It would seem that there is renewed interest in the knowledge base of geography educators (Smith 2002). For now, though, there are three empirical studies (Giannangelo and Frazee 1977; Gregg 2001; Whisenant 2002) that consider the role of the teacher in geography education specifically. In each study, limited understanding of geography and poor preservice preparation are noted.

Giannangelo and Frazee (1977) assessed elementary teachers' map reading abilities using the map reading section of the Iowa Basic Skills Test at the sixth grade level. No teacher attained a perfect score and one-third of participants fell below the sixth grade level. The authors assert that if teachers' scores had been equalized to their "grade" level, the scores would have been much lower. It is likely that these teachers lack the content knowledge to develop map literacy effectively among their students.

Gregg (2001) examined the content knowledge of pre-service geography teachers, considering their preparedness and subsequent ability to teach fourth grade students about rivers. It was found that geographic concepts were often over-simplified and erroneous information was either presented to students, or went unchallenged when offered by students. For example: "One teacher informed the children that the Nile River ends in a waterfall" (Gregg 2001, 65). Beyond erroneous information, it would seem that

the preservice teachers in this study, focused their lessons on factual information rather than conceptual understanding. Inaccuracies, oversimplification, and misguided focus are attributed to insufficient knowledge about rivers. It cannot be expected that educators will leave teacher preparation programs with *all* the content knowledge they will ever need, however, Gregg argues, they can be prepared to assess their knowledge, identify deficiencies, and have the requisite skills to remedy any gaps in their knowledge.

Additional research examined the effects of teacher conceptualizations of geography on curricular emphasis (Whisenant 2002). Conceptualizations of geography were framed according to Pattison's (1964) four traditions (area studies, human-environment interactions, earth science, and spatial analysis). It was found that teachers placed emphasis on area studies and human-environment interactions; far less attention was given to spatial analysis and earth science. Some teachers in this study stated that they wanted their students to develop spatial analysis skills, but their curriculum did not reflect this desire. Earth science faired even worse. Whisenant notes that, despite the discipline's human and physical interests, it is most often taught within the social studies where locational and cultural topics are stressed. These topics are emphasized because teachers view them as important, and/or they are comfortable teaching them. A significant finding of this study is that teachers who have a partial or limited conceptualization of geography tend to "select course content that is less complex regardless of the grade level taught" (Whisenant 2002, 94). Like Gregg, Whisenant finds geography teachers have a shallow conceptualization of the discipline at both the elementary and secondary levels. She believes this limited view may be related to pre-service preparation.

Gregg and Whisenant's research offers geography-specific support to the literature about teacher beliefs, knowledge, and practices. In the classroom, student learning is dependent on what a teacher knows, and both studies point to the problem of preservice preparation in geography. This matter is addressed next.

Preservice Preparation in Geography

As previously noted, teachers who have limited content knowledge are less likely to be effective in the classroom. The social studies are a composite discipline, which has

been dominated by history (Bednarz 2002). It would seem that adequate preparation in sub-fields other than history is a problem. For example, Aske (2003) notes the limited preparation of high school social studies teachers in economics and Mitchell et al., (1997) discuss poor preparation in civics. Geography too shares this problem (Bednarz 2002; Bednarz and Bednarz 1995; Boehm, Brierly, and Sharma 1994). Preservice teachers may see little value in geography courses because of a limited understanding of the discipline. Generally, people have little idea about what geography is and what geographers do; teacher conceptualization of geography has been found to be little different (Whisenant 2002). Bednarz and Bednarz (1995) note that educating preservice teachers in geography faces a few hurdles: geography faculty do not understand the teacher education process, education faculty generally do not understand geography, and there is limited communication between the two groups. This task of preservice education in geography is further compromised by limited attention by geographers and educators alike (Boehm, Brierley, and Sharma 1994).

The need for more comprehensive preservice education in geography has been noted. It has been suggested that those certified in geography at grades seven through twelve take at least twenty-four hours of coursework, including physical, economic, and world regional (Boehm, Brierley, and Sharma 1994, 23). However, the reality is that many preservice social studies teachers take only one geography course during their college preparation (Wilson, Weller, and Cole 1998).

In Texas specifically, the state exerts limited control over preservice teacher preparation. Certification is earned at three grade levels: early childhood to grade four; grades four through eight; and, grades eight through twelve. Certification at the first two grade levels is a *generalist* certification, allowing educators to teach a variety of subjects, including social studies. At the high school level, teachers can be certified in social studies, or history. Course requirements for this preparation are determined by individual academic institutions, consequently, course requirements vary between teacher preparation programs.

It is likely though that the certification process in Texas, as well as other states, is about to change due to the No Child Left Behind Act of 2001. This act is meant to improve educational quality across subjects for all American students, with a particular focus on improving the quality of teachers. By the 2005–2006 academic year, teachers

in core subjects[8] must be *highly qualified*, which means a Bachelor's degree, full state certification, and *demonstrated competency in the core academic subject area assigned* (Texas Education Agency 2003). For future elementary teachers, competency is demonstrated by passing approved competency exams; secondary teachers must either pass a content exam applicable to the teaching assignment, or have an academic degree in the subject area in which they teach. This requirement means that high school World Geography Teachers would have to show some kind of competence in the discipline.

This discussion of preservice preparation in geography assumes that geography courses will better prepare future educators to teach map skills than other disciplines. Certainly, by taking a variety of geography courses, students will be exposed to maps, however it is unknown how much discussion about maps takes place in undergraduate geography courses. As Downs and Liben (1991) have noted, most geography faculty assume basic map competency of their students, and consequently spend little time discussing the components and uses of maps. Couple that with the difficulty preservice teachers often have translating course content knowledge into teachable material for their students, and the situation is worrisome.

Curricular Issues

Research Question 3 considers the extent to which educators understand the curricular requirements specific to map literacy. It is understood that the term *curriculum* is much debated and contested (see Clandinin and Connelly 1992, Posner 1992, Queen 1999); it is not the purpose of this study to debate the conceptualization of this term. Instead, this study is interested in teachers' understanding of the *formal* curriculum, in this case the state-mandated TEKS. For these reasons, *curriculum* is defined in this study as "the content or objectives for which schools hold students accountable" (Posner 1992, 4). In Texas, a formal, required curriculum, the TEKS, is in place; it would be difficult to conceive of a Texas teacher ignorant of the TEKS. However, there are other factors that influence implementation of any curriculum. Implementation is not as simple as making a curriculum law. Instead, the curriculum is filtered through textbooks and other support materials, formal assessments, and teachers. Each of these factors is discussed below, but first the curriculum particular to map literacy is discussed. To do so, it is necessary to consider both the National Geography Standards and the TEKS.

Map Literacy, Geography for Life, and the TEKS

The criteria for map literacy embodied in the TEKS is attributable to the National Geography Standards. The Standards were used as a guide for the geography strand of the TEKS. Published in 1994, they offered a current reflection of the knowledge and skills that comprise geographic literacy. In an effort to move away from the rote memorization common to geography education, the Standards encouraged "doing geography, rather than studying geography" (Bednarz 2002, 162).

Geography for Life provides benchmarks at three key grade levels: fourth, eighth, and twelfth. The benchmarks are spiraling in nature; as students grow intellectually, the Standards grow increasingly challenging. The Standards outline eighteen specific goals (*standards*) that are divided among a framework of six general themes (*essential elements*): the World in Spatial Terms, Places and Regions, Physical Systems, Human Systems, Environment and Society, and the Uses of Geography. Each standard is accompanied by a set of criteria outlining what students should be able to do, based on

their geographic knowledge. For further guidance, *learning opportunities* accompany each criterion.

Map literacy is contained within the first essential element. Table 2 offers a sample of what students should know and be able to do with regard to the first essential element at each grade level. From this table, it is clear that students are expected to understand maps and map elements, as well as use maps to understand and illustrate geographic concepts. In other words, students should have opportunities to learn *about* maps, as well as learn *with* maps.

Like the Standards, the TEKS provide a scope and sequence of what students should know and be able to do. Their focus on knowledge and skills is similar in structure to national standards documents like *Geography for Life*. The TEKS were adopted in 1997 for all grades and all subject areas. As noted previously, geography and map literacy fall squarely within the social studies. The complementarity of the geography strand of the social studies TEKS and *Geography for Life*, as well as the spiraling nature of both sets of standards means that Texas students who complete thirteen years of social studies should be exposed to each of the eighteen standards in *Geography for Life* (Whisenant 2002, 8). However, in the area of map literacy, it would seem that *Geography for Life* requires more of students than the TEKS. For example, the Standards advocate that by the end of the fourth grade, students should be able to "observe and compare the patterns and densities of places on Earth's surface" (Geography Education Standards Project 1994, 111); the TEKS contain a similar requirement, but not until the sixth grade: "The student is expected to pose and answer questions about geographic distributions and patterns for selected world regions an countries shown on maps, graphs, charts, models, and databases" (Texas Education Agency 1997, 6.3B).

Table 2. Sample Criteria for Map Literacy at Three Grade Levels*

Standard	Grade	Sample Criterion	Learning opportunity
1: Map Use	4	A. Identify, describe the characteristics, purposes of geographic representations, tools, & technologies	Examine a variety of maps to identify, describe their basic elements (e.g., title, legend, cardinal & intermediate directions)
	8	C. Evaluate the relative merits of maps in terms of their value in solving geographic problems	Choose the most appropriate maps and graphics in an atlas to answer specific questions about geographic issues
	12	B. Use maps & other geographic representations to analyze world events, suggest solutions to world problems	Use several different maps to account for selected consequences of human/environment interactions
2: Mental Maps	4	A. Identify major physical, human features at a variety of scales using maps, globes, other sources of graphic information	Use labels and symbols to locate & identify physical & human features (e.g., largest cities, historic sites, landforms) on a prepared base map of the state or the U.S.
	8	A. Identify locations of certain physical & human features, events on maps, answer related geographic questions	Identify the largest urban areas in the U.S. now and in the past.
	12	C. Compare the mental maps of individuals to identify common factors that affect the development of spatial understanding & preferences	Compare maps of the world using different projections and perceptions of space to draw conclusions about factors that influence mental maps.
3: Spatial Analysis	4	B. Use the spatial concepts of location, distance, direction, scale, movement, and region to describe the spatial organization of places	Locate the homes of classmates and the school on a map, measure the distance from each to school, determine the direction from each home to school
	8	C. Explain the different ways in which places are connected and how these connections demonstrate interdependence and accessibility	Develop time lines, maps, and graphs to determine how changing transportation & communication technology has affected relationships between places.
	12	A. Apply concepts of spatial interaction to account for patterns of movement in space	Predict the effects of changing community transportation routes on the current structure & pattern of retail-trade areas, parks, and school bus routes, given that such changes may create a new network of connections between locations & new intervening opportunities for shopping or services

(Geography Education Standards Project 1994) *Text of standards, criteria, and learning opportunities are abbreviated due to space.

Teachers, Curricular Materials, and Formal Assessments

Implementation of the curriculum is affected by a variety of factors, including teachers, curricular support materials, and high stakes testing. These three factors are interrelated. Teachers select what to teach from textbooks, but textbooks also guide what content is taught from day to day, and the content of assessments, which should reflect the content of the curriculum, influences the content of textbooks and other support materials, as well as the topics teachers cover or ignore.

Even with a state-mandated curriculum, state-adopted textbooks, and a formal assessment (the Texas Assessment of Knowledge and Skills, or TAKS), teachers act as an important filter of the curriculum (Cornett 1990; Feldman 2002; Floden et al., 1981; Whisenant 2002). In order to implement a curriculum, teachers must be familiar with it. That familiarity means an ability to describe the basic knowledge and skills students should acquire by the end of the school year. Teachers might know the curriculum (either in detail or in general) and know they are supposed to teach it, but that does not necessarily mean that they do; they may even state their support of a given curriculum, but then resist full implementation (Feldman 2002; Floden et al., 1981).

The reasons why are related to teacher beliefs, knowledge, and practices. For example, teachers' ideas of teaching and learning might run counter to the curriculum. In a case study of two Physics teachers, it was found that teachers' conceptions of what *should* be taught adversely affected implementation of a new curriculum (Feldman 2002). Clark and Peterson (1986, 291) concur, warning that: "When implementing a significant curricular, organizational, or instructional change...teachers' belief systems can be ignored only at the innovator's peril."

Similarly, in a case study of three geography educators, Bednarz (2003a) finds little evidence to support the claims of study participants that they are in fact teaching Standards-based geography. For example, in observations of a unit about culture, "students, by and large, were presented with disconnected sets of facts and concepts, not the systematic understanding of the core concepts related to culture presented in the Standards" (Bednarz 2003a, 104). One possible reason for this finding is that the teachers do not understand or correctly interpret the goals of the Standards.

Further evidence comes from a Dutch study about teachers' adoption of a new curriculum in classical languages (Verhoeven and Verloop 2002). It is found that the intended, formal curriculum is quite different from the implemented curriculum. Like Bednarz (2003a), Verhoeven and Verloop find that teachers placed greater emphasis on rote learning (e.g., translation) rather than deep understanding (e.g., reading comprehension). Two possible explanations are suggested: (1) teachers "lack the skills needed for constructing reading-comprehension questions that assess higher-order skills" (Verhooven and Verloop 2002, 100); or, (2) teachers' support for the new curriculum is stated but not really believed. These three studies from different disciplines illustrate the disparity that can occur between the formal, intended curriculum and the one that actually gets taught.

Support materials also play an important role in curriculum implementation. Textbooks are often used as an everyday guide; Venezky (1992, 437) describes textbooks as the "surrogate curriculum." With contemporary texts including teacher guides, study guides or workbooks for students, overheads, and additional instructional materials, they might be better described as "instructional systems" (Posner 1992, 5). Teachers often look to these instructional systems to guide the specifics of what and how they teach. Such instructional materials are important for teachers who need specific guides; the Standards and the TEKS tell teachers what the results of learning should be, not how to get there. The appeal of textbook reliance is not difficult to understand: they offer expertise on a topic that might not be possessed by the teacher, logical sequencing, and a variety of supplementals like activities, questions, test items, and even identification of areas where students might face difficulties (Venezky 1992, 442).

In the case of a new curriculum, instructional materials are crucial for successful implementation. For example, Bednarz (2003a, 101) notes that in geography "The lack of supplemental material and weak support from textbook providers are major impediments to translating the content and skills of *Geography for Life* into meaningful, easily implemented classroom-ready and teacher-friendly curricula." In Texas, the importance of materials which support the curriculum is addressed through a state-adoption process. State-level textbook review panels evaluate materials to identify those texts that conform with each element of the TEKS. Based on these evaluations,

textbooks and their ancillary materials are placed on the conforming list, the nonconforming list, or rejected. TEA states the conforming materials address 100% of the TEKS for the subject area and grade adopted while nonconforming materials address between 50-99% of the TEKS (TEA 2003). Local school districts review materials from these lists and make selections. Because Texas has a state-mandated curriculum and textbook selection process, and also because Texas has a large population of students to educate, publishers develop Texas-edition textbooks which specifically address the TEKS. In the social studies, new textbooks were approved by the State Board of Education (SBOE) in 2002, for implementation during the 2003-2004 school year. With three exceptions (sociology, psychology, and advanced placement courses at the high school level), all social studies adoptions on the conforming list were Texas-editions.

There is little research that considers how well adopted textbooks in the social studies correlate to the TEKS. In an evaluation of conforming World Geography texts with 2002 release dates, Bednarz (2003b) finds that nearly ten years after the publication of the Standards and six years after adoption of the TEKS, textbooks are beginning to reflect the Standards. In the area of map skills in particular, Bednarz (2003b) finds a mixed bag. All four of the textbooks are filled with maps, pictures, diagrams, and graphs, and all include some type of map skill development, which more often than not focuses on low-level map reading skills like drill and practice—a finding not much different than an examination of map and globe skills in elementary school textbooks nearly thirty years ago (Hawkins 1977). From the textbook analysis, it would seem that the Standards are slowly infiltrating the textbooks at the World Geography level. It is slow progress to be sure, and in a top-down fashion: from national standards to state standards to textbooks and ancillary materials to educators.

Beyond textbooks, a plethora of map and globe skills programs and workbooks are available to educators. Companies like Cram, Rand McNally, Nystrom, and National Geographic offer such materials for a variety of grade levels and a range of costs. There are also a growing number of technology-infused materials to help develop map literacy. There is little research though that evaluates the pedagogy and content of these materials.

High stakes testing is one more factor in how curriculum is implemented. Assessment is an important part of education; it is important to know how much students are learning. In Texas, students are assessed in all subject areas at different points during their academic careers by the Texas Assessment of Knowledge and Skills (TAKS).[9] The social studies are assessed at three points: grades eight, ten, and eleven.

Two problems are associated with high stakes testing. First, teachers may teach to the test. Instead of addressing the goals of the curriculum (which, as an end result, should prepare students for assessment), teachers focus on memorization and drill, and consequently teach a rather limited portion of the curriculum (Smith 1991; Smith and Rottenberg 1991; Yeh 2001). Second, subjects not being tested may be under-taught. In considering the status of geography education, Bednarz (2002, 168) notes: “The impact of testing is especially severe at the K–8 level, where many teachers report that their administrators prohibit them from teaching any content that is not assessed.” This assertion is supported by the research of Konvicka (2001) who found that Texas elementary teachers spend less than twenty minutes a day teaching the social studies and geography; teachers cite the state assessment test, the Texas Assessment of Academic Skills (TAAS), as the primary limiting factor of teaching the social studies and geography. Such a finding might be expected since the social studies are not assessed at the elementary level; social studies is assessed at grades eight, ten, and eleven.

Summary

The literature reviewed in this section informs us about (1) maps and how people learn them, (2) teachers’ beliefs, knowledge, and practices, and (3) the curriculum. These three sections all contribute to the present study’s objective: to understand how teachers approach the development of map literacy. This objective rests on the assumption that teachers are a significant determinant in student learning; if teachers have limited knowledge about maps, map learning, curricular requirements, or do not believe them to be a significant component of their students’ education, then they will not be taught. At this point, there exists no inventory of current instructional methods in map literacy. Such an inventory would reveal the content and duration of such lessons, providing baseline data for future research in curriculum development and assessment upon which to build. Experimental studies testing the effectiveness of current practices,

of newly developed models, or curriculum can be conducted appropriately only when a description of current practices is available (Clark and Peterson 1986).

While map learning is relatively well-researched as compared to other areas of geographic education, the literature reviewed reveals significant gaps. A summary of what we know and do not know follows. It is important to note, that outside of navigation, a relatively small number of studies provide the information below.

- Research has concentrated primarily on learning *about* maps; research has not considered how maps are used to understand geographic concepts or spatial relationships.
- Extensive research has focused on navigation tasks involving simple maps and young children; a smaller number of studies suggest that as map complexity and task complexity increase, adults have difficulties in navigation. The extensive research in navigation seems particularly disproportionate when reviewing the National Geography Standards and the TEKS. While learning how to use a map for navigation is one component of the Standards and the TEKS, there are many other aspects of map literacy which have been ignored.
- Cartographers suggest that an understanding of scale, projection, and symbols is necessary to fully understand a map. Research has considered map users' comprehension of symbols quite well; scant attention has been paid to projection and scale.
- Rotation and alignment are stumbling blocks for many map users regardless of age (Blades and Spencer 1987, 1990; Downs and Liben 1991).
- Topographic maps are difficult to understand, but with instruction, students' ability to visualize three-dimensions from a two-dimensional map improves (Boardman 1989; Livni and Bar 2001; Saku 1992; Underwood 1981).
- Explicating the map making process is important. Wiegand and Stiell (1996, 23) report that children generally accept the differences between maps based on their conception of how maps are made: cartographers design maps from their first-hand experiences visiting the places they are representing. With an understanding of how maps are made, and practice making them, students are likely to better understand cartographic principles (Bausmith and Leinhardt 1998; Wiegand 2002);

- Maps provide both discreet pieces of information, as well as a “big picture” which reveals relationships between phenomena in space; while students have shown some success at identifying those discreet pieces of information (through symbol identification studies), it is unclear whether students are able to integrate the pieces into a big picture. Boardman (1989) finds that students are unable to do so; Blades and Spencer (1990) could not provide evidence that subjects could integrate information, but instead believed that with age, children would be able to form integrated spatial knowledge from maps. If students are to be able to use maps in the rich ways envisioned by the Standards and the TEKS, they must be able to form that “big picture.”
- Map users with extensive geographical background have superior memory of maps, and are more successful in certain map tasks (Anderson and Leinhardt 2002; Ormrod et al., 1988; Saku 1992; Underwood 1981). This finding may be due to an ability to learn both spatial and verbal information (Thorndyke and Stasz 1980). This finding has significant implications for instruction since “students’ relative lack of practice at learning spatial information may restrict their repertoire of learning techniques and highlight ability differences” (Thorndyke and Stasz 1980, 173).
- Finally, map skills improve with age and practice—a finding reiterated throughout the studies reviewed here. This finding has two important implications: first, research has neglected older children, especially those in grades seven to twelve. It is especially ironic given that the bulk of geography education occurs in these grades. Second, if students are to become fluent map users, then they must be exposed to many different maps for many different purposes.

Research about teacher beliefs, knowledge, and practices is extensive. From these studies, it is clear that what gets taught is affected by whether a teacher believes the topic to be important and whether she has the requisite skills and knowledge to do so. Also, contributing to what gets taught is the curriculum and high stakes testing. These factors, along, in all likelihood, with others, influence and shape one another to result in what actually gets taught. A summary of points includes:

- In the area of map literacy, teachers may be constrained by limited knowledge. Many studies have pointed to untrained geography teachers (Bednarz 2002;

Bednarz and Bednarz 1995; Boehm, Brierly, and Sharma 1994; Konvicka 2001; Wilson, Weller, and Cole 1998). Research further suggests that people with a background in geography show superior abilities in some map tasks (Anderson and Leinhardt 2002; Ormrod et al., 1988; Saku 1992; Underwood 1981). These two findings combined indicate the importance of geographic training for those required to teach map skills.

- Teachers might not believe that map literacy is important for the grade level they are teaching. This might be due to limited awareness of the curriculum, limited amount of time to teach un-assessed materials, or just a personal viewpoint (Bednarz 2003a; Feldman 2002; Verhoeven and Verloop 2002). Such a viewpoint, though, is misaligned with the Standards and the state-mandated curriculum, potentially leaving students ill-prepared for state-wide assessments. In addition to map learning improving with age and practice, the Standards and the TEKS are spiraling in nature: if students are to reach the literacy levels described in these documents at grade twelve, then they must meet the levels in all the previous years of their education. There can be no missing link.
- Previous studies in the area of teacher practices in geography describe a rather bleak picture. Limited conceptualization (Whisenant 2002), limited time spent teaching the subject (Konvicka 2002), subscribing to, but not actually teaching the Standards (Bednarz 2003a), and limited content knowledge (Giannangelo and Frazee 1977; Gregg 2001) have all been described. Three of these studies describe practices in Texas classrooms. These studies suggest the possibility that map learning will not be taught in a manner that is aligned with the Standards or the TEKS. This idea is further supported by research in map instruction: most studies describe “typical” map instruction as either independent seat work, spent studying the map or as altogether nonexistent.
- While the TEKS are mandated by law, it does not mean necessarily that they are taught. Instead the TEKS are filtered to students through teachers, curriculum materials, and even the test that is meant to assess the TEKS.
- The TEKS and the Standards recognize the importance of maps to geography and the social studies. They also recognize that learning both *about* and *with* maps should occur throughout a student’s life. Research about maps suggests that users

have varying degrees of difficulty with a variety of tasks, but research also indicates that with age and practice, map use improves. This finding links nicely with the Standards and the TEKS which advocate a spiraling curriculum in which map skills plays a role throughout.

A Model of Map Instruction

Based on the research outlined in this chapter, a hypothesized model of map instruction is illustrated in Figure 1. The model is based on the initial question of the present study: how are maps taught in the Texas K–12 classroom? Research suggests that map instruction might be a product of three domains: teacher practice; the curriculum; and, research about map learning. It is assumed that these three domains are interrelated and influence each other to varying degrees. The curriculum in Texas is law and, therefore, should influence teacher practice, and how maps are taught. Research about how people learn both *about* and *with* maps should influence the curriculum; it should also inform teacher practices by contributing to their knowledge about maps and map learning. As illustrated in the diagram, teacher practice is influenced by beliefs and knowledge. Following Shulman (1986a, b) and others, teacher knowledge can be delineated between pedagogical knowledge, content knowledge, pedagogical content knowledge, and curricular knowledge. All four are important components of teacher knowledge. Ideally, teacher practice, the curriculum, and research about map learning would be complementary, and provide a united

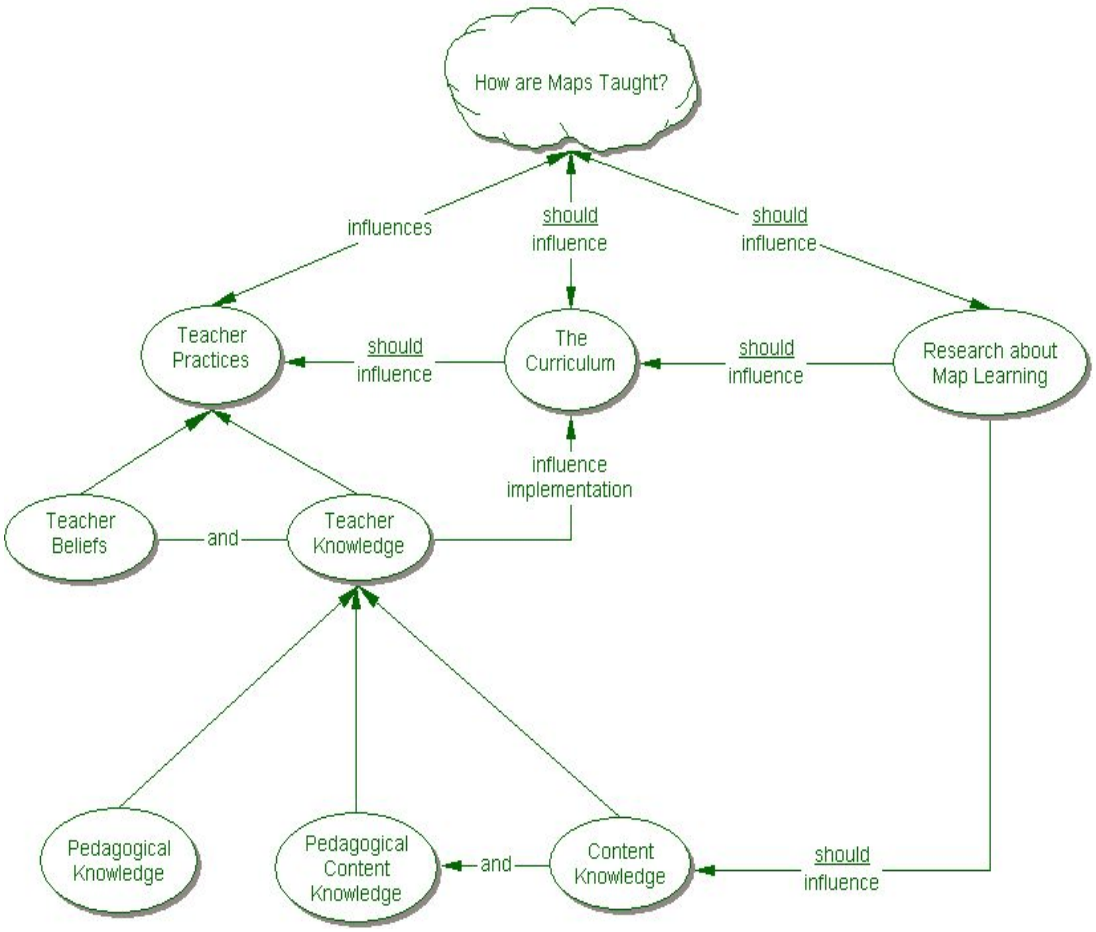


Figure 1. An initial model of map instruction.

foundation upon which map instruction is based. This model is revisited in Chapter IV where the applicability of the model to map instruction based on the present study's results is considered.

Conclusion

It would seem that to a certain degree there is a match between what research about map learning says students are capable of doing, and what the curriculum expects students to be able to do. Researchers involved in map learning have paid more attention to what *should* be done in a classroom, rather than what *is*. This is evidenced by the number of studies (Atkins 1981; Chiodo 1997; Livni and Bar 2001) that mention "traditional" map instruction but do not describe what that entails; they have left a frustrating void when trying to understand teaching practice. The heavy emphasis on navigation and to a lesser extent, symbol interpretation, is not well-aligned with curricular emphases, and also means that there are significant gaps in understanding other aspects of map learning. As Gregg and Leinhardt (1994) note, there are many other aspects of map learning worthy of study. It would seem that the gap Bednarz and Bednarz (1995) describe in preservice education between geographers and education faculty is found elsewhere: map learning research has generally not addressed the needs of the classroom. Ideally, a complementarity would exist between teaching, curriculum, and research, each offering the other ideas of what is done (practice), what is supposed to be done (curriculum), and what is possible to do (research).

CHAPTER III
METHODOLOGY

This research was conducted in two phases. The goal was to develop a picture of teachers' beliefs, knowledge, and practices about map literacy. In the first phase, a mail survey was used to explore Texas teachers' practices when developing map literacy in their classrooms, and to identify potential subjects for Phase II. The second phase of research consisted of interviews and classroom observations with geography and social studies teachers in order to examine the interaction between beliefs, knowledge, and practices as they relate specifically to map literacy. Both quantitative and qualitative data were gathered. Quantitative measures provided general, baseline data about teachers' beliefs, knowledge, and practices. Qualitative methods provided a deeper understanding of these issues (Bogdan and Biklen 1992). The benefits of using both qualitative and quantitative methods include garnering richer data, as well as corroboration of data through triangulation (Miles and Huberman 1994, 41).

Objectives and Research Questions

This study investigates how teachers develop map literacy in their classroom, by examining the interaction of teachers' beliefs, knowledge and practices, and exploring the influence of the state-mandated curriculum on the way that teachers structure map learning.

The primary research question was: How do teachers develop map literacy in geography and the social studies? This broad question is comprised of three more specific questions:

(1a) What are teachers' beliefs about map literacy?; and,

(1b) What knowledge about map literacy do teachers possess?

(2) What are teachers' practices, that is what, when, and how map literacy is taught currently in geography/social studies courses?

(3) To what extent do teachers understand the curricular requirements about map literacy?

Phase I: The Survey

The objective of Phase I was to gather data pertinent to each of the three research questions above, with an emphasis on Research Question 2: What are teachers' practices (which includes the content, duration, and procedures used to develop map literacy). I used a survey mailed to a sample of teachers to identify trends at various grade levels and courses was used. Phase I also was instrumental in subject selection for Phase II.

Survey Creation

A twenty-one item survey to determine the role of maps in the classroom was developed (Appendix B). Survey items were developed to address the three research questions of this study, with a focus on teacher practices (Research Question 2). In addition, background information about survey respondents, such as courses taught and number of years teaching, were also included. Table 3 illustrates the relationship between the research questions and each survey item. Given the interrelationships between teacher beliefs, knowledge, and practices, and the curriculum, some survey items could be attached to multiple research questions. I chose to attach each item to only one research question with the acknowledgment that it is a loose classification.

The questionnaire was limited in length to two pages, front and back. It contains both open-ended and closed-ended questions. Eleven items (questions 1, 5–9, 11, 12, 14 and 20) of the survey are multiple-choice format. Another three items (questions 2, 3, and 13) are quantitative in nature, and survey questions 4 and 10 ask for product names (textbooks and any technology used to teach map literacy). For those questions, a limited number of responses were expected.

Table 3. Relationship between Research Questions and Survey Items

Research Question	Survey Question*
1a. What are teachers beliefs about maps?	16. What is the most important map skill students...? 17. What activities do you think improve students'...? 18. Why do you think the activities described in...?
1b. What knowledge about maps do teachers possess?	20. In order to read and interpret a map, a person must understand... 21. How would you define geographic literacy?
2. What are teachers' practices, that is the what, when, and how map skills are currently taught in geography/social studies courses?	7. If yes, how often do you use your textbook to help...? 8. What other sources (in addition to the textbook)...? 9. Do you use technology-based resources (such Tom Snyder's...? 10. If yes, please explain what technology-based resources you use... 11. If no, please explain why you do not use technology-based...? 11b. Of the items selected above, which is the most significant...? 13. Approximately what percent of total class time do you spend...? 14. Which statement best describes the frequency of map skills instruc...? 15. What topics (e.g., scale) do you cover when you teach map skills?
3. To what extent do teachers understand the curricular requirements about map skills?	5. Are map skills a component of the TEKS at your grade level? 6. Do you teach map skills? 6b. If no, please explain. 12. What guidelines determine your geography curriculum? 19. In your opinion, what is the role of map skills in geography?
Background Information	1. What course(s) do you teach? 2. What grades do you teach? 3. How many years have you been teaching geography/social studies? 4. What textbook do you use to teach geography/social studies?

*Survey questions are shortened in this table due to space limitations; the complete questionnaire is included as Appendix B.

It seemed appropriate in the multiple choice questions to guide respondents' answers. For example, Question 7, How often do you use your textbook to help plan your map skills lessons?, provides five choices from "always" to "never." The choices were provided because (1) it might be difficult for teachers to quantify how often they use their textbook, or (2) it may be unclear how to quantify their response (e.g., in hours? in

verbal terms, such as “a lot”?). Providing choices makes responding to the questions a faster process and allows for easier data analysis.

Open-ended items (questions 15–19, and 21) allowed respondents to write their answers freely. Space for answers was ruled so that respondents had a guide as to expected length of answers. By using such a format, guiding respondents to a particular choice was avoided, and it allowed for a variety of responses. By using both open-ended and multiple choice questions in the survey, I sought a compromise between convenience (close-ended) and richness of answers (open-ended).

To fine tune the instrument, the survey was field-tested with a small (n = 12) sample of Texas social studies teachers. These teachers came from one school district in a large metropolitan area. The survey was distributed and collected by a social studies teacher from that district to her colleagues. Teachers were instructed to complete the survey and include any editorial comments about it (e.g., content, readability, appearance).

Research Question 1: Teacher Beliefs and Knowledge

Five survey items address teacher beliefs and knowledge related to map literacy. Question 16 asked teachers to identify the most important map skill students learn. Responses to this question reflect a teacher’s conception of map literacy, revealing what aspect(s) of map literacy is essential for students to acquire. Questions 17 and 18 asked teachers to consider what activities help develop students’ understanding of maps. Again, these questions tap into teachers’ beliefs about how students best learn maps. While these questions asked for teachers’ thoughts about maps and learning, it was expected that they relate to practices as well.

Questions 20 and 21 relate to teacher knowledge. Question 20 is close-ended, asking teachers what cartographic principles a person must understand in order to read and interpret a map. This question is similar to Question 15: What topics do you cover when you teach map skills?—an open-ended question that is classified within Research Question 2. Question 20 is different than Question 15 though in that it asks teachers to assess what a person must understand to read and interpret a map, not what they teach specifically. In other words, teachers might *know* that an understanding of

projection is important to fully understand a map, but they may not *teach* it because they believe it to be inappropriate for their grade level.

Question 21, How would you define geographic literacy, is included to understand how teachers' relate map literacy to geographic literacy (if at all). Maps are a component of geography, but they do not define the discipline. It is possible that some teachers equate using maps with geography; this question is included to understand how teachers frame map literacy within geography and the social studies.

Research Question 2: Teacher Practices

Nine items address teacher practices regarding map literacy. The emphasis placed on this research question in the survey is due to the overarching objective of this study: to understand how map literacy is developed by geography and social studies teachers. Survey items 7–11 ask teachers what resources they use to help plan their lessons. By determining what resources are used, an understanding of teacher practices emerges. For example, question 7 asks teachers how often they use their textbook to plan map skills lessons. If teachers rely on their textbook for map literacy, then a look at the textbook (addressed by Question 4 of the survey) provides a general understanding of teacher practices.

Questions 9–11 consider the role of technology in map literacy. A number of technologies exist today which can support map learning, including web-based mapping programs, Geographic Information Systems (GIS), and Internet map libraries providing maps for almost any space or time period conceivable. These resources range from free to expensive, user-friendly to expertise-needed. They provide an important resource for educators to help students learn both *about* and *with* maps, make use of technology, and use the same (or similar) tools in the same (or similar) ways that geographers do. Using technology is recommended by the Standards; it is required by the TEKS. Although not specified in geography, it is included as part of the social studies skills strand. Teachers' use of technology, or lack of, provide an important understanding of how they approach map learning.

Questions 13 and 14 consider the *when* component of Research Question 2. Question 13 asks teachers how much time is spent on map learning. The duration of map instruction is unknown, and this estimate provides an indication of its importance

within geography and social studies. It is often assumed that units on map learning occur during the first few weeks of a school year (because social studies textbooks often include a map skills unit at the beginning of the book), but the timing is also unknown.

Question 15, mentioned above briefly, consider the topics taught about maps. The question was open-ended and meant to capture what topics are covered in instruction. Survey items 16, 17, and 18 are related to question 15. In combination, these questions are meant to provide a picture of what topics are taught, including those that are most important, and how they are taught.

Research Question 3: Curricular Knowledge

The extent to which teachers recognize the curricular requirements involved in map literacy was addressed by Research Question 3, and survey items 5, 6, 12, and 19. Questions 5 and 6 address teachers' recognition of the TEKS. Map literacy is a component of the social studies from kindergarten through eighth and throughout much of the high school social studies curriculum. Question 12 asks for further information about what sources, including the TEKS and the Standards, guide teachers' particular curriculum. Question 19, an open ended item, asked teachers to explain the role of maps in geography and the social studies. These four items were meant to develop an understanding of teachers' knowledge about how maps fit into the geography and social studies curriculum.

Sample Selection and Survey Implementation

The sample selection for this study was purposeful. Teachers came from Texas, specifically from the membership of the Texas Alliance for Geographic Education's (TAGE). As noted previously, Texas has a relatively strong geography curriculum compared to other states, and consequently, Texas social studies teachers should be teaching map skills at all grade levels.

Teacher-members of TAGE were selected for three reasons. First, they were an accessible sample of teachers. Second, by contacting teachers who have an interest in geographic education (as evidenced by their membership in TAGE), greater interest in the research project and thus, a better response rate was anticipated. Third, I sought a

pool of *experts*—teachers who revealed an interest in education and have sought to develop their pedagogical and content knowledge. It is assumed that this group of teachers likely represent the best of the best. Their expertise is considered in the final results of this research.

The survey was distributed to five hundred eighty-eight geography and social studies teacher-members of TAGE. The sample comprises approximately ten percent of the six thousand TAGE membership. This number was selected because it fell within sample sizes used in other mail survey research, as described by Bradburn and Sudman (1988, 125). The sample was selected using simple random sampling from the TAGE database. Simple random sampling is used commonly when surveying members of an organization for which a list is available (Bradburn and Sudman 1988, 114). Surveys were distributed at the end of April 2002 via the mail with a postage-paid return envelope. A cover letter explaining the purpose of the study accompanied each survey. Two reminder mailings were sent out in an attempt to increase response rate. Twenty-six percent of the total number of surveys mailed were returned due to incorrect addresses; 4.25 percent were returned by individual teachers uncompleted because they were retired, or no longer teaching. A total of eighty-eight completed surveys were returned. That number represents 15 percent of the total mailed; 21.5 percent of the number that could have been returned, less the incorrect addresses. It is recognized that the response rate is relatively low for mail surveys.

Respondents were classified at one of three grade levels: *elementary* (grade K–4), *middle* (grades 5–8), or *high* (grades 9–12). The number of respondents by grade level is illustrated in Table 4. The target sample for this study was kindergarten through twelfth grade teachers, however two college-level educators responded to this survey. Except where noted, their responses are not included as part of this study's analysis.

Table 4. Surveys Returned by Grade Level Taught

Level	Grades	Number	Percent of Total
Elementary	K–4	26	29.5
Middle	5–8	21*	23.8
High	9–12	42*	47.7
College	College	2	2.3
Total Surveys Returned		88	

*Three respondents teach grades 6–12; they are classified as both middle and high school teachers.

Grades five and six typically might be considered elementary level, however the Texas Education Agency (TEA) and the Texas State Board of Educator Certification (SBEC) consider grades five and six to be part of middle school. In addition, benchmarks outlined in the National Geography Standards and the National Assessment for Educational Progress (NAEP), are established at grades four, eight, and twelve. For the analysis of the present study, the grade levels established by TEA, SBEC, the Standards, and NAEP are followed. This distinction is discussed further in the data analysis section of this chapter.

Data Organization and Maintenance

Completed surveys were organized by grade level as they were received. They were also organized into contact/no contact groups. If respondents were willing to participate in Phase II of this study (interviews and classroom observation), they were asked to complete contact information. Each TAGE member selected to receive a survey was assigned a number to identify her/him. The number was noted on the survey so that I could account for who had returned a survey and who had not (which was important in sending reminder cards for unreturned surveys). By assigning numbers, names of respondents could be kept confidential.

Coding and Analysis

Survey data were analyzed in two ways: first, individual questions were examined; second, each survey was evaluated holistically using a map literacy continuum. By examining individual questions, a *big picture* of the ways that map learning is

approached was sought: is there a general method employed by the sample as whole? Does it vary depending on grade level? Or, is developing map literacy more random, with each individual having her own unique approach? The Map Literacy Continuum was developed to analyze each survey respondent along a continuum from basic to advanced with regard to a teacher's approach to map learning. This aspect of the analysis was conducted primarily to identify subjects for Phase II of this study, however, the results can be used to (1) classify the entire sample along the continuum, and (2) identify areas within map learning that are not reportedly taught. I refer to this approach as *analysis along a Map Literacy Continuum*. Details for each of these analytic techniques follows.

Question Analysis

Close-ended survey data were coded and entered into a spreadsheet; open-ended data were entered into a word processing program to identify commonalities, and codes derived from these commonalities were developed. The tag number assigned to each survey was used to identify a respondent in both the spreadsheet and the text document.

Question 11	Choice	Numeric Code
Please explain why you do not use technology-based resources to teach map skills (check all that apply):	There is limited access to technology in my school or classroom.	1
	I would not feel comfortable using technology-based resources to teach map skills.	2
	Technology-based resources are inappropriate for my grade level.	3
	I am unsure about what products are available.	4
	I do not have enough time to learn to use such materials.	5
	Other (please explain)	6 (and recorded reasons given)

Figure 2. Example of numeric coding of Survey Item 11. If a respondent selected, for example, the first choice, *There is limited access to technology in my school or classroom*, the number one (1) was recorded in a spreadsheet.

Close-ended data were coded numerically as illustrated in Figure 2. Because the data collected was nominal, descriptive statistics were used to analyze responses. Averages for each question were tabulated based on (1) the entire sample, (2) by grade level, and (3) by contact information (to identify any difference between survey respondents who agreed to be interviewed and those who did not). Open-ended questions were examined on a question by question basis: each individual's survey response for a particular survey item was grouped together. For each question, the total number of responses were read, and initial codes were developed based upon the responses. A matrix for each question was used to display codes and tallies; an example of this matrix for survey item 17 (What activities do you think help students understand maps?) is illustrated in Figure 3.

Tallies were recorded by tag number so that the exact response could be found easily. In addition, the tag number was used to identify the grade level of the respondent so that any potential differences between elementary, middle, and high school teachers could be considered. A "notes" column was used to record any ideas that developed, or uncertainties about a particular classification. Unclassified items (responses that did not fit into the developed categories) were noted on the matrix in order to find discrepancies in the data and weaknesses in the analysis. From this initial analysis, codes could be refined, broadened, or collapsed. In this particular example, hands-on activities were noted by many respondents, but the type of hands-on activity varied from the generic "hands-on" to more specific descriptions that involved using technology, playing games, or having students create their own maps. By coding the data in this way, generalizations about respondents' answers to a particular question were identified.

Following Miles and Huberman (1994), a checklist matrix was used to summarize survey data (Figure 4). This display was used to develop a general picture based on survey data of teachers' beliefs, knowledge, and practices regarding map literacy, as

Response/Category	Sub-category	Tag #	Comment
Hands-on	Hands-on	2, 6, 7, 10, 12, 22, 25, 29, 30, 31, 33, 34, 37, 40, 46, 52, 58, 63, 68, 72, 73, 74, 77, 78, 80, 81, 83, 84, 86, 88	
	Using atlases	7, 9, 78	
	Problem solving	39, 47, 55, 64, 70, 71, 85, 88	
	Map creation	1, 4, 6, 10, 13, 15, 17, 19, 22, 25, 38, 43, 45, 48, 52, 55, 57, 64, 65, 66, 67, 73, 74, 75, 84, 85	Some map creation is focused on location; some is focused on using correct terminology (19, 35, 84)
	Maps as a tool for understanding	4, 8, 15, 41, 42, 62	
	Games	43, 47, 58, 77, 78, 82, 84, 88	
	Technology	34, 38, 54, 68, 72	
Repetition	Repetition (to learn skills)	40, 44, 45, 46, 50, 51, 53, 54, 66, 74, 76, 85, 87	
	Repetition focus on location	5, 7, 9, 11, 16, 17, 21, 22, 25, 32, 35, 40, 54, 56, 61, 67, 75, 82	
Relevance to student		18, 24, 62, 71, 72, 73, 69, 79,	
Unclassified Items:			

Figure 3. Example of coding matrix for Survey Item 17. Responses were categorized by code. If the respondent noted multiple categories, then her/his tag number was attached to more than one category. For example Tag #22 noted both map creation and repetition focused on location, and consequently, the tag number is recorded in both categories.

Research Question*	Survey Item	Elementary	Middle	High	Entire Sample
1a: beliefs	16				
	17				
	18				
1b: knowledge	20				
	21				
2: practices	7				
	8				
	9				
	10				
	11				
	13				
	14				
	15				
3: curricular requirements	5				
	6				
	12				
	19				

*Research questions are shortened due to space limitations.

Figure 4. Checklist matrix used for summary analysis of survey data.

well as their understanding of curricular requirements. The display provides generalizations about (1) elementary teachers, (2) middle school teachers, (3) high school teachers, and (4) for the entire sample. Both direct quotes and summary phrases are used in this matrix. By doing so, a profile of how map literacy is developed by survey respondents was created at each grade level, and for the survey sample as a whole.

Analysis along a Map Literacy Continuum

The Map Literacy Continuum (Figure 5) was adapted from map skills outlined in the geography achievement levels of the National Assessment of Educational Progress (NAEP) and the National Geography Standards. NAEP's proficiency levels for geography and the Standards were used because they offered a detailed conceptualization of map literacy. NAEP assesses what students know and are able to do in core academic subjects, including geography, at three key grade levels (four, eight, and twelve) (National Assessment Governing Board 2001). Like NAEP, the Standards describe what a geographically informed person knows and is able to do at grades four, eight, and twelve. The content of the Standards mirrors that of NAEP. The criteria of the Map Literacy Continuum generally matches the TEKS; correlation between the TEKS and the Map Literacy Continuum is included as Appendix C. The TEKS offer grade specific standards, however, they are not as detailed as those found in NAEP and the Standards with regards to map literacy.

Grd.	Basic (Knowing)	Proficient (Understanding)	Advanced (Applying)
E **K–4**	a. use a map to find information b. identify locations c. read simple maps, keys & legends d. draw simple maps, keys, & legends e. identify, describe basic map elements	a. (read &) interpret maps b. use number/letter grids to plot locations c. understand relative location terms d. draw sketch map of observed landscapes e. observe the distribution of features on maps	a. solve simple problems using maps, atlases b. draw sketch maps of places c. describe and compare differences, similarities, and patterns of change in landscapes d. determine the impact of change in one place
M **5–8**	a. possess fundamental knowledge and vocabulary of distance, direction, scale, boundary, site, and situation b. solve fundamental locational questions using latitude and longitude c. interpret simple map scales d. identify locations e. explain differences between maps, globes, aerial photos, satellite images f. find a wide range of information using an atlas or almanac. g. draw sketch maps & compare with atlases for accuracy	a. solve locational questions requiring integration of information from two or more sources, such as atlases or globes b. compare information at different scales c. choose appropriate maps to answer particular questions; evaluate the goodness of maps (e.g., select best projection for purpose) d. use map information to describe the role that regions play in influencing trade, migration patterns; cultural, political interaction e. create thematic maps w/ data, symbols, color f. explain why *x* is located where it is	a. use case studies for spatial analysis and to develop maps and other graphics b. use one category of a map or aerial photograph to predict other features of a place such as vegetation based on climate or population density based on topographic features. c. analyze & explain patterns of land use; consider human-environment interaction
H **9–12**	a. solve simple locational problems using maps and globes (using applicable units of measurement) b. read maps c. identify several basic types of map projections d. use maps to illustrate spatial patterns (e.g., regional boundaries change)	a. interpret maps to analyze spatial phenomena; discuss economic, political, & social factors that define, interpret space (using geographic concepts) b. design maps based on descriptive data c. report both historical and contemporary events within a geographic framework using tools such as special-purpose maps and primary and secondary source materials. d. collect, compare, explain the significance of maps from different sources, points of view	a. apply a wide range of map skills; b. develop maps using fundamental cartographic principles including translating narratives about places and events into graphic representations c. compare maps of the world using different projections, perceptions of space to draw conclusions about factors that influence mental maps

Adapted from *Geography Framework for the 1994 and 2001 National Assessment of Educational Progress* and *Geography for Life*.

Figure 5. The Map Literacy Continuum.

Following the organization of the *Geography Framework* used by NAEP and *Geography for Life* (Geography Education Standards Project 1994), the Map Literacy Continuum provides three levels of mastery (basic, proficient, and advanced) at three grade levels (elementary, middle, and high school). The categories of basic, proficient, and advanced build on one another, so that a student with proficient skills can perform the basic tasks as well as the proficient ones; grade levels build on one another, so that a high school student at the basic level can accomplish the basic tasks outlined in elementary and middle grades as well. For students to meet these standards, they must be taught both *about* maps and *with* maps (Acheson and Bednarz 2003). In the former, students are equipped with the requisite skills in order to read, interpret, and produce maps; in the latter, students can use maps to understand and explain geographic concepts and relationships. The criteria outlined in NAEP, the Standards, and the TEKS establish what *students* should know and be able to do, and consequently relates to teacher knowledge and practice. Teachers must have the content and pedagogical content knowledge to teach these topics, the curricular knowledge that these criteria should be included in their practices, and they must explicitly teach these topics. It is important to note that teachers not meeting the *basic* criteria at their grade level as outlined in the continuum, are classified as *below basic*. It is possible that the map skills taught are not meeting even the basic requirements outlined in the continuum, and consequently warrant *below basic* classification. In using the *below basic* classification, I follow NAEP: students who do not meet the *basic* criteria, are classified as such.

This continuum requires that the foundation for map skills be laid during elementary schooling. Early instruction focuses on map basics like terminology, interpreting symbols, finding locations, and reading and drawing simple maps. Instruction in middle and high school grades should move away from these basics toward more complex, sophisticated tasks, such as problem solving with maps, illustrating geographic concepts with maps, and using Geographic Information Systems (GIS) to create maps and analyze spatial patterns. As NAEP proficiency standards expect, students move from *knowing* to *understanding* to *applying*. This movement should be evident in instruction as well.

The continuum provides a general classification of map skills teaching as *basic*, *proficient*, or *advanced*. In an effort to further distinguish map skills teaching, a 10-point

scale, from basic (1) to advanced (10), was used in conjunction with the continuum. This scale is represented in Figure 6. By using the continuum *and* the scale, teachers could be categorized as “highly basic” or “lowly proficient.” The three general categories coupled with a number rating permitted greater distinction between respondents, and a more accurate categorization of teachers’ beliefs, knowledge, and practices regarding map skills.

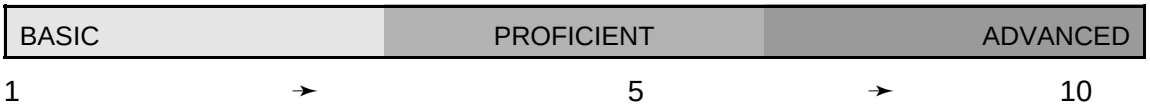


Figure 6. A 10-point scale for the Map Literacy Continuum.

The continuum and scale provide a general description of how map skills are taught. Because teachers in this sample came from a variety of grade levels, the continuum classification cannot be used strictly. For example, a first grade teacher cannot be expected to teach the same map skills as a fourth grade teacher (the upper elementary grade level). More reasonably, a first grade teacher would concentrate on basic map skills that lay the foundation for more advanced skills instruction in the fourth grade.

Two grades, fifth and ninth, pose additional problems for using this continuum. Because fifth and ninth grades are on the cusp of previous grade levels, it might not be fair to evaluate teachers at the higher grade level. Fifth grade teachers were grouped with middle school, however, they were evaluated on two levels: elementary and middle. Ninth grade teachers, were evaluated at the high school grade level only. Because geography is taught as a single subject in Texas during the ninth (and sometimes tenth) grade, that grade represents the best opportunity for students to receive advanced map skills instruction. If students are to develop basic map literacy by grade twelve, the majority of instruction must occur during the ninth grade.

This continuum is used also to determine what topics were reportedly taught by educators in this sample. Are certain topics of this continuum regularly taught? Are certain topics rarely taught? The continuum provides the focus of map skills lessons by the survey participants.

Individual surveys were coded by reading through all responses. When a proficiency standard was described, it was noted by level (elementary, middle, high),

proficiency level (basic, proficient, advanced), and the standard itself. For example, a respondent teaching elementary grades wrote "...making inferences on how the geography of an area affects life in that area and checking their inferences..." (#74). This response is coded as 4A-c:

- 4 represents fourth grade level;
- A represents advanced proficiency levels at this grade; and,
- c represents the standard on the continuum designated by the letter c (*describe and compare differences, similarities, and patterns of change in landscapes*).

Each survey was coded twice; surveys with discrepancies were coded a third time. Coding was reviewed by a colleague to ensure reliability: for approximately half of the surveys, a colleague examined the surveys with the Map Literacy Continuum in hand and discussed my codings until satisfied with my evaluation.

Phase II: Interviews and Observations

Phase I of this study provided initial data about how teachers develop map literacy in their classroom. Phase II addressed the research questions in more depth, with greater attention given to teachers' beliefs, knowledge, and curricular understanding about map literacy (since the mail survey focused more on practices). Interviews and observations were seen as an opportunity to gather rich data from a small number of teachers, complementing the survey data which gathered surface data from a larger sample.

Subject Selection

Participants in this phase were selected from a pool of survey respondents who volunteered to be interviewed and observed. Forty-eight (54.5 percent) respondents agreed to participate further; participants are classified by grade level in Table 5.

Table 5. Participants Who Volunteered/Declined to Participate in Phase II

	Elementary	Middle*	High*	Total
Volunteered	11 (42.3%)	12 (66.7%)	25 (60.97%)	48 (54.5%)
Declined	15 (57.7%)	6 (33.3%)	16 (39.02%)	40 (45.5%)

*Three respondents teach middle and high school grades.

It was intended to select three teachers from each grade level who exhibited the three levels of proficiency described by the Map Literacy Continuum: basic, proficient, and advanced. However, two factors prevented such selection. First, there were simply not enough teachers who could be classified as proficient or advanced for all grade levels. Only two teachers in the entire sample were classified as advanced, both were elementary teachers, one of whom retired in between Phase I and Phase II. Second, a number of teachers contacted to participate in Phase II declined, or simply did not return requests to participate. In all, twenty-five teachers were contacted: nine elementary teachers, eight middle school teachers, and eight high school teachers. Of the twenty-five contacted, eleven teachers were interviewed; description of the subjects is included in Table 6. The twenty-five contacted exhibited the range of proficiency levels within their grade level in an effort to interview and observe teachers with a range of approaches toward map literacy. All teachers who agreed to be interviewed and observed, were, for a total of eleven participants in Phase II. As can be seen in Table 6, interviewees ranged in grade taught, experience teaching, and proficiency level (as assessed by the Map Literacy Continuum during survey analysis).

Sources of Data and Schedule

The potential interviewees were contacted by letter in January 2003; the letter reiterated the purpose of the study and requested their further participation. Letters were followed up with e-mail or phone calls, depending on their preference as indicated on the survey. As noted above, eleven of the twenty-five potential interviewees agreed to continued participation. Teachers provided me with dates convenient to their schedules. In all cases, teachers arranged with their supervisors for me to visit their classroom.

Table 6. Description of Interviewees

Name*	Grade Level	Proficiency**	Years Teaching***	Notes
Carr	E (K–5)	Advanced	18	Teaches only Gifted and Talented
Ling	E (4)	Proficient	17	
Henry	E (1)	Proficient	17	
Arrow	M (6–7)	Basic/ Proficient	4	
Paris	M (6)	Basic	7	
Michaels	M (8)	Proficient	23	
Pyle	M (7)	Proficient	21	
Barry	M (5)	Basic	10	
Semple	H (W.G.)****	Below Basic	10	
Island	H (9–12)	Proficient	6	Teaches at a non-traditional high school for students who cannot attend regular school due to illness, pregnancy, or learning disabilities
Wick	H (W.G.)	Basic	5	At the time of completing survey, taught World Geography; teaches 7th & 8th presently

*Names are pseudonyms. **Based on survey evaluation using the Map Literacy Continuum. ***Years Teaching refers to the number of years teaching geography/social studies; teachers may have taught other subjects. ****WG = World Geography Studies

Interviews and observations occurred on the same day. Interviews lasted approximately one hour; observations occurred for two to three hours. There was not a set order to interviews and observations: in six cases, interviews occurred after observation, and in five, they occurred before observation. This arrangement was based

on the teacher's schedule. Since map learning could conceivably occur at any time during the school year, it was not a requirement for observation. I explained to teachers that while I would prefer to observe instruction in map learning, I was most interested in observing their approach to geography/social studies instruction. In eight of the eleven classrooms, I observed instruction that included learning *with* or *about* maps. In these cases, map learning was part of the regular instruction; the teachers arranged my visit to coincide with this instruction.

Data for this phase of research came from three primary sources: audio tapes of interviews, field notes taken during observation, and documents supplied by the interviewee. Documents included classroom materials used during observation, additional curriculum materials, and a "map literacy proficiency standards" form. This form (Appendix D) is a list of the criteria stipulated in the Map Literary Continuum (Figure 5) for each grade level (elementary, middle, and high school). Each teacher was given the form appropriate to her grade level and asked to note which items she included as part of her instruction. Realizing that teachers may check all items because they think they are supposed to be teaching them, a few criteria from other grade levels were added. Teachers were informed that not all of the proficiency standards were applicable to the grade they teach, and they should consequently only check those that they include as part of their instruction in map literacy. The form was completed during the interview in all but one case so that any questions teachers had could be clarified. The one teacher who did not complete the form during the interview mailed the item to me after the interview because I forgot to bring the form with me.

Field notes taken during each observation concentrated on instruction: the content presented, teacher interaction with the class, and classroom management. I was interested in observing what content was presented and how it was presented. These observations suggest teaching style: is course content presented in a factual, didactic fashion, or does the approach encourage critical thinking and questioning on the part of students? Observations provided corroboration of a teacher's stated (during the interview and/or survey) classroom practices. For example, if a teacher noted hands-on activities as an important aspect of learning, I sought evidence of that during the short period of time I visited her class.

Interviews were conducted to clarify and confirm survey data, develop a deep understanding of teachers' beliefs, knowledge, and practices regarding map literacy, and determine their familiarity with curricular requirements. Interviews are commonly used when trying to capture teacher beliefs and knowledge (Clark and Peterson 1986; Munby 1984; Rearden 1998; Smith and Shepard 1988). Interviews followed a semi-standardized format aligned with my research questions (Table 7). Background information such as preparation in geography and professional development experiences was sought to better understand interviewees preparation as well as to begin the interview with easy-to-answer questions, designed to set the interviewee at ease. Teachers were asked to describe what a map is, as well as examine two maps,[10] to understand their conception of and knowledge about maps (Research Question 1b). Questions about map skills at the interviewee's particular grade level were asked to understand teacher knowledge about curricular requirements (Research Question 3). Questions about maps being easy to understand, identifying the stumbling blocks students have with maps, and justifying their place in the curriculum point to teachers' beliefs about map literacy (Research Question 1b). Interviewees were asked to clarify their survey responses, describe students' access to maps, and describe how they use maps in the classroom in order to understand their practices (Research Question 2). While each of these questions were essentially covered with each interviewee, the interviews were kept conversational, and allowed to veer off in other directions when appropriate.

Table 7. Relationship of Interview Protocol to Research Questions

Research Question:	Interview Questions*
Background Information	1. What type of preparation have you had in geography (college courses,...)?** 2. When you started teaching geography, did you feel prepared to do so? 3. To what extent did college course work prepare you to teach geography? Map...?
1b: Knowledge	4. What is a map? 5. What do you use a map for? a. If you had to name the primary use of a map, what would it be? 6. We're going to look at some maps, can you tell me some information about... a. Western Gulf Region of the US and Mexico (Goode's World Atlas) 1. Tell me what this map tells you (prompt if needed) 2. Is there information on this map that you think should be included, or...? 3. Would you use this map with your students? Why or why not? 4. Do you think the average student in your class would be able to (identify locations, predict other features, suggest why *x* is located where it is, interpret the map scale...? b. Thematic map of Economies of the US (Rand McNally Classroom Atlas) 1. Repeat the same questions used with the Western Gulf Region map 7. When you select a map to use in your classroom, what kind of criteria do you...?
3: Curricular Requirements	8. There are spots in the Standards where students are expected to be able to judge the appropriateness of maps. Do you have students do this? 9. How important are map skills at the grade you teach? a. According to the TEKS? b. According to the textbook? c. According to you, personally? 10. Do you use the TEKS to help plan your map skills lessons? 11. Describe what students are expected to know about or be able to do with maps...?
1a: Beliefs	12. Are maps easy to understand? Why or why not? 13. What do kids find difficult about maps? 14. Why teach map skills (other than being required by the curriculum)?
2: Practices	15. What kind of access do students have to maps, globes? 16. How often do they use them (daily, once a week, monthly)? 17. On your survey, you noted the following items were needed in order to read...? 18. Again, on your survey, you said you teach the following topics; give me an idea...? 19. Give me an idea of how you would teach a student to read a map. Walk me through it. 20. Do you have students construct maps? Why or why not? a. What do you think they learn from constructing maps? b. Are students required to include: 1. include map elements? 2. check their maps against an atlas or wall map? 3. draw to scale? 4. include lines of latitude and longitude? 21. When students of average ability leave your classroom at the end of the year, what should they be able to do with maps?

*The order of interview questions as shown in this table were generally the order in which they were asked during interviews.**Interview questions are shortened in this table due to space limitations. The complete interview protocol is available as Appendix E.

Data Organization, Coding, and Analysis

Interview data were analyzed using grounded theory techniques. Immediately after each interview and observation, a summary of the meeting was recorded in order to reflect on the main themes, issues, and questions that derived from the interview and observation (Miles and Huberman 1994, 51). Interviews were transcribed, marking the time regularly so that sections could be listened to again easily, as suggested by Kvale (1996). Codes from the survey analysis, particularly those in the Map Literacy Continuum, were used to analyze interview data, and additional codes were developed from listening to interviews and (re-)reading transcripts. From these initial codes, pattern codes were developed (Miles and Huberman 1994, 69). Checklist matrices were used to organize interview data into categories along a major variable; in this case, each of my research questions. The checklist format allowed for systematic classification which encourages comparability and allows for verification. Drawing conclusions, or interpreting, the data followed the tactics outlined by Miles and Huberman (1994, 245–287).

General Methodological Concerns

Some general methodological concerns regarding the survey, interviews, and observations should be noted.

Ethics

Subjects who participated in this study were fully informed about the purposes and objectives of this study and were assured confidentiality (Erickson 1990, 138–9). The overall risks from participation were minimal: teachers' responses were (and continue to be) kept confidential, and in most cases, anonymous. In addition, participants were told that I alone would listen to the tape recording of their voices. It was expected that by informing participants and minimizing any risks, they would be more at ease, subsequently result in a better relationship and more candid responses.

Validity

Since this research involves qualitative methods, validity, or *data trustworthiness*, must be addressed. Multiple methods (a survey, interviews, and observations) were used to ensure data trustworthiness through triangulation. The survey was field tested with a small number of teachers prior to implementation in order to achieve face validity. Throughout the study, competing explanations and discrepant data have been noted and examined so that alternative explanations could be developed. Final reports were promised to each interviewee, requiring this researcher to be fair and honest about what was said and observed.

Reliability

Reliability in qualitative research means *"whether the results are consistent with the data collected*" (Merriam 1998, 206, author's emphasis). Reliability is improved by detailing the investigator's position, triangulation, and developing an audit trail. The investigator's position includes this researcher's assumptions and theories about the study, the selection of study participants and an adequate description of them, and a description of how and from where the data were collected (Merriam 1998, 207). Assumptions and theories were addressed in Chapters I and II; the description of the study participants and data collection are addressed in the present chapter. Triangulation was achieved through multiple data collection methods. The techniques used for data collection and analysis, and an account of decisions made throughout this study have been recorded (Merriam 1998, 207) so that an audit trail is available.

Conclusion

A mail survey was used to gain initial understanding of the ways that teachers' develop map literacy in their classrooms. Survey data were analyzed both quantitatively (descriptive statistics) and qualitatively. From that sample of survey respondents, eleven teachers were identified for interviews and observations in order to gain deeper understanding of how map literacy is developed. Using general qualitative research strategies, specifically interviews and observations, data were collected in the form of digitally recorded interviews, observation notes, and documents. Grounded theory

techniques were used to develop codes, identify patterns, and form conclusions about the way map literacy is addressed by Texas teachers.

CHAPTER IV
RESEARCH RESULTS

This research examined the question of how map literacy is understood and consequently approached by Texas teachers. Three questions are specifically addressed: (1) What are teachers' beliefs and knowledge about map literacy? (2) What are teachers' practices regarding map literacy? and (3) To what extent do teachers understand the curricular requirements of map literacy? This chapter presents the results of this research. Results are discussed in three sections. Phase I, survey results, are discussed in two ways: first, in relation to each research question (section 1), and, second, in terms of the Map Literacy Continuum, as described in Chapter III (section 2). Results for Phase II, interviews and observations, are presented in relation to each research question (section 3). Results for each section are presented by grade level (elementary, middle, or high).

Phase I: The Survey

A twenty-one item survey to determine the role of maps in the classroom was developed. The objectives of the survey were to understand teachers' beliefs and knowledge, as well as their practices, particularly the frequency, sequence, and duration of map-related lessons. Survey items were developed to address the three research questions of this study. Data were analyzed in two ways: first, individual questions were examined; second, each survey was evaluated holistically using a Map Literacy Continuum. Results from individual questions are reported in relation to the research questions; these results are followed by the holistic evaluation. Background information on survey respondents is discussed first.

Survey Results by Research Question

Background Information

Survey items 1–4 gathered background information on survey respondents. These questions relate to teachers' map-related beliefs, knowledge, and practices *indirectly*. For the purposes of this study it was necessary to know respondents' subject and grade assignment. It also seemed significant when considering teachers' responses to know (1) how long they have been teaching geography and the social studies; and, (2) what textbook they use.[11]

The subjects taught are displayed in Table 8. Half of the sample identified themselves as teaching geography and the social studies, while some teach geography only. The teachers who checked *other*, largely fell into one of two categories: they were elementary teachers responsible for all subjects, or high school teachers responsible for history only or for multiple subjects.

Table 8. Survey Item 1, Subjects Taught by Sample Respondents

Grade Level	Geography Only	Geography/Social Studies	Other	Total
Elementary	0	10	11	21
Middle	0	16	8	24
Middle & High	0	3	0	3
High	16	15	7	38
College	1	0	1	2
Total:	17	44	27	88

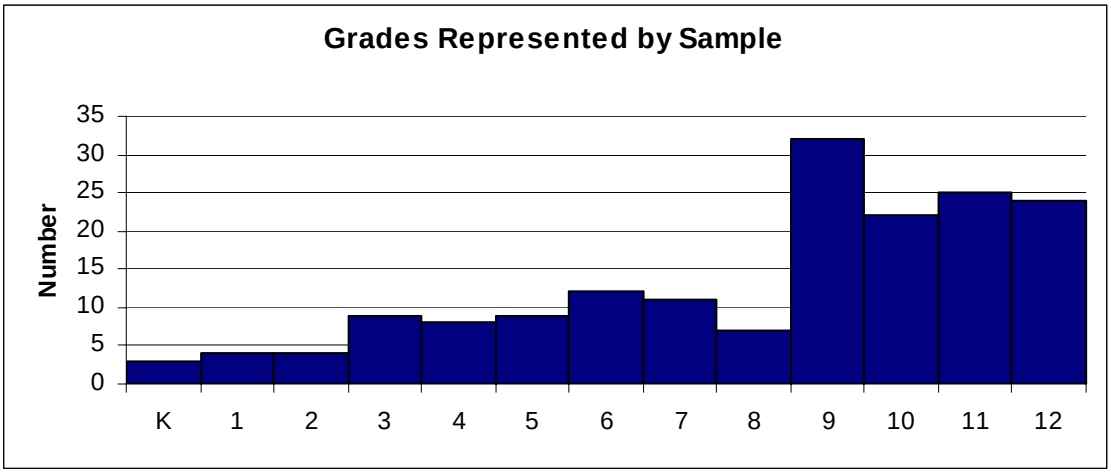
The majority of respondents teach at the high school level (grades 9–12), although the elementary (grades K–4) and middle (grades 5–8) grade levels are well represented. Table 9 shows the number of teachers within each grade level; Figure 7 shows the number of respondents for each grade, kindergarten to twelfth.

Table 9. Survey Item 2, Grade Levels Represented in the Survey

Grade Level	Number (Percent of the Sample)
Elementary	21 (23.7%)
Middle	24 (27.3%)
Middle & High	3 (3.4%)*
High	38 (43.2%)
College	2 (2.3%)**
Total:	88

*Three respondents teach middle and high school grades (2 teach 7–12; 1 teaches 6–12); these three respondents are treated as both middle school and high school level teachers. **Two respondents teach geography at the college level; as noted in Chapter III, results for college -level respondents are not discussed, unless noted otherwise.

Figure 7. Survey respondents by specific grade taught.



Teaching experience ranged from one to thirty-eight years. On average, survey respondents had been teaching for 13.7 years. Average teaching experience by level is displayed in Table 10. The mean, median, and mode illustrate the range of teaching experience represented by the survey sample, particularly at the middle and high school levels.

Table 10. Survey Item 3, Average Number of Years Teaching

Grade Level	Average Number of Years		
	Mean	Median	Mode
Elementary	17.7	17	17
Middle	12.7	10	10
High	12.2	8	6
Total Sample	13.7	11	6

Research Question 1: Teacher Beliefs and Knowledge

Research Question 1 investigated teachers' beliefs and knowledge about map literacy. In the survey, this question was addressed by survey items 16, 17, 18, 20, and 21. Items 16, 17, and 18 address teacher beliefs; items 20 and 21 address teacher knowledge.

Survey Item 16: Respondents reported what they believed to be the most important skill students gained from their instruction about maps. This question was open-ended. Responses were read for commonalities and categorized by these commonalities. Three primary categories were identified: (1) learning the basics, (2) developing place location knowledge, and (3) reading and interpreting maps. Results are illustrated in Table 11.

Table 11. Survey Item 16, Instructional Emphasis

	Learning the Basics	Location	Reading, Interpreting Maps	Other		
				Way-finding	None	Unclassified
Percent of Elementary	38.1	23.8	28.6	4.8	14.3	4.8
Percent of Middle	18.5	29.6	59.3	0	0	7.5
Percent of High	17.1	29.3	31.7	9.8	4.9	4.9
Percent of Total	22.6	25.8	35.5	5.4	5.4	5.4

*Percentages represent percent within a category, e.g., 38.1% of elementary teachers focus on learning the basics while 22.6 of the entire sample focus on this topic. Totals exceed 100% because responses were applicable to multiple categories.

Respondents who focus on *learning the basics* emphasize latitude and longitude, scale, direction, determining distance, and projection. This category is most evident among elementary level respondents. Of these topics, determining distance is noted most often, but by only nine respondents (10.2 percent of the sample). While respondents report teaching these topics, it is unclear if the focus is on simply learning the terms or understanding how these concepts relate to map reading, analysis, and interpretation. Locational knowledge is also significant. An important component of geography education is to develop students' mental map of the world's places, and this goal is most often accomplished by looking at a map. It is not surprising that one-quarter of survey respondents' associate place knowledge with map learning. Reading and interpreting maps is the most significant category for the entire sample, but especially by middle school respondents. Responses to this question ranged from basic interpretation skills ("how to read and interpret basic information from a map" [66])[12] to the seemingly higher-order, application of knowledge gleaned from maps ("interpreting map data and applying information in problem solving situations" [68]).

Survey Item 17: This question asked respondents to describe activities that they think improve students' understanding of maps. Three broad categories were identified: hands-on activities, repetition, and relevance to students (Table 12). Hands-on activities included using atlases, solving problems based on maps, creating maps, and playing games with maps. For example, one respondent who teaches first grade wrote: "I place

a grid on the classroom floor. They have [the] same grid on paper with symbols for furniture (square, circle, rectangle, etc.). As I move objects in the room grid, they move them on their grid. This seems to help them understand what a map is" [74]. Hands-on activities were noted more often by elementary and middle school respondents. Repetition, or practice, with maps was noted the most by high school respondents. It often was linked to developing students' place knowledge: "Practice with all kinds of maps, locating and placing places on maps, use of magnetic board to practice place location, exposure to all types of maps and map project [sic]" [54]. A small number of respondents noted the importance of making learning and/or content relevant to students: "Anything that incorporates personal knowledge and/or benefit" [71]. It is noteworthy that the majority of activities mentioned were not specific to map learning; instead, these three categories could just have easily been applied to learning any other topic or skill.

Table 12. Survey Item 17, Activities that Improve Students' Understanding of Maps

	Hands-on Activities	Repetition	Relevance to Students
Percent of Elementary	71.4	28.6	4.8
Percent of Middle	77.8	25.9	18.5
Percent of High	58.5	61.0	4.9
Percent of Total	68.2	43.2	9.1

*Totals exceed 100% because responses were applicable to multiple categories.

Survey Item 18: This question is a follow-up to question 17: respondents explain why they think the activities described in the previous question are effective. Responses fall within four primary categories: students learn by doing, the activities are relevant to students, they foster critical thinking skills, and drill drives the message home (Table 13). Most respondents fell within the first three categories; there is minimal difference between these categories at any grade level. The fourth category, drill drives the meaning home, applies to a only small number of respondents.

Table 13. Survey Item 18, Activities Are Meaningful Because....

	Doing	Relevance	Critical Thinking	Drill
Percent of Elementary	28.6	23.8	19.0	9.5
Percent of Middle	37.0	29.6	22.2	0
Percent of High	22.0	26.8	31.7	12.2
Total	28.4	25.0	26.1	8.0

*Totals exceed 100% because some responses were applicable to multiple categories.

Survey Item 20: This closed-ended question provides a list of criteria from which respondents select those items that they think are necessary for map reading and interpretation. The results for this question are displayed in Table 14. Responses to the seven listed items were generally high, with the exception of *projection* for the elementary level. Just 33.3 percent of elementary level teachers checked *projection*, although 85.7 percent of elementary respondents selected *a map is a flat representation of the spherical earth*—essentially the concept of projection.

Table 14. Survey Item 20, Essential Elements for Map Comprehension

	Symbols	Cardinal Directions	Scale	Projection	Lat/ Long	Map is a flat...	Color/ Shading	Other
Percent of Elementary	90.5	95.2	76.2	33.3	66.7	85.7	85.7	14.3
Percent of Middle	92.6	88.9	88.9	63	81.5	74.1	77.8	29.6
Percent of High	97.6	97.6	97.6	56.1	90.2	73.2	80.5	24.4
Percent of Total	95.5	95.5	90.9	53.4	83	77.3	81.8	23.9

Respondents were given space to note other concepts necessary for map reading and interpretation (noted in Table 14 as *other*). Roughly one quarter of respondents listed additional criteria. Examples from each grade level are included in Table 15. There were few commonalities to these responses.

Table 15. Survey Item 20, *Other* Criteria Needed to Read and Interpret a Map

	Examples:
Elementary	Pattern of the sun's rotation [77] Global location [78] Know blue water and land differences [34]
Middle	Political and special interest maps [86] Titles and use of index [70] Relationship on the map to where they reside [79] Grid systems, cardinal and intermediate directions, types of maps [M, 39]
High	What they are looking for [44] Date, grid and glossary [43] Water flows downhill [40], Contour lines [54]

Survey Item 21: The last question on the survey asked respondents to define geographic literacy. This question was included to see how teachers thought about geography, in part because it was hypothesized that some teachers might equate geography with maps. This question proved problematic for some: it was left unanswered by one-quarter of elementary and middle school respondents while others misinterpreted the question (Table 16).

Table 16. Survey Item 21, Bad Responses

	Not Answered	Question Misinterpreted
Percent of Elementary	23.8	4.8
Percent of Middle	25.9	3.7
Percent of High	9.8	4.9
Percent of Total	19.8	5.8

The remaining responses ranged across six categories: knowledge about places, location, human-environment interaction (though rarely was this term used), the Five Themes of Geography,[13] equating geography with maps, and where and why (understanding where something is located and why it is located where it is) (Table 17). A slim majority of elementary and high school level respondents defined geographic literacy as knowledge about other places. This knowledge focuses on cultures: "to understand various cultures around the world" [16]; "I hope...that students gain a better

understanding of the world around them. They need to be conscious of other cultures" [53]; "the better understanding of the world allows us to understand why people work, live and play the way they do" [61].

Table 17. Survey Item 21, Defining Geographic Literacy

	Knowledge about Places	Location	Human-Env. Interaction	Five Themes	Geography = Maps	Where and Why
Percent of Elementary	33.3	4.8	9.5	0	4.8	19.0
Percent of Middle	14.8	11.1	11.1	3.7	22.2	7.4
Percent of High	29.3	7.3	12.2	7.3	7.3	14.6
Percent of Total	25	6.8	9.1	4.5	11.4	12.5

Summary

The survey items which address Research Question 1 do not reveal any particular focus to teachers' beliefs and knowledge about maps. Teachers believe that the focus of map instruction should center around one of three areas: learning basic map attributes like latitude and longitude, scale, and cardinal directions, developing students' place knowledge, or reading and interpreting maps. It is apparent that projection is not considered a necessary component of map understanding by elementary teachers in particular, and that many might not understand what projection is, as evidenced by the difference between projection (33.3 percent) and map as a flat representation of the earth (85.7 percent). Like projection, scale is considered more important by high school teachers than by elementary teachers, although it is not as dramatic a difference. Although survey item 16 shows a shift from "learning the basics" in elementary school to "reading and interpreting maps" in middle school, high school teachers are spread across learning the basics, emphasizing location, and reading and interpreting maps. There is little evidence to suggest that teachers of different grades think differently about maps and map instruction.

Research Question 2: Teacher Practices

Research Question 2 addresses teacher practices regarding map literacy. Survey items 7–11, and 13–15 address this research question. Seven of these questions are closed-ended in nature; survey item 15 is open-ended.

Survey Item 7: This item considers the role of textbooks in developing map literacy. Use of textbooks was described along a continuum from *always* to *never*. Results are illustrated in Table 18 as percentages.

Table 18. Use of Textbook in Developing Map Literacy

	Always	Very Often	Often	Rarely	Never
Percent of Elementary	5	15	30	45	5
Percent of Middle	0	15.4	34.6	38.5	11.5
Percent of High	10	17.5	30	40	2.5
Total	5.7	17	31.8	39.8	5.7

Use of textbooks for developing map literacy falls predominantly in the *often* and *rarely* categories. However, at each level, an equal or greater number of respondents report using their textbook *often*, *very often*, or *always* as compared to those who report using it *rarely* or *never* (Table 19).

Table 19. Use of Textbooks, *Often* to *Always* Versus *Rarely* to *Never*

	Often, Very Often, and Always	Rarely and Never
Percent of Elementary	50	50
Percent of Middle	50	50
Percent of High	57.5	42.5
Total	52.5	47.5

As viewed in Table 19, there is a split between those teachers who use their textbooks with some degree of frequency and those who do not. This split is not grade related. At both elementary and middle levels, an equal number of teachers report using their texts frequently as do those who report infrequent use. At the high school level, nearly three-fifths of teachers use their textbooks with some regularity.

Survey Item 8: Respondents were asked what additional resources are used to develop map literacy. Choices included the *TEKS*, *the Internet*, *workbooks*, and an open-ended *other* (Table 20). The TEKS are noted by less than 50 percent of respondents at all three grade levels. Use of the Internet increases with grade level, while use of workbooks is widely noted by middle and high school level respondents. *Other* materials used include self-created materials and, to a lesser extent, the National Geography Standards. Given that *other* materials are used second only to workbooks, they are an important component of how map literacy is developed by survey respondents.

Table 20. Survey Item 8, Additional Resources Used by Respondents*

	TEKS	Internet	Workbooks	Other
Percent of Elementary	42.9	38.1	42.9	66.7
Percent of Middle	40.7	51.9	74.1	55.6
Percent of High	36.6	63.4	73.2	61
Percent of Total	39.8	55.7	68.2	61.4

*Totals exceed 100% because respondents selected multiple categories.

Survey Items 9–11: This series of questions examine the role of technology in teaching map lessons. Item 9 (Table 21) asked respondents if they use technology-

based resources to teach map skills. Question 10 was answered by respondents who answered yes to question 9; question 11 is answered by respondents who answered no to question 9.

Table 21. Survey Item 9, Use of Technology

	Use Technology	Do NOT Use Technology
Percent of Elementary	19	81
Percent of Middle	22.2	77.8
Percent of High	34.1	65.9
Percent of Total	27.5	72.5

The majority of survey respondents reportedly do not use technology when teaching maps; the number who use technology does increase slightly from elementary level to high school level. For those who do use technology, resources cited include the (ubiquitous and general) Internet, National Geographic's Map Machine, atlases available on CD-ROM, and Geographic Information Systems (noted by 2 high school respondents). It is interesting to compare the number who report using technology in this survey item with those reporting use of the Internet in survey item 8 (Table 22).

Table 22. Comparison of Survey Items 8 and 9

	Survey Item 8: Percent Reported Using the Internet	Survey Item 9: Percent Reported Using Technology
Percent of Elementary	38.1	19
Percent of Middle	51.9	22.2
Percent of High	63.4	34.1
Percent of Total	55.7	27.5

For each grade level, approximately twice as many respondents report using the Internet as report using technology for map skills instruction. It is difficult to explain this discrepancy. Perhaps respondents do not consider the Internet to be technology, or the question was interpreted to mean certain types of technology like Geographic Information Systems or software packages.

For those respondents who do not use technology, potential reasons why were listed in survey item 11. There was also an option to list another reason in addition to the five listed items. Respondents were allowed to select as many reasons as applicable. Results are illustrated in Table 23.

Table 23. Survey Item 11, Reasons Why Technology Is Not Used

	Limited Access	Uncomfortable Using	Inappropriate for Grade Level	Unsure of Availability	No Time to Learn To Use	Other
Percent of Elementary	33.3	9.5	4.8	**61.9***	33.3	19
Percent of Middle	**48.1**	11.1	3.7	18.5	25.9	22.2
Percent of High	**48.8**	7.3	2.4	29.3	19.5	17.1
Percent of Total	**45.5**	9.1	3.4	34.1	25	19.3

*Items in **bold** were noted as the most significant barrier to teaching maps with technology.

Regardless of grade level, access to technology is perceived as a limiting factor for many respondents. Many elementary teachers noted that they were unsure of what technology-based resources are available to help them teach about maps. A small number of teachers reported that they (1) were uncomfortable using technology, and/or (2) believed technology to be inappropriate for their grade level. Respondents were asked to select the most significant barrier to teaching with technology; the most significant factors are in bold in Table 23. As might be expected, the most significant factors also have the highest selection rates.

Survey Items 13 and 14: Common practice, as well as the typical textbook layout (which includes map skills at the beginning of the textbook), suggests that map instruction occurs at the beginning of the year for a two to six week period of time. These questions sought the timing and duration of map lessons. In question 13, respondents estimated the percentage of total class time spent teaching maps (Table 24). Estimated time spent ranged from 1 percent to 90 percent. Most estimates fell between 10–20 percent. On average, elementary teachers spend the least amount of

time on map lessons while high school respondents report spending slightly more than one-fifth of class time on map lessons.

Table 24. Survey Item 13, Percentage of Time Spent Teaching Maps

	Time Spent Teaching Maps (Percent)
Percent of Elementary	10.9
Percent of Middle	18.7
Percent of High	22.3
Percent of Total	19.4

*Nine respondents did not answer this question; these respondents were excluded for this item analysis.

In survey item 14, respondents selected the statement that best described the frequency of their instruction about maps: beginning of the year, at periodic intervals, on an as-needed basis, or *other* (Table 25). Most respondents report teaching maps at periodic intervals throughout the school year. Some respondents checked multiple boxes. For example, some reported teaching a “big” lesson about maps at the beginning of the year, followed by smaller lessons (periodic intervals) throughout the remainder of the year. This sample largely reports map skills instruction occurring throughout the school year.

Table 25. Survey Item 14, Frequency of Map Instruction*

	Beginning of the Year	Periodic Intervals	As Needed	Other
Percent of Elementary	9.5	76.2	47.6	0
Percent of Middle	29.6	81.5	18.5	7.4
Percent of High	19.5	63.4	26.5	17.1
Percent of Total	20.5	70.5	28.4	10.2

*Totals exceed 100% because some respondents selected multiple categories.

Survey Item 15: This question asked respondents what topics they cover when they teach map skills (Table 26). The question was open-ended. Six areas were commonly noted by respondents: latitude and longitude, scale, thematic maps, five components of maps,[14] symbols, and location. A smaller number of respondents noted the five themes of geography and projections. Emphasis differs by grade level. At elementary, the focus is on the five components of maps (76.2 percent), latitude and longitude (57.1 percent), and location (57.1 percent). Middle school teachers report concentration on thematic maps (70.4 percent), scale (59.3 percent) and latitude and longitude (55.6 percent). For high school teachers, the focus was on thematic maps (61 percent), the five components of maps (41.5 percent), and scale (41.5 percent). The different emphases as well as the overlap between grades suggests progression from elementary to middle, and reiteration of elementary and middle school topics by high school respondents; Table 27 shows the five topics ranked highest by each grade level.

Table 26. Survey Item 15, What Topics Do You Cover When You Teach Map Skills?*

	Location	Thematic Maps	5 Themes	5 Components of Maps	Lat & Long	Symbols	Scale	Projections
Percent of Elementary	57.1	14.3	0	76.2	57.1	38.1	33.3	4.8
Percent of Middle	44.4	70.4	11.1	51.9	55.6	29.6	59.3	7.4
Percent of High	29.3	61	7.3	41.5	31.7	14.6	41.5	19.5
Percent of Total	40.9	52.3	6.8	54.5	45.5	27.3	45.5	13.6

*Totals exceed 100% because some respondents selected multiple categories.

Table 27. Top-ranked Categories for Survey Item 15

	5 Components	Lat & Long	Location	Thematic	Scale
Elementary	1	2	3		
Middle		3		1	2
High	2			1	3

Summary

Teacher practices reveal some differences between grade levels; at the same time, few universals can be identified among teachers. Use of textbooks exemplifies this finding: at first glance, it would appear that most teachers *rarely* use their textbooks as a resource in planning map instruction, but that majority is only slightly greater than those who use their texts *often*. Further analysis reveals that about half of survey respondents report using their textbook *often*, *very often*, and *always* while the remaining half use their text *rarely* or *never*. This near fifty-fifty split occurs at each grade level. The percent of elementary, middle and high school respondents using the TEKS as a guide are nearly equal; middle and high school teachers make far greater use of workbooks than do elementary; and, the Internet is one of the few areas where use reportedly increases from elementary to middle to high school teachers. Use of technology (besides the Internet) increases somewhat, but those not using it are in the vast majority at all grade levels. Time devoted to map instruction increases with each grade level, which might perhaps be an effect of the number of geography-only teachers represented in the high school sample. For the vast majority of respondents, instruction reportedly occurs throughout the school year at periodic intervals, regardless of grade level. The content focus of map instruction does seem to differ by grade with an initial focus on map basics like title, date, directions, latitude and longitude, and finding locations, progressing to a more abstract concept like scale and dealing with thematic maps in middle school. There is a continued focus on these middle school topics in high school, but also a focus on elementary topics, such as the five components of maps.

Research Question 3: Curricular Knowledge

How well teachers understand the curricular requirements about map literacy is addressed by Research Question 3. Survey items 5, 6, 12, and 19 point to this question. Items 5, 6, and 12 are close-ended, while item 19 is open-ended.

Survey Items 5 and 6: In item 5, respondents were asked if the Texas Essential Knowledge and Skills (TEKS) includes maps at their grade level. Item 6 follows by asking whether respondents teach map skills. Instruction about maps is included in the social studies strand of the TEKS throughout the curriculum, so (public school) teachers

should be teaching maps, and these respondents largely recognize the map component of the TEKS (Table 28).

Table 28. Survey Item 5, Are Map Skills a Component of the TEKS?

	Yes	No
Percent of Elementary	90.5	9.5
Percent of Middle	85.2	14.8
Percent of High	92.7	7.3
Percent of Total	89.8	10.2

They also report teaching maps in their classroom (Table 29). There was a small number of respondents who reported that maps were not part of the TEKS for their grade level. These teachers either taught in private schools (which are not governed by the TEKS), or they taught a subject other than social studies. For example, one high school respondent [55] teaches math, in which he includes instruction about maps, although not required to by the TEKS. While most teachers report that the TEKS do, in fact, require instruction about maps, an even greater number report teaching maps.

Table 29. Survey Item 6, Do You Teach Map Skills?

	Yes	No
Percent of Elementary	95.2	4.8
Percent of Middle	96.3	3.7
Percent of High	100	0
Percent of Total	96.6	3.4

Only one elementary respondent and one middle school respondent do not teach maps, while all high school respondents do. The two respondents who report not teaching maps state that map skills are not required at their grade level.

Survey Item 12: In this question, respondents were asked to select the curriculum guides that influence their geography and social studies curriculum: the TEKS, the local school district, the National Geography Standards, and/or their textbook (Table 30). The

TEKS are the most important guide, followed, to a lesser extent by the textbook. The Standards and school district are used by the fewest respondents. It should be noted, though, that the TEKS geography strand mirrors the Standards, so if teachers are in fact guided by the TEKS, they are teaching the Standards, albeit indirectly. The differences between local school district curricula and the TEKS is unknown. TEA estimates that three hundred independent school districts (ISD) develop local curricula. For example, Houston ISD uses *Project Clear*, an enormous binder which provides a step-by-step guide to implementing the TEKS. In the Richardson ISD, the district curriculum lays out the TEKS to be met each semester on poster-sized paper in tiny print.

Table 30. Survey Item 12, What Influences the Geography/Social Studies Curriculum?*

	TEKS	School District	The Standards	Textbook
Percent of Elementary	76.2	38.1	33.3	47.6
Percent of Middle	85.2	33.3	33.3	33.3
Percent of High	82.9	39	51.2	51.2
Percent of Total	79.5	37.5	40.9	45.5

*Totals exceed 100% because respondents could select multiple categories.

Survey Item 19: In this question, respondents considered the role of maps in the social studies. This open-ended question yielded a variety of responses, classified into six primary categories (Table 31). Approximately 15 percent of respondents viewed maps primarily as a tool to *show location*. For example, one respondent wrote that maps are used to “give a sense of direction and understanding of location” [13], while another said “For students to be able to locate features on a map” [16]. Respondents particularly from the elementary level believed that maps could be used to illustrate *a global perspective*: “a global perspective” [7]; “learning about our world—we work and

Table 31. Survey Item 19, What Is the Role of Map Skills in Geography and the Social Studies?*

	Shows Location	"A Global Perspective"	Relationships	A Bridge in the Social Studies	"A Picture's Worth a 1,000 Words"	Focus on Skills	Misunderstood	Unclassified
Percent of Elementary	14.3	52.4	14.3	19	0	9.5	0	9.5
Percent of Middle	14.8	25.9	37	37	14.8	14.8	0	3.7
Percent of High	14.6	17.1	24.4	19.5	7.3	4.9	19.5	9.8
Percent of Total	14.8	27.3	23.9	25	8	9.1	9.1	8

*Totals exceed 100% because some responses fell within multiple categories.

live in a world marketplace" [26]; and, "Creates an awareness of where events happen in the world and familiarizes students with the world outside their own community" [38]. Other respondents noted the ability of maps to show *relationships*. Some responses in the category specifically noted the relationship between humans and their environments (although none used the term *human-environment interaction* precisely). The fourth category identified is *a bridge in the social sciences*; many respondents see maps as the link between the many disciplines found under the umbrella of the social studies: "students need to understand the basis of map skills to be able to comprehend geography and history" [31]; and, "geographical skills complete the bridge between historical, physical, and cultural social studies" [60]. A small number of respondents believed that maps can be used to represent a vast amount of information in a relatively compact form (*a picture's worth a 1,000 words*). An equally small number of respondents answered this question focused on the need for skills (*focus on skills*): "crucial—helps students with TEKS and TAAS" [20]; "it is a vital component to understand and utilize correctly in order to advance geographic skills" [30]; "essential skill, one all students must master before leaving high school" [63].

In addition to these six, two other categories are included in Table 31. A small number of responses could not be classified into these six categories (*unclassified*), and a rather large proportion of high school respondents misunderstood the question (*misunderstood*). Those that misunderstood the question answered it in terms of *how* important maps are in the social studies (e.g., very important), rather than describe the role of maps in the social studies.

Summary

Teachers report that map skills are required at their grade level and, with few exceptions, that they do teach them. The primary curricular guide is the state-mandated TEKS. The textbook is noted as a guide for approximately half of elementary and high school respondents, and half of all high school respondents report use of the Standards. For those teaching World Geography, the Standards might have greater visibility. There was limited consensus about the role of map literacy in the social studies. In respondents' conceptualization of the social studies, map instruction plays a variety of roles.

Survey Analysis Along a Map Skills Continuum

The continuum was used to evaluate survey results alongside a set of established proficiency standards. In using a continuum guided by NAEP's achievement levels, the skills and knowledge about which students are tested is considered. The results from the NAEP test are used as a benchmark to consider how geographically literate American students are. It seems reasonable to consider teachers' practices in light of the NAEP criteria.

As described in Chapter III, individual surveys were coded using the Map Literacy Continuum. Criteria reportedly taught were coded by grade level, proficiency level, and the standard itself. For example, a respondent teaching elementary grades wrote "...making inferences on how the geography of an area affects life in that area and checking their inferences..." (#74). This response is coded as 4A-c:

- 4 represents fourth grade level
- A represents advanced proficiency levels at this grade; and,
- c represents the standard on the continuum designated by the letter c (*describe and compare differences, similarities, and patterns of change in landscapes*).

It was also noted in Chapter III that a respondent could be categorized as *below basic*: those who failed to note any of the criteria at their grade level are described as *below basic*. This *below basic* categorization was particularly prevalent at the high school level.

It is clear from this study's results that there is a gap between NAEP's expectations and how teachers think about, and consequently teach map skills (Figure 8). In this sample, instruction is focused on the *basic* and *proficient* criteria at elementary grades and *basic* criteria in middle school. To a lesser extent, *advanced* topics at the elementary level and *proficient* topics at the middle school level are taught. At the middle school level, only one topic within *advanced* is taught with some regularity: analyze and explain patterns of land use; consider human-environment interaction

Grd.	Basic (Knowing)	Proficient (Understanding)	Advanced (Applying)
E K-4	a. use a map to find information b. **identify locations*** c. **read simple maps, keys & legends** d. draw simple maps, map keys, & legends e. **<u>identify, describe basic map elements</u>****	a. (read &) interpret maps b. use number/letter grids to plot locations c. **<u>understand relative location terms</u>** d. draw sketch map of observed landscapes e. observe the distribution of features on maps	a. solve simple problems using maps, atlases b. draw sketch maps of places c. **describe, compare differences, similarities, patterns of change in landscapes** d. determine the impact of change in one place
M 5-8	a. **<u>possess fundamental knowledge and vocabulary of distance, direction, scale, boundary, site, and situation</u>** b. solve fundamental locational questions using latitude and longitude c. interpret simple map scales d. **identify locations** e. explain differences between maps, globes, aerial photos, satellite images f. find a wide range of information using an atlas or almanac. g. draw sketch maps, compare with atlases	a. solve locational questions requiring integration of information from two or more sources, such as atlases or globes b. compare information at different scales c. choose appropriate maps to answer particular questions; evaluate the goodness of maps (e.g., select best projection for purpose) d. **use map information to describe the role that regions play in influencing trade, migration patterns; cultural, political...** e. create thematic maps w/ data, symbols, color f. **explain why *x* is located where it is**	a. use case studies for spatial analysis and to develop maps and other graphics b. use one category of a map or aerial photograph to predict other features of a place such as vegetation based on climate or population density based on topographic features. c. **analyze & explain patterns of land use; consider human-environment interaction**
H 9-12	a. solve simple locational problems using maps and globes (using applicable units of measurement) b. read maps c. identify several basic types of map projections d. use maps to illustrate spatial patterns (e.g., regional boundaries change)	a. <u>interpret maps to analyze spatial phenomena; discuss economic, political, & social factors that define, interpret space (using geographic concepts)</u> b. design maps based on descriptive data c. report both historical and contemporary events within a geographic framework using tools such as special-purpose maps and primary and secondary source materials. d. collect, compare, explain the significance of maps from different sources, points of view	a. apply a wide range of map skills; b. develop maps using fundamental cartographic principles including translating narratives about places and events into graphic representations c. compare maps of the world using different projections, perceptions of space to draw conclusions about factors that influence mental maps

*Items in **bold** are taught more frequently. **Items <u>underlined</u> are the most popular item at that grade level.

Figure 8. Topics reportedly taught within the Map Literacy Continuum.

(M-Ac). This item, though, is noted by high school teachers, rather than those at middle school. Along the continuum, high school topics are essentially absent. Given that nearly half of the respondents are high school teachers, a greater concentration in high school topics might be expected. Instead, it seems that elementary teachers are teaching at their grade level, particularly within the basic and proficient areas. Middle school teachers focus on basic skills at their grade level, but also teach a number of topics found within the elementary level. High school teachers are teaching basic middle school topics, and even elementary topics.

As described in Chapter III, each survey was coded as below basic, basic, proficient, or advanced according to the grade level at which the respondent teaches. Surveys at all three grade levels fell below the basic criteria of the continuum. While the elementary and middle levels are small in number (one and two, respectively), the majority (62.5 percent) of high school teachers fall below the basic level. At the elementary and middle levels, most reported teaching aligned with the *basic* category. Smaller numbers are found within the proficient area. Only surveys from elementary educators contained responses that collectively amounted to advanced map skills teaching. However, only two teachers could be categorized as advanced. Details of specific topics taught within map skills for each grade level are below.

Elementary Level Teachers (Grades K–4)

Of the three grade levels, elementary teachers in this study are the most advanced in thinking about, and teaching maps to students. They tend to teach map skills across the continuum; that is, they teach basic-level skills, as well as proficient-level, and even some advanced. Within the continuum, emphasis is placed in four areas:

- Identifying locations (E-Bb);
- Identify, describe basic map elements (E-Be);
- Understand relative location terms (E-Pc); and,
- Describe and compare differences, similarities, and patterns of change in landscapes (E-Ac).

Understanding relative location is interesting because it is not only routinely noted by elementary level teachers, but also is considered important by middle and high school

teachers. This item may be an example of middle and high school teachers focusing on concepts that should have been taught in previous grades.

Middle School Level Teachers (Grades 5–8)

Survey responses at the middle school level reflect an emphasis on basic skills. Skills at the proficient level are less common, and advanced skills are essentially absent. Only four educators gave responses that could be considered advanced. Middle school respondents report teaching a number of elementary level topics. For example, middle school teachers noted relative location (E-Pc), reading maps (E-Pb), and plotting locations using latitude and longitude (E-Pe) as important topics to teach their students.

At the middle school level, emphasis is placed in four areas:

- Possess fundamental knowledge and vocabulary of distance, direction, scale, boundary, site and situation (M-Ba);
- Identify locations (M-Bd);
- Use map information to describe the role regions play in influencing trade, migration patterns; cultural, political, interaction (M-Pd); and,
- Explain why *x* is located where it is (M-Pf).

At this level, identifying location was noted most frequently. The importance of a map to show students where something is located was evident throughout the surveys at all grade levels. The activities described in survey responses reenforce the idea that the primary purpose of a map is to show location. A map, of course, is ideal for showing location. However, it appears that more sophisticated use of maps does not occur. Using maps to solve problems, to illustrate a point, or make inferences about a location or landscape is rarely noted.

High School Level Teachers (Grades 9–12)

High school teachers represent the greatest number of respondents and are the least advanced in thinking about maps and teaching them to students. More teachers at this level were teaching below basic high school skills; 62.5 percent were *below basic*. This result is especially troubling because it is at the high school level that geography is taught as a single subject, providing the best opportunity for map skills to be taught in a sophisticated manner.

At the high school level, the most commonly reported topics are:

- interpret maps to analyze spatial phenomena; discuss economic, political, and social factors that define, interpret space (using geographic concepts) (H-Pa);
- use maps to illustrate spatial patterns (H-Bd); and,
- read maps (H-Bb).

These topics, though, are reported by only 35 percent, 25 percent, and 20 percent respectively of the high school sample. While topics that could be understood to fall under *interpret maps to analyze spatial phenomena; discuss economic, political, and social factors that define, interpret space* (H-Pa) is noted most often, at no point are geographic concepts mentioned. More commonly, high school teachers report teaching cartographic vocabulary (62.5 percent) and identifying locations (40 percent); both basic level, middle school topics.

Topics Not Taught within the Continuum

Within the continuum, most items were mentioned by at least one survey respondent. Only one item was never reported: compare information presented at different scales (M-Pb). Many items were noted by only one or two respondents, leaving these areas largely untaught by this sample of teachers (see Figure 8). At all grade levels, advanced skills are essentially absent. Perhaps more troubling is the near absence of all high school level skills. High school survey respondents are instead focused on middle school, and even elementary level skills.

Perhaps even more troubling is that there is no mention of geographic concepts by any survey respondents. Maps are an excellent tool for teaching geography (and its related concepts), but there is no indication that maps are used for this purpose. This could be due to the conceptualization of geography by some survey respondents who

equated geography with map skills. For example, one respondent defined geographic literacy as: “The ability to read and understand any type of map given” [#12]. Nearly one-fifth of the sample (19.8 percent) did not provide an answer to the question of defining geographic literacy; this lack of response could be attributed to a limited conceptualization of geography.

Phase II: Interviews and Observations

The research questions of this study were further investigated through interviews and observations. Based on survey analysis, eleven teachers were selected from the sample of survey respondents, as outlined in Chapter III. Pseudonyms are used for each of the interviewees to ensure their confidentiality. In this section, a description of interviewees background and survey responses is presented. A summary of classroom observation is also included. This description is followed by results, organized by each research question. Research question results are further organized by grade level.

Subject Profiles—Elementary School *(Kindergarten–4)*

Teacher 1: Ms. Carr

Ms. Carr teaches gifted and talented students, grades kindergarten to fifth. She meets with each grade level once a week (e.g., fourth grade on Tuesdays). She has been teaching for eighteen years. Her situation is unique: she teaches only gifted and talented students, meets with them only once a week (although for the whole day), and teaches integrated lessons (rather than teaching a discreet subject). She team teaches with another teacher; she is responsible for language arts and social studies. Her academic preparation in geography consisted of one three-hour course. Ms. Carr has been actively involved in the Texas Alliance for Geographic Education (TAGE), and credits this involvement with her ability to teach geography.

Based on her survey responses, Ms. Carr was classified as *advanced* (7–8) in her instruction about maps. Her instruction includes basic topics like using a map to find information and identifying basic map elements, as well as topics categorized as proficient (understand relative location terms and drawing sketch maps) and as advanced (solving problems based on map information, comparing and contrasting

different landscapes). Ms. Carr is one of only two survey respondents classified as *advanced*.

I observed Ms. Carr teaching her fourth grade class. On that day students were working on two projects: a scale drawing of the library, and researching individual reports on disasters. Students had previously taken measurements of the library, and were in the process of translating their sketch and measurements into a scale drawing. When they completed their drawing, they moved on to researching their disaster projects. Students' work was individual, and Ms. Carr spent time with each child, checking her/his work. Most often she did not answer their questions directly, but asked them questions in return until they came up with "the answer." Time was made at the end of the day for students to reflect on what they had learned, what they had liked, and what they had disliked. Ms. Carr and her team teacher try to make time for student reflection every day, although it does not always happen.

Teacher 2: Ms. Henry

Ms. Henry has taught first grade for seventeen years. She also has taught second grade in a private school. She plans to retire two years from now. Her classroom is self-contained; she is responsible for all subjects (except art and physical education). She has a composite certification to teach elementary school. Ms. Henry does not remember taking any geography courses in college ("I'm not sure...it's been so long since I've been in college.") but does remember taking a sociology course that included "quite a bit of geography."

Ms. Henry was classified as *proficient* (4) based on survey responses. She teaches direction, how to read a map key, compass rose, and use of color in symbolization—all *basic* topics. She also has students draw maps of their bedroom, school, and house (observed landscapes) and develops students' understanding of relative location terms. Such activities fall within the *proficient* category. She also addresses an advanced criterion: describe and compare differences, similarities, and patterns of change in landscapes.

On the day that Ms. Henry was observed, reading was taught during the morning, and a mapping activity was introduced and completed in the afternoon. Reading instruction occurred in pairs of students; while Ms. Henry met with two students, the rest

of the class worked at different learning centers: science, geography (map work), listening, or mathematics. The afternoon map lesson involved students interpreting a map of a zoo, placing symbols on the map, and answering questions which forced them to decipher the symbols. This activity was particularly relevant to students as Ms. Henry used it to announce the class' upcoming field trip—to the zoo. The map was simple, containing iconic symbols, and appropriate for first graders.

Teacher 3: Ms. Ling

Ms. Ling has been an elementary school teacher for the past seventeen years; she teaches fourth grade. She had a course in social studies methods in college, but no coursework in geography specifically. Despite the lack of coursework, she felt prepared to teach students about maps. She has been active in professional development activities, participating in many geography teacher institutes, including development of the Standards.

Ms. Ling's approach to map instruction is within the *proficient* category. Instruction includes interpretation of symbols, drawing sketch maps, understanding basic map elements, and determining the impact of change in one place on another. She was one of the few teachers who cited the Standards as a source in developing map lessons (survey item 8).

On the day that Ms. Ling's fourth grade class was observed, she had students create a map of the world by folding a sheet of paper in a precise order, lines were then drawn along the folds, and the continents emerged. The activity was taken from *The Journal of Geography*. The map created placed the Pacific Ocean in the center of the map; by doing this activity, she hoped to develop students' mental map of the world and have them see that there is not just one world map, centered around the Atlantic Ocean. Some students had difficulty folding their maps, and because the process was cumulative, those students were left behind, unable to progress. The map was not completed during my observation because Ms. Ling wanted students to spend some time in the library to read some poetry by a children's author coming to visit the school in the next week. She seemed unsure about whether they would complete that task at a later time. I was left with the impression that Ms. Ling is a creative teacher, making use of a variety of resources and actively seeking new content for her students. She also

places a heavy emphasis on student discovery. However, her approach results in many unfinished projects and without such follow-through makes her goals for student learning potentially unreachable.

Subject Profiles—Middle School (Grades 5–8)

Teacher 4: Ms. Barry

Ms. Barry teaches the fifth grade; she has been teaching at this grade for ten years. She team-teaches with another teacher; she is responsible for math, science and geography while her team-teacher is responsible for language arts and social studies other than geography. Ms. Barry teaches geography by default: her team teacher does not like to teach geography.

Because Ms. Barry teaches fifth grade, her survey was evaluated at both the elementary and the middle school level. At both levels, her map instruction is *basic* (elementary = 4; middle = 1). She reports having students using a map to find information, identifying locations, and using grids to identify locations. These are basic to proficient skills at the elementary-level continuum. Identifying locations and using latitude and longitude to solve locational questions fall within the basic category at the middle school level.

The day that I observed Ms. Barry, her focus was on math, economics, and technology. Worksheets were used to practice metric conversions, followed by some daily math problems (Arithmetic Developed Daily—ADD). In this activity, students explain how they solve math problems, and multiple solutions are sought. This activity was followed by their economics project, “Enterprise City” where, on this day, they practiced writing checks and balancing a check book. The culmination of Enterprise City is a field trip to a “town” that students, assigned to a variety of professions, run. The project is meant to model the everyday life of adults: students have job responsibilities, they get paid, pay bills, and must decide how to spend any extra money. At the end of the day, students practiced math problems on an Internet site. The instruction I observed centered around worksheets, and learning activities were teacher-controlled.

Teacher 5: Ms. Paris

Ms. Paris has taught sixth grade social studies for seven years. She has a bachelor's degree in social work, and a master's in education. As an undergraduate she took one course in geography. She felt unprepared to teach geography, but when she first started teaching, there was also little emphasis in the social studies on geography. She describes teaching geography as a "real struggle" although participation in Friends of Geography (FOG), a Houston-based professional development organization, was helpful.

Her survey responses indicate a *basic* approach to map instruction. She has students describe and compare landscapes (EA-c), interpret maps (EP-a), understand map terminology (MB-a), and use map information to describe regional interaction (MP-d). She also has students draw sketch maps (MB-g) and include basic map elements, but those maps are of fictitious places. Such a task means that some basic map elements, like projection and scale, are irrelevant.

On the day I visited Ms. Paris' class, she was teaching a unit on Africa. Students were given the task of outlining the chapter to identify important themes, not a skill directly related to TEKS objectives. As I observed her class, I followed along in the teacher's wrap-around edition of their textbook; her lesson differed little from the textbook. However, she began the class by assessing students' knowledge about Africa and related some of the content to students' lives. For example, in looking at environmental change in Africa, she described what their neighborhood looked like fifty to seventy-five years ago: it was farmland which is now highly urbanized. She asks students if "once you start changing an environment, is there a possibility that it could go back? have you seen it happen?"—a higher-order, thinking question. I observed students working individually at their desk with their textbooks for most of the class periods, however time was made for student discussion and higher-order questioning.

Teacher 6: Ms. Arrow

Ms. Arrow teaches sixth and seventh grade social studies; she has done so for the past four years. Her bachelor's degree is in history, and she has a master's in secondary education. She has had no college course work in geography, and has not

participated in professional development for geography. She believes the last geography course she took was ninth grade World Geography. She described herself as semi-prepared to teach geography because "I just kind of understand geography, but as far as any pedagogy, as to how to do it, I have never had any."

Her survey was evaluated as *basic-proficient* (4–5). She includes topics like orientation, legends, and symbols (MB-a), scale interpretation (MB-c), and answering questions by using a variety of maps (MP-a). Ms. Arrow also spends time teaching the history of cartography. She equates geographic literacy with map literacy: "Geographic literacy means to be able to look at a map and be able to understand where it is, what time period it represents and what information the map conveys" (survey item 21).

During observation, Ms. Arrow had students reenact the Battle of the Sabine Pass. Their school atrium is shaped much like the Sabine Pass, and Ms. Arrow thought it would be a good activity for students to understand the spatial arrangement of the battle site. I observed the re-enactment in two classes. During the first class, Ms. Arrow had little control over the class and there was no time left to discuss what they did, why they did it, and what they learned. It seemed rather chaotic. During the second re-enactment, students appeared to be more on task, and Ms. Arrow had time at the end of class to discuss the reenactment. During this second observation of the class, Ms. Arrow had time to answer student questions and assess their learning (which she had planned to do in the earlier class).

Teacher 7: Ms. Pyle

Ms. Pyle teaches seventh grade social studies. She has taught for twenty-one years. She has a bachelor's in English, with a minor in history, and a master's in education with a specialization in reading. She does not recall taking any courses in geography, but has participated in professional development: "I can't think of any geography courses that I took, but I've tried to keep current with it, through professional development." She says she felt prepared to teach geography at this level because "most teachers with a modicum of intellect can teach any subject to seventh grade students, and particularly that goes on down with each grade level" (meaning that teaching each grade below seventh is increasingly easier because students know less and less).

Based on her survey, Ms. Pyle was classified as *basic-proficient* (4–5). Her instruction focused on basic map terminology (MB-a), identifying locations (MB-d), and using maps to problem-solve (MP-a). She places particular emphasis on interpreting data in order to understand "why things happen the way they do" (survey item 19).

On the day of observation, Ms. Pyle's classes were working in pairs on a PowerPoint presentation about some aspect of Texas history. The pairs selected their topics. The requirements for the project included fifteen slides, and they were required to include a map pertinent to their topic. This project was intended to integrate many social studies TEKS, particularly history, technology, and geography. Students were clearly interested in the project. Ms. Pyle stressed the importance of student discovery, and wanted students to decide what was important to include in their presentation. However, with few guidelines presented, their focus tended to be on the presentation's appearance rather than its content.

Teacher 8: Ms. Michaels

Ms. Michaels teaches eighth grade U.S. History. She has taught for twenty-three years. Her major was education, and she has taken eighteen graduate hours in history. She realized while still an undergraduate that she wanted to be a history teacher. She has not taken any geography courses, or been involved in professional development. In preparation to teach geography, she focuses on supplemental materials: "I just try to get the best material I can to teach geography, to teach map skills." But geography is not her focus: "and even in my class, I don't focus so much on teaching geography. I want to teach my history through...there are so many ways to teach geography through history." For this teacher, maps are equated with geography.

Ms. Michaels's survey responses were evaluated as *proficient* (6). Her instruction includes some elementary-level topics: identifying continents and oceans (EB-b), understanding relative location (EP-c), and interpreting maps (EP-a). However, she also includes basic map elements (MB-a), solving locational questions (MP-a), using maps to compare regions and note relationships (MP-d), and explaining why a particular feature is located where it is (MP-f). She describes an activity where students use maps and a reading to understand why West Virginia split from Virginia in 1863. This activity suggests learning *with* maps.

At the time of observation, Ms. Michael's class was studying the Lewis and Clark Expedition. On the day of my visit, the blackboard outlined the day's objectives as: *Explain the significance of 1803*; *Create a thematic map*. In order to earn an "A" on the map, students were given the following "hints": *use pencil*, *print*, *color last*, and *check off as you go*. The criteria for earning an A are focused largely on aesthetics rather than content ("check off as you go" at least suggests some content focus). Students were given a blank outline map, a list of features, and instructed to label and color the map per the blackboard instructions using their textbook maps, a desktop map of the United States, and an Internet site about the expedition. The map created was not so much thematic as it was a labeled list of places. The activity was directed and controlled, and focused on Ms. Michaels' learning objective: to develop students' place knowledge.

Subject Profiles—High School (Grade 9–12)

Teacher 9: Ms. Wick

When Ms. Wick answered the survey, she taught high school World Geography; at the time of the interview, she was teaching seventh and eighth graders in a new school and a new district. She hopes to teach World Geography again when a position opens up in her new district. In college, she majored in French and history. She taught history for "a number of years," then returned to school for a master's in theater, and then went into business, before returning to teaching. When she returned to teaching, she had a composite certification because "it was easier to get a job with a composite and I really liked geography." The last geography course she had was in the sixth grade.

Her approach to map instruction is *basic* (1). Ms. Wick emphasizes using latitude and longitude (MB-b), understanding directions (EP-c), and map reading (HB-b). The topics covered were low level. While it might be expected that some topics get re-taught at the high school level, it cannot be at the expense of level-appropriate topics.

During observation, Ms. Wick's class was examining American Indians in the West during the nineteenth century: students labeled maps with human and physical features so that they could see areas of contested land between American Indians and settlers. By doing this, she wants students to have a mental map of the topics they are discussing. Students were required to add certain map elements to their outline map, including a compass rose even though, in this case, there was already one on the map.

When a student asked why they must add an additional compass, she reminded them that it is one of their “map rules.” It is a redundant practice, and reflects an inflexibility to the “rules.” Ms. Wick described this activity as developing students’ “spatial relations” (forming connections) and “spatial coordination” (taking information from a small scale map and putting it on a large scale map), but it seems mostly like map labeling.

Teacher 10: Mr. Semple

Mr. Semple teaches World Geography (ninth and tenth grades); he has done so for the past six years. His bachelor’s degree is in industrial engineering, and he worked in industry for twenty-seven years. He took twenty-four credit hours in geography, and received social studies composite certification from the University of Houston–Clear Lake. He has also been active in professional development activities, including FOG. Of the eleven interviewees, Mr. Semple has the most extensive academic preparation in geography.

Despite that preparation, his survey was evaluated as *below basic*. His survey focused on identifying locations. He includes space photography and thematic maps in his coverage as well. But the activities he describes center around place knowledge: “I have some Mickey Mouse maps of the all of the continents. We color for prizes. ‘Shout out’ means to yell the name I am pointing at. The stick is passed around by the students who then must find what I ask for” (survey item 17). He describes three activities, all of which focus on identifying locations.

I observed Mr. Semple’s pre-advanced placement World Geography class. They were studying South Asia at the time of my visit. The class was spent playing “pass the stick.” In this game, students are given a pointer with which they point to locations on the map that Mr. Semple calls out. Upon completing the task correctly, students are given some chocolate and then pass the stick to the classmate of their choosing. This game continued for the entire ninety-minute block period. The activity focused on drill and developing students’ place knowledge. On that day, there was no discussion as to why the places they were learning were important to know.

Teacher 11: Mr. Island

Mr. Island teaches all social studies courses for grades 9–12. His present school is for non-traditional students, who range in age from sixteen to twenty. He came to teaching after a career in business. He has been teaching for ten years. His bachelors degree is in history and English literature. He received certification after completing some course requirements in education at the University of Texas–Arlington. While he did not have any coursework in geography, he felt prepared to teach the subject: “I really didn’t worry about it.”

Based on survey responses, Mr. Island was categorized as *proficient* (5). His approach includes reading maps (HB-b), using maps to illustrate spatial patterns (HB-d), and interpreting maps to analyze spatial phenomena (HP-a). He described using a variety of maps specific to the content or task at hand. He also discusses points of view and distortion in maps (HP-d). His survey responses suggest a more complete approach to map instruction as compared to other high school level survey respondents.

Mr. Island teaches at a non-traditional high school. Consequently, he does not stand up in front of a class. Students work independently, at their own pace. When students need help, he works with them individually. I observed his classroom for approximately ninety minutes, in which he directed students to stay on task, answered individual questions, and corrected students’ work.

Results—Research Question 1 (Teacher Beliefs and Knowledge)

Research Question 1 considers teachers' beliefs and knowledge about maps. This question is based on research which suggests that teachers teach the content and skills they believe to be important, and about which they have knowledge. Results are presented by grade level; teacher beliefs are discussed first, followed by teacher knowledge.

Elementary School Teachers

Interviewees were asked a series of questions that addressed teacher beliefs (outlined in Chapter III): are maps easy to understand?; what do students find difficult about maps?; and, why teach map skills (other than being required by the curriculum)? At the elementary level, teachers' beliefs about map instruction revolve around three themes: (1) maps are easy to understand *if* you understand certain map basics, (2) map detail is believed to be an impediment to understanding, and (3) map learning is an important component of education.

Perhaps due to the grades that they teach, elementary teachers believe that maps can be easy to understand once you have learned some basics: "If they're explained to you, yes. I think there has to be instruction in order to understand" [Carr, 37:15]; "...there are a lot of details that they have to look at. And if they are not taught to look, ok what does this means, I think they have to be taught" [Ling 1:20]. Ms. Henry suggests that students' difficulties with maps lie in reading ability: teaching first graders, she finds that some words just are not yet in their vocabularies. However, she goes on to suggest that not all adults can use maps easily: "I don't think they're easy for everyone. I think it's like directionality, you either have it or you don't. Some people just aren't able to get it" [Henry 32:40]. This quote suggests a belief that certain spatial abilities are innate.

Elementary teachers note four areas that hinder students' use of maps: (1) reading ability, (2) scale, (3) visualizing elevation, and (4) the degree of map detail. Reading ability is noted above; interestingly while Ms. Henry sees this as a barrier, she does not believe symbol interpretation is a problem: "No, I don't think so, the basic symbols. They know that the little tree stands for the forest, and the squiggly blue line is a river and the bigger one is gonna be a lake. They know those basic symbols" [Ms. Henry 36:50].

While this is a rather rigid interpretation of symbols, for the age level she teaches, it seems appropriate to remain in the concrete realm. Scale is noted as a difficult concept to grasp by Ms. Carr and Ms. Ling, but Ms. Carr notes a remedy to this problem:

> But at A&M in our class, they talked about taking pictures. So I take pictures of the children, and put it next to them and we talk about why, and the kids come up with why, you know, they can see that everything in relation has stayed the same in size to each other, and that kind of helps. .... They kind of understand a picture is a small version of you because their grandma can't carry you around in her purse, but she can carry a picture of you. And we can't carry the whole United States but we can carry a picture of it [Carr 41:50–52:50].

Ms. Carr notes that visualizing elevation from a flat map can also be a stumbling block (an issue noted by Ms. Barry in middle school).

Of the stumbling blocks noted, the most significant and common to all three is map detail. Each believed that too much detail makes a map confusing. An example of a map with too much detail according to these three teachers is the reference map used during the interviews. The issue of map detail is a common thread for all interviewees: it is noted at each grade level, and by most of the teachers interviewed.

Elementary teachers are in agreement about why map instruction is necessary. They all consider the ability to use a map as a life skill:

> Well, it's a life skill. You need it to be able to function. Everyone is going to travel and everyone is going to have a job that at some time is going to require them to get from one place to another [Henry 37:55].

> I think it's important—we're taking a vacation and we need to plan it. I'm moving to a new area, I'm going to look at a map of population, to find suburbs, I'm going to look at data on schools, I'm going to look at a map and find income of that area. It's just something that you use all through life and anytime anything happens in the world you need to have an idea of where that happened, or you need to be able to use a map or globe and find it [Carr 58:10].

> I think we live in the world and need to understand where places are and why places are. And to understand cultures. You can't understand anything in the world without having a map and without knowing locations, points, places. I mean, it all integrates [Ling 6:45].

For Ms. Henry maps are important for showing locations and finding one's way. She notes that there are some jobs that you could not have without being able to read a map, using a taxi driver as an example, which again illustrates her emphasis on

locations and way finding. Ms. Ling and Ms. Carr also see the importance of using maps for locational information, but they also suggest more sophisticated uses of maps: integrating a variety of map information (from a variety of maps) with other data to make a decision about where to move in the case of Ms. Carr, and maps as a portal to understanding relationships between places in the case of Ms. Ling.

In the area of teacher knowledge, two themes predominate: (1) teachers read and interpret maps acceptably well, although with some limitations; and, (2) teachers are reluctant to critically evaluate maps.

Each teacher sees a map as a representation of reality that shows location. Ms. Carr specifies that it is "a picture of the way things are—to scale" [Carr 4:20]. In interpreting the two maps used during interviews, teachers' interpretations were sound. They correctly identified the maps' purposes, interpreted the symbols, and noted extensive information from the maps. There were two limitations to their interpretation: projection (particularly for Ms. Ling) and a somewhat limited focus on relationships.

Projection was a stumbling block. When asked about the first map's projection, Ms. Ling stated "It's pretty relative. The, it's pretty relative to the size. The size is pretty, it's pretty true to size" [Ling 11:30]. Ms. Carr and Ms. Henry said that they teach little about projection, other than that a map is a flat representation of the earth, but clearly understood the concept. For their grade level, it is reasonable coverage.

When asked what kind of information the reference map communicates, respondents gave quite a bit of accurate information: cities, elevation, water bodies, population, and transportation networks. While this information was noted, it was as discreet units of information with no interconnections noted. When asked specifically if the map could be used for higher order activities, teachers identified connections between data. For example, they were asked about population concentrations in Dallas–Ft. Worth, Houston, and San Antonio:

> Yes...yes you could [use this map to explain population concentrations] and that would also show you why the populations are more dense along the coastal plains because you do have the higher elevations, and it doesn't give you any indication of rainfall but you might assume that in those higher elevations, you may not have access to, it's much harder to live up in the mountains, and if you knew this was desert out here, though it doesn't give you any indication but if you had studied, and um, you could see the elevation, you could see it rising, and

> you could also see that it is rugged country and you might not want to live in such a place [Ling 15:10].
>
> Uhhh, well...San Antonio and Houston are on major interstates and so is Dallas, it's on I-20 so commercially it's a good place to be. Houston, you also have a port city, so and, you have the availability to have a business to ship goods, same as here, you have a business to ship goods. San Antonio has major ways to Mexico so that gives it another market. And it's on 1-10, isn't that I-10? [the roads are not labeled]. Houston is on a coastal plain, Dallas is uh kind of like on the prairie sort of land. Um, San Antonio grew up here because of its relation to Mexico I think. And it's on a major highway. So you're not really in mountainous areas. This one, Ft. Worth, was really an opening out west. When you get out here, the lands aren't really very good for city growth because they're flat, there's not a lot of water. There's water all through east Texas, and San Antonio rivers, there's water supplies [Carr 11:53].

While both Ms. Ling and Ms. Carr bring prior knowledge into their responses, they also integrate map information (location, elevation, access to water, transportation networks) to explain population concentrations. While these answers were elicited by questioning, Ms. Ling and Ms. Carr clearly were able to determine relationships based on map information.

Interestingly, the teachers' were reluctant to critically evaluate the maps. While the reference map was considered inappropriate for elementary levels, its content was not criticized. Teachers questioned the content of the thematic map more. For example, Ms. Carr noted that on the economies map, East Texas was not associated with forestry, but when asked if that was an error, she replied: "Well, it would depend because I would think East Texas has a lot of forestry industry but maybe this is based on so much per area or something" [Ms. Carr 21:42]. She might be right, she might be wrong (source information is not included in the atlas so there is no way of knowing), but she shied away from saying the map might contain errors. The lack of critical evaluation of maps is further evident when teachers are asked what criteria they use to select a map:

> With our last social studies unit adoption, we got some maps. And they're pretty durable maps, but I don't use them too much. I use the ones I have used for years. I pull out the ones that are appropriate: it's got be large, it has to have pictures on it, simple words they can read, and it can't have too much information [Henry 23:00].

> Well, with lower elementary, size, a bigger size is good. One consideration is: do I have it? Because we don't get a lot maps. But for the younger grades, it's size and readability [Carr 30:20].

> I think the most important criteria for this age level is to be able to see the countries clearly, and say 'this is over there'... but I think you would choose maps and I don't specifically say choose because I have maps on rollers, and I said it's for the appropriateness of what you are talking about. So, you have airways maps to show highways in the sky, and if you are traveling you are going to use a highway map. And I would think you would want the colors to be fairly bright—not dull—especially for this age. And I think in having chosen textbooks that we chose for this year, the graphics and the maps were clear and to the point [Ling 36:20].

The criteria described above are legitimate concerns. A map absolutely should pertain to the topic at hand, it must be strong enough to sustain repeated handling by many hands, it must be comprehensible to its audience, and it should be aesthetically pleasing. But there are other important concerns as well: is the content based on accurate data? Is the map up-to-date? Were cartographic principles adhered to? This type of critical evaluation is no different than evaluating other sources, but it is clearly absent.

Middle School Teachers

With regards to Research Question 1, middle school interviewees share some commonalities with the elementary teachers interviewed in this study. There are also some differences. Four themes are identified: (1) maps are already understood by students, (2) too much detail on maps is confusing, (3) there are barriers to students' learning, and (4) the primary use of maps is to develop students' place knowledge.

Middle school teachers believe that maps are generally easy to understand. While they might require instruction at an early age, their students come to them knowing what a map is and how to read one, with one exception. Ms. Arrow notes that:

> They're real easy for me to understand and I have to remember that they're not easy for all kids to understand. Some of them understand easily and some of them don't. And I have to remember that not everybody has those spatial skills [Arrow 37:00].

According to the middle school interviewees, if a map is difficult to read, then it is due to too much detail. On this point, elementary and middle school teachers are in agreement. These teachers cited the reference map as an example of one with too much detail. Ms. Pyle suggests that a *good* map is one that is easy to read, simple.

In addition to map detail, directions (Barry, Arrow, Pyle) and visualizing elevation from a two-dimensional map (Barry, Paris), also are noted as a stumbling block for students. Middle school teachers also find that student concentration is a barrier to teaching maps:

> Then, kids, well, you see how they are today [laughter]. They're just – constant motion. And if there's too much to distract then they, then they get especially lost in it...especially of maps of places that are unfamiliar, they would look at this and say where's this and who cares? [Barry 21:50].

The view of student concentration as a barrier to learning maps (or anything else) is reiterated by high school teachers as well.

Middle school teachers note that teaching maps is an important component of education, largely because it is important for students to know where things are located: "I think it's important to know location" [Michaels 26:05]. Beyond location, the theme of maps providing a global perspective is also evident:

> Geography, let's start with geography, is very important for kids so they know where they are and where everybody else is. It's not enough to know 'I live in Lubbock, Texas.' They need to know 'I live in Lubbock, Texas and I'm interconnected with Leningrad and Lisbon and with...' and I think visually maps convey that interconnection [Pyle 34:15].

This idea of interconnections illustrated by maps is shared by one other teacher (Paris) at the middle school level. This theme seems like a step above locational knowledge, and perhaps is an indication of moving along the continuum from *knowing* to *understanding*. However, the idea of *applying* is not evident.

Middle school teachers' knowledge about maps includes the following characteristics: (1) their map reading abilities are good, although some gaps exist in their knowledge, (2) there is limited integration of map information which often results in simplified explanations, and (3) maps are not critically evaluated. These themes are similar to those identified among elementary teachers.

Teachers define a map in much the same way as elementary school teachers. Although two of the teachers were surprised by the question, saying that they had never really thought about it. One of these teachers (Michaels) did not give a definition: "Now, I could do that but I don't teach that because when my students come to me, they already know how to do that. I would have to stop and think about that. I guess I've never really thought about that" [Michaels 3:35].

In discussing the two maps with middle school teachers, their ability to read maps is generally good. Teachers had no difficulty understanding what each map conveyed, and described the variety of information found within the maps well. However, there are gaps in teachers' knowledge. Projection is a significant gap; only one teacher (Arrow) clearly understood what projection is. Two (Barry and Paris) clearly did not know what it is. One (Pyle) seemed unsure: "I know there are different projectors [sic]...I know there's a little residual knowledge somewhere that we did learn about it somewhere but I don't teach it" [Pyle 12:40]. There was also incorrect terminology used (*relative position*, *relative size*, *relative distance*), literal interpretation of color/shading (Ms. Paris interpreted brown shading on the reference map as *desert* rather than high elevation), and misunderstanding about what *thematic maps* are (Pyle).

Teachers often failed to make connections between the map data, and offered simplified explanations. Again, this idea is illustrated using the concentrations of population in Dallas, Houston, and San Antonio. Most offered water as the only reason. Water is certainly an important factor in urban development, but there are other reasons as well, such as climate, topography, accessibility, and transportation networks. One teacher did note transportation networks: "...they are hubs of freeways, but that came later, after they were already centers of activity..." [Arrow 11:25]. She does see transportation as a possibility but fails to connect that extensive transportation networks attract more people and cause a place to grow. Transportation networks were her only explanation.

Critical evaluation of maps is lacking, as evidenced through a series of interview questions (as outlined in the interview protocol, Chapter III, questions 6a-2, 7, 8). In examining both maps, teachers were asked if information was missing or needed to be included. There was a general unwillingness to critique the maps:

> Well, I would...it depends, see they're showing the portion of the western Gulf region and Mexico, I do not know a great deal. See I would not know if something is left off of here because that is not my specialty, so by the title, it appears to me that it's showing what it's showing, so I would not see if there is information missing [Pyle 12:00].

For the thematic map, teachers did suggest that the graphs of corn production and petroleum reserves were superfluous, but that was the only significant criticism. Not surprisingly, teachers do not have students evaluate the appropriateness of maps. Ms. Pyle says that she does have students do this, however I observed students selecting maps in her class based on whether the topic alone matched their need. She believed they were critically evaluating the map's content and goodness. The lack of critical evaluation is evidenced further in the criteria teachers use to select maps: they must be easy to read, appropriate to the topic, and available. These are legitimate criteria, but there seems to be little consideration about the overall accuracy of maps. Two teachers (Paris and Pyle) alluded to the importance of selecting good maps: they select maps from "reputable" companies.

High School Teachers

The beliefs and knowledge held by high school teachers about maps and map instruction share many commonalities with elementary and middle school teachers. Four characteristics are identified with regards to the beliefs and knowledge of this group of interviewees: (1) map instruction is vital because students must know locations and maps illustrate relationships, (2) too much detail on maps is confusing, (3) student concentration hampers map learning, and (4) gaps exist in teachers' knowledge about maps. There is no consensus for these teachers about whether maps are easy to understand: Mr. Semple finds them easy, Mr. Island says they are very difficult and require training, and Ms. Wick falls somewhere in between:

> Hmm. Depends on the map. Some maps are, some maps aren't. Umm. And it depends on your skill level too. If you have the proper background, you can look at any map and figure out things on your own. It's learning to take the time to do that... [Wick 32:35].

The high school level teachers interviewed have all been responsible for World Geography: Ms. Wick is currently teaching seventh and eighth grade, but had been teaching World Geography when she answered the survey; Mr. Island is responsible for all social studies subjects at the high school level, including World Geography; and, Mr. Semple currently teaches World Geography. Perhaps not surprisingly, these teachers emphasize the importance of map instruction. They assert that maps are vital not just to geography, but also the social studies. The reason for this importance is based primarily on the need to know locations. Mr. Semple represents an extreme case, equating map literacy with place knowledge: "I tell you what, if I were going to give them a final exam on map skills, I would make it matching and they should know all, what is it, 160 or 190 countries in the world" [Semple 48:20]. For two of the teachers (Wick and Island), maps play a crucial role in illustrating relationships: "Social studies is relationships. Physical relationships, cultural relationships. And maps help you with both" [Wick 31:00].

As for student difficulty with maps, these interviews identify two issues. First, the idea that map detail can confuse students is noted by Ms. Wick and Mr. Island. This idea is present at all grade levels, by nearly all teachers. Second, student concentration is seen as a barrier to learning and using maps: "Students want to find the answer now. Not stop and think. So if it's not black and white, 'gee I have to think' so if it's not obvious, they really start to get frustrated" [Wick 39:15]. This idea was noted by middle school teachers as well.

Generally, teachers' reading of maps was acceptable. However, misunderstanding was evident. For example, Mr. Island misinterpreted the color/shading of the reference map, assuming it represented vegetation rather than elevation, he measures distance using the graphic (bar) scale on a world map,[15] and was unclear about projection: "The type of projection? Probably not...do you mean like Mercator or Peterson, or do you mean like elevation? I probably know too much here" [25:14].

Limited integration of map information and simplified explanations is less evident among high school interviewees, as compared to those from middle school, but still

noticeable. Mr. Semple attributes the locations to water, and he does not really use the map to answer the question: “I’m bringing my history up here and the history is not in the map. Houston, it’s a port. And Dallas–Ft. Worth started up a long a river, and San Antonio too although their rivers aren’t as big. That’s a big part of it” [17:45]. Ms. Wick and Mr. Island do integrate map information. In describing students’ ability to integrate information, Ms. Wick says: “They should be able to reason that out...why people would cluster to certain areas, closeness to water, habitability of the land” [15:30]. Mr. Island is an exception in the sample: he immediately interprets relationships he sees on the reference map:

> Ok, the first thing you can get is telling where people live and why they live there...so the map gives us...centers of population, gives us landforms, gives us environmental bands, it tells us why people are there, it also tells us how people communicate with one another—we have these lines of communication, we’ll call them “roads.” transportation is the lifeblood of any civilization. You can make the greatest stuff on earth but if you can’t get it there, nobody’s gonna buy it. The other thing this does, is it’s a political map what it does for us is shows us the division of states, and it also shows Mexico [Island 15:20].

He is the only teacher to do this without prompting, unfortunately he also has a tendency to read too much into maps:

> Well, we’re calling these thematic maps [referring to the thematic maps] but they’re not as good a thematic map as this map [the reference map] is because what this map does is it takes all these characteristics and if the teacher’s knowledgeable and puts them all in one place and shows how they interact. Now if you wanted to teach a unit on climate of the United States because somebody wanted to be a meteorologist, then ok. But you can infer climate from this [referring to the reference map] [Island 33:15].

The idea that one map could supply all needed knowledge is truly a limited understanding of what maps can and cannot be used for.

Results—Research Question 2 (Teacher Practices)

The second research question of this study addresses teacher practices. A desired outcome of the interviews was to develop a more detailed understanding of how maps are presented and used in classrooms. To that end, teachers were asked to describe how often maps were used, what activities they were used for, and the approach used

to teach map reading. As part of the interview protocol, teachers were asked if students could do certain tasks (which are drawn from the Map Literacy Continuum) with maps; what teachers think students can do does not always align with what teachers have students do.

Elementary School Teachers

The practices of these elementary teachers are quite similar. Maps and instruction about reading maps is part of their regular practice. All three have students construct maps. And, their goals tend to be similar, age appropriate, but not necessarily aligned with their stated practices.

Maps are used regularly in each classroom, and the walls are covered with maps. In teaching students to read a map, both Ms. Henry and Ms. Carr use the book *Me On the Map* which explains a bird's eye view, as well as nesting,[16] as a boy flies above the ground, looking down. This provides students with an idea of what a map represents. Ms. Carr moves from that book to a map, asking students what it is that they see, shows them the title, directions, and explains scale through taking a picture (as described previously). Ms. Henry has students create a map of their bedroom after reading this book. Ms. Ling's approach is different. She sits down with students individually and has them trace routes with their finger and point out locations. This approach reflects her conception of a map's purpose: location and way-finding.

At the elementary level, teacher practices relating to map instruction tend to be hands-on: each teacher has students create maps. In Ms. Henry's class, first graders draw maps of their bedroom; Ms. Carr's students draw simple maps beginning in the first grade, and by the time they reach fourth grade, they draw a map of their library to scale; and, Ms. Ling's students hand draw maps, create "tear" maps (pieces of paper are torn to form a world map), and create maps on the computer. Their reasoning for this practice is that by creating maps, students become better map users: "Constructing a map, they have to be able to read it, and understand it and interpret it. And if they look at each others' maps, and they can look at each other's and understand it, then they know they have been successful" [Henry 43:10]. However, requirements for these created maps are uneven. Students are required to add symbols in Ms. Henry's class but not a key. Ms. Ling has not had students draw maps to scale or with latitude and

longitude this year (although she has in the past), but suggests having students draw a map with lines of latitude and longitude but not to scale. Given that the intersections of latitude and longitude are precise points on the globe, scale drawing is necessary for the activity to be meaningful.

In describing what students should know and be able to do with maps by the end of the year, the three teachers have similar goals:

> Well, hopefully they will have mastered the TEKS requirements. I want them to be able to know what a map is, know where directions are, know what a compass rose is, what a key is and how to read it.....They know water and green is for grass and trees and brown is for dirt or desert, so I would like them to know the basic land formations. I would like them to know where you live influences how you live: why people live by water, why people live in the mountains or wherever people live and that in relation to the jobs people have [Henry 46:35].

> At the end of fifth grade? They should be able to use a map, they should know about scale, they should know the cardinal directions. They should know about what a compass rose is, they know what a title is. They know to use maps for information. When we do the environment, we use maps to find the rainforest. We use maps to find population density in the world and to decide which places have the greatest population density. They ought to be able to read a lot of different maps, and they ought to be able to make a map, with the major elements in it [Carr 56:35].

> Well, I think they should be able to read maps and I think they should be able to look at the scale and find the distance on maps, point to point...and, I think just have a general knowledge of ‘em and be able to draw a mental map....But I think basically to understand and appreciate, well, what I really like is for them to have some understanding of the global perspective rather than just insular with Texas and the United States [Ling 23:00].

These responses are interesting, particularly in comparison with their map drawing activities. For Ms. Henry and Ms. Ling there is a disconnect between practices and goals. Ms. Ling wants students to use scale to determine distance but has not had students draw maps to scale, or recognized the connection between lines of latitude and longitude with map scale. Ms. Henry does not require students to add some of the elements she wants them to learn to their maps. Ms. Henry and Ms. Ling note the importance of relationships and the role of maps in illuminating relationships between humans and their environment (Henry) and one place in relation to many other places (Ling). Ms. Carr’s goals do align with her practices; for each of the goals she describes, there are corresponding units.

Middle School Teachers

The practices of middle school teachers display five commonalities: (1) maps are used regularly throughout the school year, but, (2) maps are used for location and little else, (3) the same topics taught in elementary are re-taught, (4) teachers' conceptualization of map instruction is undeveloped, and (5) the TEKS are omnipresent, although perhaps only in name. These themes are, of course, interrelated. Each one is discussed below.

Map instruction for these teachers includes a *big* unit at the beginning of the year, lasting anywhere from a couple of days (Michaels) to six weeks (Arrow). This big unit is followed up throughout the year with map-specific lessons on a periodic basis. But all teachers report using maps throughout the year on at least a weekly basis. Interestingly, each of the teachers reported on their survey that they teach maps throughout the year on a periodic basis. Two of the teachers (Ms. Arrow and Ms. Paris) clarified that, throughout the year, map instruction is interwoven with the content being taught; in other words, it is not a separate lesson.

While maps appear to be used regularly in each of the five classrooms, they are used primarily for developing students' place knowledge, whether it be learning the fifty states (Barry) or seeing where a battle occurred (Michaels). When asked to explain the inclusion of map instruction (other than being required by the curriculum), Ms. Michaels states only this: "I think it's important to know location" [Michaels 26:05]. There is no better tool than a map to illustrate location; however, as their only use, it is rather limited.

Beyond using maps for location, teachers spend time teaching basic map elements such as finding locations with latitude and longitude (including prime meridian, equator, and hemispheres), directions, reading legends, and locating oceans, continents, and the fifty states. These topics are not different from those covered by the elementary teachers interviewed for this study. They recognize that students should already know these topics, but they find that students may or may not have learned them already. For example, Ms. Arrow describes her seventh grade students' ability to measure distance using scale:

> Some of them are, and some of them aren't [capable of measuring distance using scale]. I just had something with them that required them to do it, and some did great and some of them couldn't do it. And I just kind of threw it at them....And I just made the assumption that they had had it, and I was wrong [Arrow 15:30].

Ms. Arrow discovered that students had not mastered a skill that she believed (and the TEKS stipulate) seventh grade students should already know at this point in their schooling. It is important to teach these topics, even late. Unfortunately, the result is that valuable class time is spent teaching topics that students should have learned previously.

Time is not spent teaching students how to read a map, though. Teachers report that students come to them knowing what a map is and basically how to use it. Consequently, these teachers have not spent much time considering how to teach someone to read a map. However, when they do describe the process they would use, it is surprisingly similar:

> Well, again, I've said this, but I tell them: look at the key, look at the title. The title tells you what this map is and then look at the key, that tells you what the map is trying to say. So I really stress that, stress looking at the title, looking at the key, otherwise, you're not going to know what it is unless they do that. And then any other information, it's kind of like a puzzle you know....If I had to teach it in kindergarten, I'm not sure how I would teach it because I've never had to deal with a child who has no idea what a map is [Pyle 47:00].

> Well, I would teach them to use the key and we would go over the key and make sure that they could understand that that's what's giving them the information. Teach them to read the title of the map. Most of my students, if they have trouble reading the map, it may be because they don't read well. And they don't understand the concept. So it's more than just not being able to read the map. You're not going to have a healthy, average eighth grader who can't read a map. It's going to be some other problem. Does that make sense? So I don't know, I've never thought about that from that point of view because I don't teach the little ones. Kids who've never seen a map before...I know there's a lot of materials out there for lower levels, but I guess I've never taught anyone who hasn't ever seen a map before [Michaels 29:30].

There appears to be no step from initial learning of what a map is to reading more complex maps. Middle school teachers note, including the two above, that map detail

can be confusing; their solution is not to teach students to deal with, for example, maps like the reference map, but to avoid them.

Middle school teachers' conceptualization of map literacy is under-developed or directionless. Goals for students tend to be limited: teachers want students to know how to use a key, understand directions, and be able to read a map. These goals are generally below their grade level. Ms. Arrow at least wants students to be able to interpret a map, and is one of the only teachers in the entire sample to address projection, and she does it well. Ms. Paris notes that in the future they will be required to help students interpret maps (but not yet). Ms. Barry wants students to be able to locate the fifty states, but noted: "but I still can't tell you where they are. They can find California, Florida...Michigan" [Barry 27:35]. This interview was conducted two months before the school year ended, and she was sure they had mastered only three states. As an example of a mapping activity, Ms. Pyle said: "I don't use the questions in the textbook, although some are derived from that: instead of 'list three ways that the Indians used buffalo', 'draw three ways...'" [Pyle 36:20], apparently not realizing that this example is not really mapping.

In each of the interviews, the TEKS came up frequently, often without prompting. Acceptance of the TEKS varies; Ms. Pyle describes it as a good curriculum while Ms. Barry and Ms. Michaels see it as a serious constraint on classroom time. Regardless, the TEKS loom large, and they influence time which influences practice. All teachers report teaching the TEKS, but there is evidence to suggest that, in relation to map skills, adherence is nominal. The TEKS are described further in the next section, Research Question 3.

High School Teachers

The practices of high school teachers revolve around three themes: (1) the focus is on developing students' place knowledge, (2) time is spent teaching topics that should already be known by students, and (3) student abilities are viewed as a constraint. Unlike middle school teachers, the TEKS and, relatedly time, are not identified as a constraint by these teachers. While their practices are generally below the basic level for high school, each teacher offers something good to her/his lesson; the good things will conclude this section.

Each of the three teachers see the importance of maps in understanding where places are located, and their practices reflect this belief. For example, in observing Mr. Semple's World Geography class, the entire ninety-minute period was spent having students locate countries and cities on a map of South Asia. This activity is repeated throughout the year with each region studied in the class. When asked what kinds of things a map can be used for, Ms. Wick replies: "To familiarize yourself with your surroundings. To find out where other places might be in relationship to yourself" [Wick 5:15]. Mr. Island describes a typical geography test:

> On my geography tests, they are given a series of countries or regions or landforms and they are given a blank map and they have to fill it out. But they are allowed to use an atlas. So what I am measuring is not whether they have memorized where Bosnia Herzegovina is, but whether they can use an atlas [Island 38:14].

There is indication by both Mr. Island and Ms. Wick that maps are used for more than just locating places; each uses maps to illustrate relationships between places (as is evident in Ms. Wick's comment above).

When describing the topics included in map instruction, the high school teachers include directions, measuring distance using scale, identifying locations using grids, and reading the title and key on a map. Teachers at elementary and middle school levels also teach these topics (which, according to the TEKS, should have been learned in elementary school). It is recognized by Ms. Wick that these topics should already be known, but her students do not:

> My ninth graders...have so little experience in that district. The concentration in social studies at the elementary level just had not been there. And junior high wasn't much better. And so the exposure to maps and map reading...There was one class where I spent the whole year and they still couldn't do latitude and longitude. These kids [snaps her fingers], they know it. The come into seventh grade knowing it. So it depends on the background they get in the early years [Wick 22:30].

This example illustrates the constraint (real or perceived) of students' abilities on teachers' practices. If students enter a grade unprepared, or off-level, time is spent (re-)teaching these topics. Mr. Semple also notes students' limited knowledge, as well as their unwillingness to learn. This problem is not an issue for Mr. Island because he

teaches in a non-traditional school where students work at their own pace and receive individualized instruction.

While teacher practices at the high school level are not very different from those at middle and elementary levels, some beneficial practices can be identified. Mr. Island includes the issues of bias and perspective in maps as part of his instruction. Bias and perspective in maps are important components when critically evaluating a map. Along the Map Literacy Continuum, this topic is related to *proficient* (HP-d) and *advanced* (HA-c) criteria at the high school level. Ms. Wick constantly has students use multiple maps to understand and explain processes, such as population settlement and movement (HP-a). Recognizing his students limited resources, Mr. Semple gives students blank maps to label and develop their own, personal atlas with which they can study at home. The activity is not higher order, but it reflects alignment of an activity with an intended outcome, as well as cognizance of resource limitations.

Results—Research Question 3 (Curricular Knowledge)

This question addresses teachers' understanding of the curricular requirements regarding map literacy. Social studies curriculum is state-mandated; teachers are required to teach the Texas Essential Knowledge and Skills. While it is expected that teachers are familiar with the TEKS, teachers' specific knowledge of TEKS related to map literacy is unknown. The teachers interviewed in this study all recognize the TEKS; the TEKS often were mentioned before I specifically asked about them. With regards to map literacy specifically, teachers at each grade level had difficulty noting specific TEKS.

Elementary School Teachers

All three teachers view the TEKS as important. Ms. Henry and Ms. Carr believe that they extend the TEKS to cover more than they are required to do. Ms. Ling believes that she should do more with them. Ms. Carr correlates the TEKS to her lesson plans. Ms. Ling and Ms. Henry sometimes correlate specific TEKS to their lessons, but not always. Ms. Ling states: "You can't go 1, a, b, c. You have to go along with what is appropriate with the grade" [Ling 25:54]. Her comment is interesting considering that the TEKS are supposed to be grade appropriate. While none of the teachers cite specific TEKS, they

do describe what students are expected to know and be able to do at the end of the year:

- Understanding directions, compass rose, interpreting a map key and associating it with the symbols on the map, identifying locations (Ms. Henry);
- Identifying locations, interpreting a map key, make a map, estimate distance using scale (Ms. Carr); and,
- Reading maps, interpreting a map key, using a map for way finding, developing an appreciation for maps.

Middle School Teachers

Teachers' awareness of curricular requirements about map literacy is best described as limited. Teachers report TEKS-based instruction, but there is little evidence to support this assertion. There are map-related TEKS for each grade level. Middle school teachers have admitted somewhat limited map instruction, as well as teaching topics they know students should have already learned.

The disconnect between practices and curriculum could be due to unawareness (teachers had difficulty identifying even one specific TEKS related to map literacy) or it could be a time constraint. For some, the TEKS are seen as a real constraint on what they have time to teach:

> I do not teach types of maps just because I don't have time. And I can't stress enough how we are in this mad dash from the day school starts until the TAKS test. We have to follow the TEKS...I mean we have to. We could just spend loads of time on geography when school first starts...we could spend 6 weeks if we wanted to do loads of lessons with maps. We have no time for that. So, mostly we're concerned with location, you know, that they can name and locate certain places on the map [Michaels 8:15].

> This is going to sound really tacky, but, I don't know, I think it's probably true everywhere. If it's not tested at the grade level, it's not, a lot of emphasis is not put on it. That's all there is to it. If it's going to be tested, it's going to be taught [Barry 17:50].

For these two teachers in particular, they perceive that the TEKS severely limit what they teach. For Ms. Michaels, the statement "We follow the TEKS" ignores the geography strand of the TEKS, which is especially troublesome given that the mapping strand in grade eight is rather strong (Appendix A). The implication is that until maps are

tested in the way that they are described in the TEKS they will fall by the wayside. This idea is supported by Ms. Paris:

> So, yes, with the new books and the new emphasis on geography, it will come. It's going to have to come because some of the questions on the eighth grade, what they've been sampling us with are interpreting maps. And you're gonna have to be able to see this and this and this [she's pointing to maps] and come to a conclusion. And you know I can't teach American History but I can teach maps. So it is an area that is evolving. The need is definitely there [Paris 24:40].

Regardless of how teacher's perceive the TEKS (constraint or helpful guide), each teacher reports following the TEKS when teaching about maps in particular. Those interviewed had a difficult time citing TEKS specific to map literacy. It is understandable that teachers cannot provide a complete list, but some general idea of what they encompass is a reasonable expectation. Teacher practices should align with the TEKS, but in the case of map literacy, they appear to in name only.

High School Teachers

Two themes are identified among high school interviewees: (1) the TEKS are nominally important and little specific knowledge of their requirements is evident, and (2) the TEKS are not seen as a constraint on teacher practice.

The teachers interviewed reflect similar knowledge—both within their group as well as to the interviewees—about curricular requirements in the area of map instruction. That is to say, they are aware of the TEKS, they purport to include them in their instruction, but they do not offer any specific knowledge of the curriculum. Ms. Wick states:

> I don't stop and look at the TEKS when I plan a lesson. Do I know what the TEKS are for my grade, do I know what's expected of me? Yes. But if you're teaching your subject area, and you understand it, you generally don't have to say 'oh, am I covering this?' everyday. I went to a workshop yesterday for social studies—the Regents committee put together a workshop on social studies—and every workshop says 'these are the TEKS that are covered' and thank goodness I work in a place where I don't have to list 'these are the TEKS that are covered.' They trust me to do my job. But the TEKS are important because there are a lot of people who have no clue what to cover [Wick 37:15].

Ms. Wick alludes to the tediousness of correlating TEKS to lessons, but the flip side is that by doing that, one becomes familiar with the curriculum, is able to discuss its goals, and perhaps even teach those goals. Limited alignment between teacher practices and the curriculum is evident.

The TEKS do not offer the same kind of pressure to this group as they do to the middle school teachers. Mr. Island makes sure that they are covered in his lessons, but he does not "teach to the test" [Island 34:50]. Mr. Semple teaches in Houston Independent School District where Project Clear is used as a guide and filter for the TEKS; while he uses Project Clear, he says: "But here, our kids literally can't keep up with this. They don't have the capabilities, and so you've got to get 'em at their level and hopefully you teach them something at their level rather than giving them some pie in the sky" [Semple 44:30]. The curriculum is not meant to be pie-in-the-sky, but instead a set of requirements for *all* students to master, even the low-ability students.

Conclusion

This chapter has reported results of the two phases of this research. First, a mail survey considered each of the study's three research questions (beliefs and knowledge, practices, and understanding of curricular requirements) with a relatively large sample. These results reveal a rather bleak picture of map instruction: an emphasis is placed on basic skills and vocabulary with few differences between elementary, middle, and high school teachers. The second phase of research, interviews and observations with a subset of sample respondents, garnered a deeper understanding of the three research questions. First, teachers' beliefs and knowledge revealed a rather limited view of how maps can be used in the classroom, as well as some serious gaps in their knowledge. Second, teacher practices reflect beliefs and knowledge, in that these teachers present the basics about maps and little else, and they avoid teaching topics that they are unsure about. Third, teacher knowledge about curricular requirements specific to map literacy is limited. Teachers know of the TEKS, but they generally cannot cite specific goals relating to map instruction that their students are expected to achieve. Findings

are surprisingly similar for all grade levels. The results suggest that the conceptualization of map instruction by teachers involved in this study is generally undeveloped.

CHAPTER V
IMPLICATIONS AND CONCLUSION

Maps play a central role in the discipline of geography. Their importance lies in the spatial nature of the discipline; geographers use maps to illustrate, understand, and explain locational issues, patterns, and relationships. The centrality of maps to geography is evidenced by the National Geography Standards, *Geography for Life* (Geography Education Standards Project 1994). In that document, the first of six essential elements, The World in Spatial Terms, provides learners with the "essential grounding in the geographic way of approaching the world" (Geography Education Standards Project 1994, 33). Maps are fundamental to the first essential element but there are opportunities to learn *with* maps throughout each of the six essential elements. Just as maps do not encompass geography, geography does not encompass maps; their use transcends the discipline. Within a person's education, she is likely to see and use maps in many disciplines, including history, mathematics, science, and, of course, geography. Outside of the context of school, people are equally likely to see and use maps: reading the newspaper, in their job, or traveling. Maps hold value for nearly everyone at some point in their lives, providing, at the very least, a pragmatic argument for their inclusion in instruction.

The focus of this research was to understand how teachers in the state of Texas think about and develop map literacy among their students. As described previously, map literacy involves reading, interpreting, analyzing, and making decisions based on information derived from maps. In other words, map literacy includes learning *about* maps and learning *with* maps.[17] As described in Chapter II, this study began with an initial model of how maps might be taught (Figure 1). This model outlined the components of map instruction: teacher practices, the curriculum, and research about map learning. Extensive research suggests that teacher practices, including teacher beliefs and knowledge, are a significant determinant in how maps are taught. Because the curriculum in Texas is state-mandated, it was expected to impact the focus and content of map skills instruction. Research about map learning *ideally* would impact

how maps are taught in the classroom. Such research provides indications of what students' are able to do with maps at particular ages, providing important information to educators. However, research suggests that teachers understand research articles differently than academics (Bartels 2003), suggesting a poor link between research about map learning and its impact on teacher knowledge. The results of this research are discussed in relation to this initial model of map instruction. There are three primary components to this model: teacher practice, the curriculum, and research about map learning. Each of these components is discussed in a section that includes a summary of findings, conclusions, and implications. The role of teacher practices is considered first. This section is divided into three parts: teacher beliefs, teacher knowledge, and teacher practices. The role of the curriculum in map instruction is considered next, followed by a consideration of the role of research about map learning in how maps are taught. The model of map instruction is reevaluated based on the findings of this study. Finally, recommendations for ways to improve map instruction are suggested. The chapter concludes with a consideration of study limitations and future avenues for research.

The Role of Teacher Practice

Teacher practices are integral to how maps are taught. Research Questions 1 and 2 address this component of the model. Specifically, Research Question 1 examines teacher beliefs and knowledge about maps; Research Question 2 addresses teacher practices. Beliefs and knowledge are significant factors of teacher practice. Beliefs are an important component of practices. Research has found that what gets taught is significantly influenced by what teachers believe is important and feel confident teaching (Handal and Lauvas 1987; Munby 1984; Smith and Shepard 1988). Teacher knowledge is significant as well. As described in Chapter II, teacher knowledge can be divided among four domains: pedagogical knowledge, subject matter (or, content) knowledge, pedagogical content knowledge, and curricular knowledge. These four domains of teacher knowledge are integral to effective instruction (Grossman, Wilson, and Shulman 1989; Lee 1995; Shulman 1987).

This study finds that teacher beliefs and knowledge are key determinants of teacher practice. Teacher beliefs are discussed first. Teacher knowledge, including a section

about the importance of academic preparation and professional development on teacher knowledge, follows. The third section considers teacher practices, including (1) instructional emphases, (2) the timing and duration of map instruction, (3) the importance of supplemental materials in map instruction, and (4) the relationship between grade levels and practices.

Summary of Findings

This research finds that teachers believe maps to be an important component of geography and the social studies, and teachers do include instruction about maps that they believe aligns with the state-mandated curriculum. Teachers have a limited understanding of maps and their uses (content knowledge), which consequently limits instruction about maps (pedagogical content knowledge). The following section considers the role of teacher beliefs, knowledge, and practices in map instruction, using evidence from study.

Teacher Beliefs

Survey respondents report that map skills provide one of three results: they provide students with a global perspective, they act as a bridge in the social sciences, or they help students see relationships (presumably between places). How maps are taught, though, is constrained by teacher beliefs.

First, teachers in this sample tended to view maps as truth: maps were not critically evaluated. Teachers select maps based on criteria like reproducibility, legibility, and size. They expect the information on maps to be accurate, and some (Paris, Pyle) do this by relying on a company they believe to be reputable. Critical evaluation of source material, including maps, is an important component of a student's education (and of the social studies TEKS beginning in the eighth grade), but such evaluation of maps by teachers appears to be absent. These teachers are not different than the general public: cartographers have found that most people spend little time critically evaluating maps (Gersmehl 1996; Monmonier 1993, 1996; Muehrcke and Muehrcke 1998).

Second, teachers' beliefs about students' abilities affect how map instruction occurs. Teachers interviewed had definite ideas about the role of student abilities in the content they could teach. In Ms. Carr's classroom, maps were used in sophisticated ways, but

she reminded me that her students were gifted and talented, which therefore allowed her to do advanced tasks, such as teaching first graders to understand the concept of scale by taking a Polaroid picture of them and then, to estimate distance between two locations using a bar scale; getting third graders to compare and contrast Egyptian life along the Nile with American life along the Mississippi; and having fourth graders draw a classroom to scale. Mr. Semple discussed the limited abilities of his students as a real constraint to map instruction, saying that there was no point in even trying some activities. Ms. Wick and Ms. Barry also noted student abilities as a constraint. For example, Ms. Wick stated: “Students want to find the answer now. Not stop and think. So if it’s not black and white, ‘gee I have to think’ so if it’s not obvious, they really start to get frustrated” [Wick 39:15]. This idea is reiterated by Ms. Barry:

> Then...kids...well you see how they are today [laughter]. They’re just...constant motion and if there’s too much to distract then they, then they get lost in it. You know, like this [referring to her classroom atlas] and especially of maps of places that are unfamiliar, they would look at this and say where’s this and who cares?” [Barry 21:50]

Ms. Barry recognizes students’ resistance to learning content. Student resistance is common in the classroom, and subsequently requires negotiation between teacher and students (Winograd 2002), but that negotiation should not result in teachers keeping the content at a low level.

Teacher Knowledge

Teacher knowledge about maps and their varied uses was limited. It must be noted that teachers’ knowledge generally was *not incorrect*, but rather, *incomplete*. Interview data revealed teachers’ map reading abilities are generally acceptable. Where teachers’ knowledge tends to be limited is in map analysis and interpretation. The distinction between map *reading*, *analysis*, and *interpretation* follows Muehrcke and Muehrcke (1998). Map reading entails determining what the map conveys, including deciphering the key and symbols. Map analysis occurs when spatial patterns are identified, and map interpretation involves explaining patterns and relationships, which often requires searching beyond the map in other sources. During the interview, teachers were asked a series of questions about two maps (Table 32).

Teachers rarely relied on map information to answer higher order questions. Some answered questions realizing they were not using the map, but indicated that they did not think that the map could be used to answer the questions. For example, when asked to explain the concentration of population in Texas' metropolitan areas using the reference map, Ms. Arrow explained:

> You know, I'm not sure because I think there are so many historical things that have contributed to it that yes, they are definitely hubs of freeways, but that came later, after they were already centers of activity. Now Houston being close to the Gulf you could consider that a fairly obvious reason for it being a hub, but because I know so much about them, it would really be hard for me to say that this shows why [Arrow 10:50].

Teachers did not naturally suggest the spatial relationships conveyed by maps: discreet units of data were noted but connections between data were not made. Mr. Island is the exception. He immediately discussed the relationships between phenomena, but as described in Chapter IV, he also tended to interpret more from a map than it actually shows. When respondents were specifically asked to suggest why something occurred, reasoning was often simplified. For example, in the question above (Could you use the reference map to explain the population concentration in Houston, Dallas-Ft. Worth, and San Antonio?), teachers offered water as their primary reason for location, but they had difficulty explaining San Antonio's burgeoning because they did not see a major water source. Their responses were not incorrect; it was just limited in their use of map information, and relatedly, geographic/spatial understanding.

Table 32. Interview Questions Pertaining to Maps 1 and 2

	Sample Questions:
Map 1 (Western Gulf Region of the US)	Tell me about this map. What type of information does it tell you? Can you estimate the distance between Houston & New Orleans? This map is a conic projection – what does that mean? Could this map be used to: identify locations? predict other features (like vegetation) found in this landscape? suggest why Dallas-Ft. Worth is located where it is? interpret the map scale? identify the map projection?
Map 2 (Economies of the US)	Tell me about this map. What type of information does it tell you? Could this map be used to: find information (where in the US you find "little or no economic activity"?) explain why there is little economic activity in location *x* by using the maps of climate & population? describe & compare differences in landscapes (compare the east coast with the west coast) explain why manufacturing centers are located where they are?

There is also evidence to suggest that teachers do not ask students to identify spatial relationships. When asked if students could perform similar tasks, teachers seemed to think that students *might* be able to perform some of the activities, but they were unsure, implying that they do not normally do such things in map instruction. For example, the excerpt below illustrates Ms. Paris' ideas of students' abilities to use the thematic map of the United States' economies:

Acheson: Could the average student in your class use this map to find information, like identifying where in the US you find little or no economic activity?
Paris: Yes, they could. It's nice, simple, colorful.
Acheson: Could they use this map to suggest why there is little or no economic activity there [in the desert Southwest]?
Paris: If I gave them leading questions, I think they could.
Acheson: If you gave them all three maps, so they looked at this map of economies, and this one of climate, and population, could they then use those maps in combination to suggest why?
Paris: Oh, yeah and you compared them. Yeah. I think so. I mean, most of them, if you just sat one on one with 'em I think they could.
Acheson: Could they compare and describe different economic "landscapes", such as the east coast with the west coast?

Paris: Probably with a little bit of 'let's look at it closely.' What does the yellow represent? You know, walk them through it. Probably at this level if you directed them through it, yes they could.
Acheson: Could you use that map to have them explain why manufacturing centers are located where they are? You know, if you said to them why are they located where they are, could they give you some reasons?
Paris: Yeah, I think they could. I think they could come up with some.
Acheson: And, do you do those type of activities with them?
Paris: I don't do them, um, I touch on them but I don't emphasize them. We will do some map work where you have to compare maps, you know, look at two maps to get the answer. It hasn't been a big focus [Paris 23:00].

When asked, Ms. Paris believes her students could perform these tasks with individual instruction, but it has not been an instructional focus. She does have students compare two maps to answer questions, suggesting a more sophisticated use of maps. However, data suggest, and this excerpt illustrates, that teachers have not really considered using maps in sophisticated ways.

Survey data further suggest a limited conceptualization about maps and their uses. Survey respondents cited learning basic cartographic terminology, identifying locations, and map reading as the most important knowledge students in their classrooms gained from their map instruction. These are all fundamentals of map learning. What is missing is the sophisticated use of maps to think critically, problem solve, and/or develop an understanding of spatial relations such as recognizing spatial distribution and spatial patterns, imagining maps from verbal description, overlaying and dissolving maps, sketch mapping, and associating and correlating spatially distributed phenomena (Golledge and Stimson 1997, 158). According to the state-mandated TEKS, the National Geography Standards, and the National Assessment of Educational Progress' (NAEP) benchmarks in geography, there should be evidence of more sophisticated use of maps during middle school, and particularly high school, but little is indicated.

Teacher Knowledge, Academic Preparation, and Professional Development

Teacher knowledge is related to professional development and academic preparation. Only one teacher (Semple) had more than one college course in geography, but three (Carr, Link, and Pyle) had been involved in professional development activities related to geography. These three teachers believed professional development was instrumental in preparing them to teach geography, including maps. For these three teachers, maps and geography were integral to the social studies, and were consequently integrated throughout their instruction. From professional development, they had access to resources and activities specific to map learning, and they made use of them. Professional development helped these three teachers gain both content and pedagogical content knowledge. Mr. Semple appears to be a paradox: he had by far the greatest academic preparation in geography and was, by far, the most simplistic in his use of maps in the classroom. His approach to map instruction though aligns quite well with his own academic preparation. He describes some of his course work in geography:

> I had fifteen [out of twenty-four total] credit hours [in geography] with Dr. —. And everybody hates him, the reason they hate him is because he grades hard. I mean really hard. But he pushes map skills. Big time. To the extent that when I took the first course, which was World Geography, I made my own maps of the continents so that I could get 'em big enough to fit all the stuff we had to know on them. I guess another example is when I took Latin American Geography and we walked in the first day and he handed us a list of three hundred fifty places we had to know in South America. And the test was next Monday. ...I only found three hundred twenty-five, there were twenty-five I never did find. But this gives you an idea of how hard he pushed that stuff [Semple 8:30].

Mr. Semple's practices related to map instruction mimicked what he experienced as a student in geography courses. This example also suggests the difficulty in transferring the knowledge gained in content courses to one's own classroom (content knowledge to pedagogical content knowledge). The remaining seven teachers had little academic preparation and little involvement in professional development. With the exception of Mr. Island, their conceptualization of maps and how they could be used in the classroom was rather limited: Ms. Arrow and Ms. Michaels viewed maps as a way to illustrate history; Ms. Barry, Ms. Paris, Ms. Henry, and even Ms. Wick used maps primarily to show location. From these eleven teachers, it would seem that

conceptualization of maps and map instruction is very much related to participation in and quality of professional development and academic preparation.

Teacher Practices

Research Question 2 considered the content, duration, and timing of map instruction, with content being the most important aspect of teacher practices. It is assumed that for most students, what is learned about maps will be strongly related to what teachers do in the classroom. Both the survey and interviews inform us about teacher practices.

Maps clearly are used in instruction as reported by this sample. Teachers who responded to the mail survey report teaching *about* maps: map instruction described by this sample concentrates on cartographic terminology, finding locations (often by using latitude and longitude), and estimating distance with scale. Map reading also is routinely noted. This section considers instructional emphases, the timing and duration of map instruction, and the role of support materials in teacher practices.

Instructional Emphases

Map instruction is concentrated in particular areas: place geography, map terminology, and map reading. The focus is legitimate, but rather limited. This section considers (1) instruction *about* and *with* maps, (2) map reading, and (3) topics that are reportedly not taught.

Instruction *about* and *with* maps. The focus of map instruction by teachers in this sample suggests concentration on teaching *about* maps, rather than *with* maps. The Map Literacy Continuum,[18] described in Chapter III, illustrates the sample's concentration in certain areas of map instruction. Teachers in this sample at all grade levels concentrate in three areas: elementary-basic, elementary-proficient, and middle-basic. As noted, the focus lies in identifying locations, learning cartographic terminology, and reading maps. These three areas of focus are called for in the TEKS, but other factors likely influence their strong presence in teacher practices. First, the focus on identifying locations (particularly by high school teachers) might be related to teachers' belief that place knowledge is *the* building block of geographic knowledge—an idea that has been hotly debated for some time (see Bednarz 1992). Learning cartographic terminology can be traced to textbooks and workbooks which

focus an entire lesson on scale, and one on distance, and another on directions, and so forth. The implication is that after each of these lessons are “learned” students are able to read a map. This implication rests on the assumption that students can transfer these lessons into successful map use.

From the interviews, it would seem that map reading is focused on simple maps with minimal detail, identifying locations, and interpreting symbols. And, yet, teachers’ view of the role of map skills in geography and the social studies does not directly correspond to these practices. Teachers believe that maps provide a global perspective, act as a bridge in the social sciences, or illustrate relationships, but they teach cartographic terminology, finding locations, using scale, and map reading. It might be assumed that students will indirectly learn the role of maps, but learning goals should be explicated for the benefit of the teacher and the learner (Good and Brophy 1997).

Furthermore, the concentration on teaching *about* maps is not even all that complete. Reading simple maps seems to occur at all levels, but based on survey data, there is little evidence to suggest that instruction includes the integration of map information to form a “big picture.” For example, considering the reference map used in this study, the Western Gulf Region of the United States, a big picture is formed when the location of cities can be explained based on multiple criteria, including access to water, elevation, transportation networks, location of one city in relation to others. This task is not simple; research has found it to be quite difficult for both children and adults (Blades and Spencer 1990; Boardman 1989; Ormrod et al., 1988). With few exceptions, the teachers interviewed failed to integrate map information, suggesting a limited use of maps.

Learning to construct maps occurs primarily in the elementary grades. Ms. Henry, Ms. Carr, and Ms. Link all have students create maps. In middle school, Ms. Paris has students construct maps using basic map elements (title, key, compass rose) but of a *fictitious* place. Such an activity ignores that maps are spatial representations of *real places*. Only Ms. Barry has students construct maps from observed landscapes, although she did not associate this activity with mapping until the interview:

Acheson: Do you have students construct maps?
Barry: Only for their projects, their state projects. Although, this is only the second year I've done this, this FOSS.[19] It's brand new... And they map out...the first lesson, we actually go outside and we find an area on the playground or whatever and we draw a crude diagram of what's there. And then they come back in and they map it out in the diatomaceous Earth, in a flat tray. And they add the things, you know, and they put a transparent grid over the top of it and then they draw on the transparency what they have constructed in 3-d. And that's kind of mapping...
Acheson: When you do have them construct those maps, what kind of elements do you have them include?
Barry: It's just whatever they see, you know, just whatever they see. We try to get them to see the differences in the lay of the land, does it go up here, does it go down, and they have to deal with buildings and things. ... Then they take it from the transparency and put it to paper.
Acheson: And what do you think they learn from that?
Barry: I think they learn to look at all the stuff that's involved in landform. You know that's what it is: *land-form*. You know you're seeing something besides this dirt, flat piece of dirt. And that whole landform lesson is about the ever changing Earth. You know, what happens, why we have mountains, why we have rivers.
Acheson: And are they required to include things like a title and directions?
Barry: They have a key. They put a key on that but they don't have a title or anything like that. I guess if you ever got to that point where you had enough time to do all that, then you could [Barry 35:23].

This excerpt suggests that Ms. Barry has compartmentalized the activity as a science activity, not related to the geography she teaches. Perhaps it is due to that compartmentalization that students do not have to include anything other than a map key. It is also interesting to note that Ms. Barry cited directions as a common stumbling block for students who assume that north on a map is at the top. Here she has an opportunity to integrate directions naturally into a real world experience, but she fails to see the connection. The remaining middle school teachers (Pyle, Michaels, and Arrow) concentrate on labeling and coloring blank outline maps. At the high school level map construction is also largely absent. Ms. Wick has not had students do this but plans to; Mr. Semple tried it once but said it was disastrous (although the project focused on labeling locations on a map); and, Mr. Island has students label maps using an atlas.

There is some evidence to suggest that teachers do teach *with* maps. On the survey and during interviews, teachers did report that they use maps to explain spatial relationships. For example, Ms. Michaels reported on her survey that she uses a map to illustrate how physical geography contributed to the eventual split of Virginia and West Virginia. Similarly, Ms. Wick has students examine a physical map of the United States to understand why westward migration was a slow process. From interviews and observations, it appears that Ms. Michaels uses maps to "prove" what she tells students. For example, the criteria she uses to select maps is based primarily on whether the map shows what she wants students to know. This practice is a legitimate use of maps. However, her instruction does not go beyond this use to include reasoning or problem solving with maps. In comparison, Ms. Wick has students use a map to understand and explain migration patterns. More often it seems that maps are used in ways similar to Ms. Michaels, rather than for reasoning purposes, discovering knowledge, or problem solving.

Map Reading. In this study, instruction about how to read a map occurs at the elementary level. The strategies used by elementary teachers are quite similar: students are instructed to read the title, read the key, and interpret symbols based on the key. The middle school teachers interviewed were generally unsure about how they would teach a person to read a map, in large part because they assumed that students came to their class proficient at map reading. Given Gregg's (1997) research this assumption might be faulty. Interestingly, high school teachers report that they *do* teach students how to read a map, and they described teaching students to read much in the same way that elementary teachers did. The approach described by elementary and high school teachers aligns with the definition of map reading described by Muehrcke and Muehrcke (1998). There is no indication that instruction goes beyond this point. In fact, teachers at each grade level note that too much map detail makes a map too difficult to read. Cartographers would agree that a cluttered map clouds the intended message (Dent 1999; Monmonier 1993, 1996; Muehrcke and Muehrcke 1998). But what makes a map cluttered? Most teachers believed that the reference map used in this study was a rather busy map and that students would have difficulty using such a map. It is a detailed map, and certainly not appropriate for elementary grades, and middle school students also might have difficulty with it. But at some point students

must begin to use such maps if they are to think about the world in complex ways (Geography Education Implementation Project 1994).

It is possible that students' difficulties with maps are due to limited cognitive strategies to think spatially. Maps convey information within a spatial framework, and the processes of map reading, analysis, and interpretation requires at least some of the spatial abilities described by Self and Golledge (1994). While cognitive abilities may be age-related, it is clear that "experience with representations of environments plays a powerful role in the development of spatial understanding" (Golledge and Stimson 1997, 163), providing a clear argument for the inclusion of increasingly complex maps as students progress through school. This study indicates that teachers do not make use of such maps. It also seems that these teachers have not identified ways to move students from reading simple maps to reading, analyzing, and interpreting complex maps (as evidenced by the similar methods used to teach map reading by elementary and high school teachers).

How might instruction provide the needed scaffolding in map skills? Unfortunately, there is no clear answer. Research provides little help to educators. Teachers have identified a stumbling block for students that is confirmed by research (Boardman 1989; Gerber 1994; Gregg 1997), but it has not been addressed adequately by teachers or research. The blame is shared, but probably lies more with researchers who have ignored teachers and classrooms for too long.

Limitations in Instruction. For teachers in this study, there is limited focus on projection, navigation tasks, using maps to solve problems, and using maps to support arguments. The absence of instruction about projection is interesting because every atlas, textbook, and map workbook seems to address projection. However, few of the teachers interviewed teach projection. Those that do (Arrow and Carr) showed clear understanding of what projection is and what projection means for a map. Some of the teachers interviewed introduced projection by having students draw the continents on an orange or a balloon and then peel or deflate to show what happens when a round surface is flattened out. This activity is a good one, but the problem lies in that little connection seems to be made between this activity and the maps that are used in the classroom. Only Ms. Arrow has students view a variety of projections, to compare and contrast the effects of flattening out a round surface. Students may understand that a

map is a flat representation of a round surface, and even that distortion occurs, but do they understand that distortion affects what they see?

This example illustrates how teachers' knowledge about maps affect their practices. Research suggests that teachers who feel unsure or uncomfortable teaching particular topics avoid them. In this study, most of the interviewed teachers seemed unsure about projection *and* most did not teach the topic. This avoidance might be due to limited content knowledge and pedagogical content knowledge. Most teachers interviewed understood that projection is the process of converting the three-dimensional earth to a two-dimensional piece of paper. However, when asked for further explanation, most teachers struggled to explain, for example, how a particular map projection affects the display of map information.

Ms. Carr, who understood projection, told me that there was no *fun* way to teach the topic. The lack of curricular materials in this area has been an oversight of geographic education. It also is plausible to suggest that if educators have adequate content and pedagogical content knowledge about projection, they could develop appropriate materials to teach the topic. It might be that educators understand a topic like projection, but they are unable to transfer that knowledge into "teachable" content. Relatedly, only one teacher of the eleven interviewed in this study clearly understood projection *and* taught it in her classroom.

Middle school interviewees assumed that students came to them already able to read and interpret maps accurately. This assumption runs counter to Gregg's (1997) study of fifth and seventh grade students' ability to pose problems from maps. Gregg found that students misinterpreted basic map information, and consequently could not pose or answer questions from maps. Gregg's finding suggests that these teachers' assumptions might be faulty. It is also possible that teachers' knowledge about their students' abilities is correct. However, teachers' descriptions of student difficulties with maps suggest that middle school students have not fully mastered map reading.

Teaching way finding or navigation is a prime example of beliefs not aligning with practices. In interviews, teachers justified map instruction by noting the importance of being able to find one's way. However, only one teacher, Ms. Link, explicitly incorporated way-finding as part of her instruction. If map instruction is meant to help students navigate using a map, then why does instruction not include way finding

tasks? This finding suggests a lack of alignment between teachers' goals and practices. The reasons for this are unclear. It is possible that teachers assume that teaching the components of maps, map construction, and identifying locations indirectly teaches students how to navigate using maps. It is also possible that they have not reflected on the alignment between practices and goals. Research suggests that teachers' practices and goals are not always perfectly aligned (Good and Brophy 1997), despite the fact that learning is supported when goals and practices are well aligned (Bransford, Brown, and Cocking 2000). Furthermore, reflection has been shown to be an important component of effective teaching (Bransford, Brown, and Cocking 2000), allowing educators to form connections between practices and goals.

Timing and Duration of Map Instruction

Teachers in this study report spending ten to twenty percent of their classroom time on map instruction; interviewees report using maps on a weekly basis. Most survey respondents (70.5 percent) report teaching map skills throughout the school year at periodic intervals. The time devoted to map instruction seems generous. The problem lies not in how much time is spent, but rather the content of that valuable class time. If teachers are in fact spending one-tenth of classroom time on map instruction throughout school, then why is there no visible progression from grade to grade, level to level? With some exceptions, students are engaged in low-level, rote tasks at all grade levels. One explanation may be that teachers have limited curricular knowledge, specifically understanding of the *vertical* curriculum. The vertical curriculum refers to the content of a particular subject at each grade level (Shulman 1986a). By knowing the knowledge and skills developed at each grade level, teachers understand the knowledge base of their in-coming students, and can build content upon it. Teachers in this study, particularly at the middle and high school levels, were unfamiliar with the curricular requirements related to maps at their grade level, and seemed unaware of the requirements at other grade levels. As seen in this study, limited understanding of the vertical curriculum can contribute to teaching the same topics over and over.

The Importance of Supplemental Materials

Supplemental materials are important in map instruction. Survey respondents were evenly split in their use of textbooks to plan their map skills lessons: about half of the survey reported using their textbook *often* to *always*, while the other half reported using them *rarely* to *never*. Many rely on the Internet, workbooks, and self-created materials. This is a good news/bad news situation. Given that textbooks in Texas purposefully align with the TEKS, by relying on newer editions of Texas social studies texts, teachers could conceivably incorporate map-related TEKS easily. Unfortunately, the map skills section of textbooks have tended to focus on location and factual information rather than using maps to develop spatial understanding or solve problems. The efficacy and pedagogy of these supplemental materials generally have not been evaluated, and self-created materials are largely dependent on a teacher's content and pedagogical content knowledge. Support materials are an important component of curriculum implementation because they help shape teacher practice (Bednarz 2003a; Schmidt, McKnight, and Raizen 1997).

Map instruction is limited further by access to resources: wall maps are expensive as are a classroom set of atlases (especially if you want to keep a set of up-to-date ones). Those teachers interviewed noted scrounging for resources: Ms. Carr relies on contacts made through professional development to get free maps and also buys some for her class; Mr. Island searches for historical maps at estate sales; Ms. Wick struggles to find task-specific Texas maps for her seventh grade Texas History and Geography class. The reliance on supplemental materials points to two potential problems. First, research suggests that map selection should correlate to map task (Winn 1987, 1991). However, teachers may not have access to a wide variety of maps. Second, the teachers interviewed expressed affection for geography and maps, suggesting they may go out of their way to find appropriate materials. Other teachers may not have the interest, and instead rely on the maps in the textbook which maybe out of date, overly simplified, and/or non-task specific.

Grade Level and Practices

While there is some variation in practices between grade levels, both survey and interview data suggest that these teachers' approach to map instruction is surprisingly

similar at each grade level. For example, their instructional emphasis (as reported in the survey) is focused in three areas: learning the basics, identifying locations, and reading and interpreting maps. There is some variation in emphasis based on grade level (Table 33). There is a decided focus by middle school teachers on reading and interpreting maps (which may be related to the idea expressed by middle school interviewees that students come to middle school already knowing how to read a map).

Table 33. Instructional Emphasis, Rank Order by Grade Level

	Learning the Basics	Location	Reading, Interpreting Maps
Elementary	1 (38.1%)	3 (23.8%)	2 (28.6%)
Middle	3 (18.5%)	2 (29.6%)	1 (59.3%)
High	3 (17.1%)	2 (29.3%)	1 (31.7%)
Total	3 (22.6%)	2 (25.8%)	1 (35.5%)

*Percentages represent percent of teachers within a given grade level who fell within a particular category. Totals do not equal 100% because responses were applicable to multiple categories, and there were additional categories not noted here.

Generally, though, these three topics are taught by some teachers at each grade level. It is possible that these basic topics are expanded or considered more deeply at higher grade levels. For example, developing place knowledge could add to a students' mental map or students move from using scale to measuring distance to enlarging a map to scale. The interviews, however, provided little evidence to support this possibility.

Conclusions

This research suggests that teachers in this sample believe maps to be an integral component of geography and social studies education. This belief stems from three primary ideas: maps provide a global perspective, they act as a bridge in the social sciences, or they help students see relationships (presumably between places). However, teacher conceptualization of maps and relatedly, the purpose of maps, tends to be limited. Their understanding of maps is not so much wrong as it is blank; they just have not given much consideration to maps and their uses. Interview data suggest that this limited conceptualization may be related to teacher preparation. Ten of the eleven interviewees reported only one college-level geography course, and only three reported active participation in professional development related to geography. In terms of map instruction, teachers noted the role of student abilities in guiding what they could, or could not, teach.

The limited conceptualization of maps results in their use in basic tasks like identifying locations and reading for information. This knowledge should constitute a portion of geography instruction, just as multiplication tables are part of elementary math education (Boehm and Petersen 1987), but it should not subsume it. Seldom are maps used for intermediate or advanced tasks like analysis or interpretation, despite the fact that most interviewees believe their average students could accomplish some of these tasks with instruction. Yet results from the 2001 NAEP Geography Assessment (Weiss et al., 2002) find that many students cannot accomplish such tasks. In this study, teachers' approach to map instruction is affected by a variety of factors: conceptualization of maps and their purpose, access to supplemental materials (including maps themselves), the curriculum (as well as their interpretation of it), and preparation to teach *about* and *with* maps.

Implications

Teachers teach those topics that they believe to be important (Clark and Peterson 1986; Handal and Lauvas 1987; Munby 1984; Smith and Shepard 1988). From the results of this research, one could presume that teachers *do* spend time teaching about maps. Research also suggests that content knowledge is the base of instruction; without subject matter understanding, a topic cannot be taught sufficiently. The teachers

in this sample generally have a simplistic understanding of the uses of maps. This limited knowledge about maps and the limited understanding of their uses suggests instruction will be limited as well. The beliefs and knowledge of teachers are related to their practices.

This research finds that teacher practices generally fail to teach *about* and *with* maps in the rich way conceptualized by the Standards, NAEP, and even the TEKS. If these teachers fail to meet the standards in map instruction, will their students' achieve the benchmarks outlined in these three documents? Most likely, they will not. The implication is that teacher practices must be improved. To accomplish such a task, teachers must be made aware of the misalignment between their practices and the curricular goals of the state, and be provided with the tools and support to move their practices toward alignment with the curriculum. This task is easier said than done.

The Role of the Curriculum

This next section considers the role of the curriculum in map instruction. Research Question 3 addressed teachers' understanding of the curricular requirements pertaining to map instruction. The state-mandated TEKS outlines what students should know and be able to do by the end of each year-long course; the social studies TEKS include a map component throughout the K–12 curriculum (Appendix A). Within this curriculum, there are opportunities for learning both *about* and *with* maps at all grade levels.

Summary of Findings

Survey and interview data suggest that most teachers report using the TEKS as their curriculum guide. The survey indicates at least some awareness of the requirements specifically related to map instruction for elementary and middle school teachers. However, indications of TEKS-specific knowledge about what students should know and be able to do was difficult to come by. It is hard to imagine a teacher listing each TEKS requirement for map literacy, but the generally vague responses given during interviews suggest limited knowledge—and this occurred when teachers *knew* they would be interviewed about map instruction. The summary of findings is divided into two sections: survey data and interview data.

Survey Data

Survey data confirms that teachers' recognize the role of map skills in the curriculum: 89.8 percent of survey respondents agree that map skills are included in the TEKS at their grade level. Further, the majority (96.6 percent) of teachers teach about maps. Overwhelmingly, teachers report the TEKS as their primary curricular guide when it comes to map instruction specifically. According to survey results, teachers do follow some aspects of the TEKS. Approximately three quarters (76.2 percent) of elementary teachers report teaching cartographic terminology or map basics, which the TEKS emphasize in the early grades. Most middle school teachers (70.4 percent) report that thematic maps are part of their instruction. Again, the TEKS emphasize thematic maps at grades six, seven, and eight.

That connection, however, is limited. Interview data suggest that teachers—at all grade levels—might not really understand the distinction between a reference map and a thematic map.[20] Ms. Pyle believed that a map showing the location of American Indian forts was thematic; Ms. Michaels believed that coloring Louisiana Purchase territory one color and Union territory another qualified as thematic; and, Mr. Island suggested that the map of the Western Gulf Region was really a thematic map for people with enough background knowledge. If teachers are unclear about the content they are teaching, then they cannot fully meet the curriculum. It also should be noted that any correspondence at the high school level though is largely absent.

Interview Data

Interview data provides insight into the depth of teachers' curricular knowledge. It would seem that teachers have limited specific knowledge of the TEKS, although they report teaching them. Some teachers correlate specific TEKS to their lessons; others report having a general idea of the TEKS as they go along. Some (Henry, Ling, Pyle, Wick) suggest that the TEKS are relatively easy to meet; in fact, you often meet TEKS without realizing it. Ms. Wick suggests that if you are competent in your field, they are taught naturally. This may be true, but it seems that if a curriculum is meant to ensure that all students learn basically similar content and skills, then there should be explicit links between teacher practices and the curriculum. Some of the teachers interviewed make this explicit link (Henry and Carr) by coding in TEKS to their lessons; not

surprisingly, interviews and observations indicate that these teachers meet most of the TEKS set for their grade levels (Appendix A). The limited correspondence between practices and curriculum has been identified elsewhere (Bednarz 2003a; Feldman 2003; Verhoeven and Verloop 2002). This research suggests that portions of the curriculum noted in this study could be unrealized due to a variety of factors: limited understanding of curricular requirements, an inability to implement the curriculum due to limitations in content and pedagogical content knowledge, and/or a general belief that the curriculum is not appropriate. Interview data suggests evidence of each of these three possibilities (Table 34).

Table 34. Correlation of Limitations to Curricular Implementation with Interviewees

Limitation:	As Evidenced By:*
Limited Understanding of Curricular Requirements	Barry; Paris; Arrow; Michaels; Wick; Island
Inability to Implement	Link; Barry; Paris; Pyle
Curriculum is Inappropriate	Semple; Barry

*Carr and Henry are not included in this table because interviews and observations indicate alignment between practices and curricular goals.

Ms. Michaels indicates limited understanding of the curriculum. For example, she insists that she teaches the TEKS: “Everything I teach is TEKS related. Everything” [Michaels 22:30]. And, she states that it is because she teaches the TEKS that she cannot do more with geography and map skills: when asked to describe what students should know and be able to do with maps by the end of the eighth grade, she says that students should be able to use the key to understand the map, and she hopes that when students see an inset map, they understand how it fits into the larger, surrounding map. However, neither of these goals are TEKS-based at the eighth grade level. Ms. Paris indicates difficulty implementing the map-related curriculum. She initially felt unprepared to teach geography, but also notes that there was little emphasis on the subject when she began teaching: “No, I mean, when I started less emphasis was on geography and so it just sort of evolved as the course evolved, so pure geography was a struggle” [Paris 2:05]. She also notes that teachers in her district have not been teaching geography:

> And we're finding that a lot of our geography teachers aren't teaching geography. So we're having to learn to use this material appropriately. So yes with the new books and the new emphasis on geography, it will come [Paris 24:40].

Evidence from Ms. Paris' interview suggests that the limited curricular implementation is due to a poor conceptualization of geography. She sees district-administered professional development and curricular support materials, particularly the recent adoption of new social studies textbooks, as important tools for improving that conceptualization. The curriculum is viewed as inappropriate by Mr. Semple and Ms. Barry. Both believe that it requires too much of students, and it is unfeasible to implement *all* of the requirements in one school year. For example, Mr. Semple states: "But here, our kids literally can't keep up with this. They don't have the capabilities, and so you've got to get em at their level and hopefully you teach them something at their level rather than giving them some pie in the sky" [Semple 44:30]. Each of these examples illustrates potential factors in preventing curricular implementation.

Often, curricular emphasis shapes teachers' practices, but teacher beliefs are also important: for those who think map instruction is important (Carr, Link, Semple) it gets taught regardless. Mr. Semple focuses on his version of map skills (developing students' place knowledge) despite the lack of alignment with the geography teachers at his school and Houston ISD's *Project Clear*. While his map instruction is limited, Semple offers a good example of how a teacher's beliefs are an important curricular filter (Clark and Peterson 1986). For those who don't feel one way or another about it (Barry, Paris, Michaels), the curriculum, particularly the assessment tool, guides their practice:

> If it's going to be tested, it's going to be taught [Barry 17:50].
>
> I do not teach types of maps because I don't have the time. And I can't stress enough how we are in this mad dash from the day school starts until the TAKS test [Michaels 8:15].
>
> [Map instruction] is going to have to come because some of the questions on the eighth grade [TAKS], what they've been sampling us with, are interpreting maps [Paris 25:30].

For these three teachers, their instructional emphasis is related to the assessment tool. They perceive the assessment tool as an important determinant of the content that they teach.

Conclusions

This research suggests that the TEKS related to map literacy are taught in a limited way. While the TEKS support increasingly sophisticated uses of maps, there is little evidence that such sophisticated use occurs. The TEKS are most fully realized at the elementary level; the middle and high school levels barely improve on elementary practices. The effect is a stalled curriculum. The map literacy curriculum, aligned primarily with the National Assessment of Educational Progress' (NAEP) geography benchmarks and the National Geography Standards, *Geography for Life*, used in this research requires more sophisticated use of maps than does the TEKS. Teachers do not meet the TEKS completely, nor do they meet most of the criteria outlined in the continuum. This suggests that students would be ill prepared to perform well on NAEP, and be unable to develop the ability to use maps in the rich way envisioned by the Standards and NAEP.

Furthermore, there is evidence to suggest that teachers' interpretation of requirements might not align with what was intended. The TEKS advocate the creation of maps beginning in elementary grades; map construction continues in middle and high school grades, but grows more sophisticated. Both in the surveys and interviews, many teachers report having students create maps, suggesting alignment between curriculum and practice. However, interviews suggest that middle and high school teachers' interpretation of "creation" means labeling blank outline maps. The misunderstanding of *thematic* also points to misinterpretation of curricular requirements.

Teachers in this study believed they were teaching the TEKS, and to a certain extent they were, but they are no meeting all the criteria. As research suggests, this half-way implementation could be due to a variety of factors: limited understanding of curricular requirements, an inability to implement due to content and pedagogical content knowledge limitations, and/or a general belief that the curriculum is not appropriate. Interviews suggest that each of these possibilities plays a role in curricular implementation for interviewed teachers.

Implications

The limited curricular implementation evidenced by this sample holds many of the same implications as those for teacher beliefs and knowledge, and teacher practices. The state-mandated curriculum, the TEKS, is intended to provide students with a base of knowledge and skills that will prepare them for life outside the classroom. It seems doubtful that students will meet curricular expectations without instruction to guide them.

The Role of Research about Map Learning

Teacher knowledge is largely uninformed by research about map learning. When asked to describe the sources are used to guide or develop their map skills instruction, survey respondents reported that they rely on the TEKS, the Internet, map skills workbooks, and their textbook. There is no mention of academic journals (research or teaching), and limited mention of professional development. Perhaps this finding is not surprising since other research has reported limited use of academic research articles by teachers (Bartels 2003). It also may be understandable since most academic journals are not oriented to teacher needs (Crookes 1993; Markee 1997). Approximately one-third of elementary and middle school teachers use *Geography for Life* as a curricular guide, while half of all high school teachers report using it. Both the Standards and the geography strand of the TEKS (which was modeled after the Standards) provide some connection to research about map learning, albeit indirectly. Given that this study finds generally weak alignment between teacher practices and the curriculum, the link between what learners *can do* with maps (i.e. the research) and what learners *do* with maps in the classroom (instruction) appears tenuous.

A Reconceptualized Model of Map Learning

This research, like other research, finds a link between beliefs, knowledge, practices, and curriculum. It is a complex relationship. Based on the results of this study, this model can be reconceptualized (Figure 9). In this study, map instruction is heavily affected by teacher knowledge, specifically their subject-matter content knowledge and their pedagogical content knowledge. Teachers' conceptualization of maps was generally limited, seeing them as sources of locational information or for way-finding purposes. The idea that maps are a tool which can be used to understand spatial relationships and patterns was largely absent. This study provides evidence that teachers' content knowledge about maps is limited. The results concur with other studies (Giannangelo and Frazee 1977; Gregg 2001; Whisenant 2002) that find teachers' content knowledge in geography lacking. Furthermore, research suggests that limitations in content knowledge result in a subject being under-taught (Gudmundsdottir and Shulman 1987), and constricting the teacher's ability to provide students with a deep understanding of the material which could be transferred to learning in other situations (Bednarz 2003a; Gregg 2001; Lee 1995). In other words, a shallow conceptualization of content leads to shallow teaching. These findings are evident in the present study as well.

In this model of map instruction, limited content knowledge adversely affects pedagogical content knowledge. Teachers' ability to effectively instruct students about content they do not fully understand will be impossible. Pedagogical content knowledge may also be limited by an inability of teachers to transfer their content knowledge into *teachable* content for the classroom. These teachers would not be alone: many educators have difficulty with this process (National Center for Research on Teacher Learning 1992).

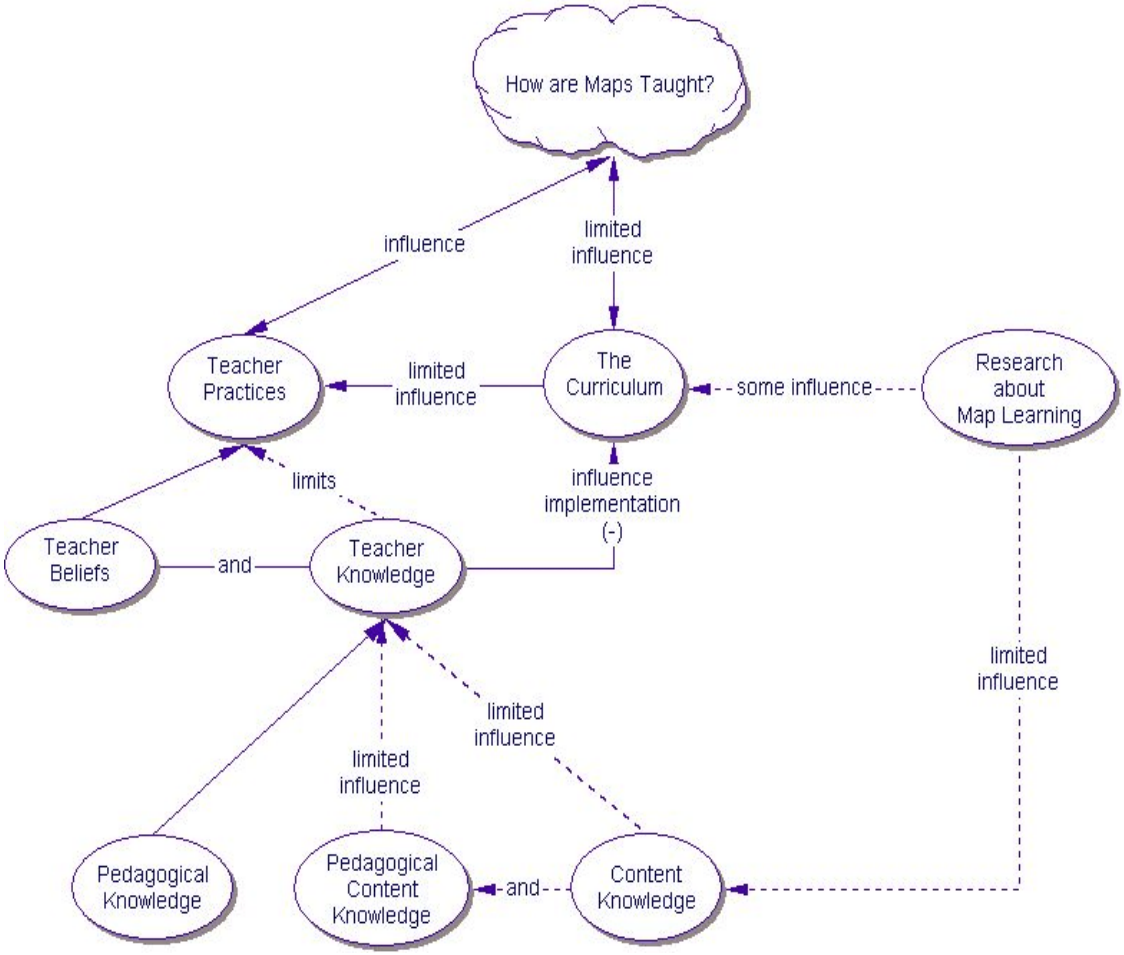


Figure 9. A reconceptualized model of map instruction.

Curricular implementation was affected by three factors: understanding of curricular goals, being able to implement the curriculum, and believing the curriculum to be appropriate. These factors are interrelated and were evident, to varying degrees, among interviewees in the second phase of this study. First, teacher knowledge affected curricular implementation: teachers can only teach what they know and understand, no matter what the curriculum says. Teachers in this study generally believed maps to be an important part of the geography and social studies curriculum, and as research about teacher beliefs suggests, there was a positive relationship between believing maps to be important and including them in instruction. While that belief is positive and bodes well for the continued use of maps in the classroom, limited content knowledge prevented maps from being taught in the ways envisioned in the National Geography Standards, the National Assessment for Educational Progress Achievement Levels for Geography, and the Texas Essential Knowledge and Skills.

Furthermore, curricular implementation was affected by teacher beliefs. Belief that the curriculum is appropriate is a significant factor in curricular implementation (Feldman 2002, Floden 1981). Two teachers in this study clearly did not believe the TEKS was an appropriate curriculum for their students. Curricular implementation was further constrained by those teachers who believed that student abilities (either disinterest, limited preparation, or poor skills) limited their ability to use maps in more sophisticated ways. Shulman's (1986a, b) idea of *curricular knowledge* is important here: teachers seemingly lacked the knowledge about curricular alternatives available for instruction about maps, which could address some of the issues pertaining to student abilities.

This model, based on the findings of this research, indicates that teacher knowledge is important in effective instruction. To be an effective teacher, one must possess pedagogical, curricular, content, and pedagogical content knowledge. While all are considered essential to good teaching, research suggests that content and pedagogical content knowledge are necessities (Garnet and Tobin 1988; Gudmundsdottir and Shulman 1987; Handal and Lauvas 1987; Lee 1995). The findings of the present student are in agreement with this previous research: without well developed content and pedagogical content knowledge, effective instruction will be elusive.

Recommendations

This study suggests a number of problems related to map instruction. No easy solutions exist. Three recommendations related to curriculum, assessment, research, and teachers are offered below. These recommendations are interrelated, and, ideally, they would be implemented in concert.

Recommendation 1, The Spiraling Curriculum Must Spiral: The TEKS are the curriculum in place. No doubt they could be stronger, aligning more closely with the benchmarks established by NAEP and the essential elements of the Standards. That criticism aside, the TEKS are, by law, the curriculum, and at the very least, its requirements need to be met. If map instruction revolves around essentially the same topics at all grade levels, then the spiraling nature of the curriculum will never be realized. It would appear from this study that the same topics are taught over and over again. The TEKS, the Standards, and NAEP were all designed to be progressive. A student's knowledge and skills at grade twelve are a composite of knowledge and skills gained in that grade and from the previous eleven years of schooling. This means that instruction should develop students' knowledge and skills. Teachers in this study report that students enter their classroom without a basic understanding of maps, limiting their ability to use maps in increasingly complex ways. Time spent ensuring that students are able to read a map, understand topics like scale, latitude and longitude, direction, and projection, and identify locations is well-spent. However, by focusing primarily on these topics, students are left with limited understanding about, and abilities to use maps in the ways envisioned by NAEP, the Standards, and even the TEKS. There are three possible reasons why teaching practice and curricular goals do not align. First, students have not been taught these skills in a way that results in long-term retention. Second, teachers are unaware of the TEKS requirements at their, and lower grade levels. Third, teachers are unable to fully implement the curricular requirements due to limited content and pedagogical content knowledge. All are reasonable possibilities.

For the curriculum to spiral, teachers must consciously teach the TEKS at their grade level. It is not enough to assume that the TEKS have been covered. Teachers must be clear that the curriculum they teach is the TEKS, and not their own. Teaching materials, assessment, and professional development must align with the TEKS in order to provide support to teachers.

Recommendation 2, Research Needs to Be Conducted to Devise Effective Instructional Strategies: For too long, researchers, particularly geographers, have ignored the classroom. Time and time again, geographic illiteracy (particularly place knowledge) is decried by the public, the press, and geographers; time and time again, the call for research in geographic education is (see Bednarz and Bednarz 1995), all seemingly to little avail. In the area of map literacy specifically, research most completely informs us about the navigational abilities of young children. This research makes an effective case for including maps at the youngest grades; beyond this, it provides little practical use for teachers. A smaller number of studies inform us that instruction is beneficial to students' map literacy, but effective, research-based instructional strategies are lacking.

Recommendation 3, Teacher Conceptualization of Maps Must Be Improved: For the previous recommendations to be effective and worthwhile, we must return to teachers. In the end, the knowledge and skills students learn in the classroom depend heavily on the teacher. This study has shown teachers' conceptualization of maps to be limited. It should be noted that map conceptualization is grade related: teachers were evaluated using a map skills continuum based on the grade level they teach. Consequently, the continuum's criteria at the elementary level is not as complex as the middle school level, and the middle school criteria are not as complex as high school's. Elementary teachers' conceptualization about what a map is and what/how it can be used were generally appropriate for their grade level. The same cannot be said for middle school and, even more so, high school teachers. If students are to use maps in increasingly sophisticated ways, then teachers must: (1) know that maps can be used this way, (2) understand that it is required by the curriculum, and (3) believe it to be an important part of the curriculum.

How to do this? There is no easy solution, but three recommendations, implemented in concert, might prove helpful. First, professional development for current teachers and academic preparation for pre-service teachers is an important step in providing educators with better understanding of how maps can be (and why they should be) used in the classroom. To accomplish this goal, geographers must be involved. Geographers are the best advocate for the discipline and can play a crucial role in ensuring that the content and skills presented in elementary and secondary grades are

representative of the discipline's knowledge base. In the college classroom, in particular, geographers can contribute to preservice preparation. Geography faculty seldom take the time to assess the cartographic knowledge of their students, instead assuming they come prepared with basic knowledge and skills (Downs and Liben 1991). This is a mistake. It does not matter if students *should* have learned these topics. As geographers and educators, we have a responsibility to ensure that students (preservice teachers included) understand the primary tool of the discipline. Teachers teach the way they were taught. By teaching both *about* and *with* maps in the college geography classroom, teachers will have a model of map instruction upon which they can base their own instruction about maps. Geographers can play a similar role in professional development. In either arena, geographers must take an active role in the professional development of teachers. After all, primary and secondary teachers will prepare future students in geography, and when done well, they potentially inspire future geographers.

Second, curriculum materials must support a broader use of maps than they currently do. As Bednarz (2003a) noted, teachers must have support materials that align with curricular goals if implementation is to be successful. The expectations of a curriculum can be established with good curriculum materials. These materials can support the development of geographic knowledge for the both the student *and* the teacher. By illustrating the knowledge students are expected to gain, educators can develop their conceptualization of the discipline.

Third, curriculum and assessment should align. This makes practical sense: assessment is an important part of education but it should not dictate instruction; the curriculum should guide instruction. Inevitably, there will be teachers who, for a variety of reasons, will teach to the test. Alignment would provide better insurance that maps (and anything else for that matter) are taught as they are envisioned by the curriculum.

Study Limitations

This study is limited by subject selection. Subjects for Phase I, the survey, were randomly selected from the mailing list of a geography-education organization. Consequently, the pool represented a sub-group of Texas social studies teachers, one that may not be representative of social studies teachers as a whole. While it was intended to select teachers with an interest in geography education, the potential differences must be considered when evaluating the final results.

The study is further limited by the subjects themselves. Subjects *chose* to respond to the mail survey, and a rather low response rate was obtained. Would the findings have been different with a 100 percent response rate? The answer is unknown. It is also unclear how the second phase of this research would have been affected by a different pool of interviewees. Participants in Phase II again self-selected for participation, and from that group I selected a small number of participants. Based on survey analysis, every effort was made to select teachers who ranged across the Map Literacy Continuum, but this effort was hampered at times due to teachers' schedules.

It is possible that the survey did not provide adequate opportunity for teachers to articulate their beliefs, knowledge, and practices about map literacy. It could be that teachers distinguish between teaching *about* maps and teaching *with* maps; and, based on the wording of survey items, they believed the focus to be primarily about the former. The survey though had been field-tested prior to distribution, and those teachers who completed the beta version, offered answers complete enough to suggest face validity.

The results for the second phase of this study are based on interviews and relatively brief observations. Teachers did select the days that I visited their classroom, allowing them some control over the content taught and activities observed. I assume that what I observed was representative of a typical day in this teacher's classroom—an assumption based in part on each teacher's assessment of it being a "typical" day. Clearly, extended observation would provide a better picture of these teachers' practices, and greater confidence in this study's conclusions.

Future Research Questions

This research suggests several avenues for further study. First, this study raises some interesting questions about the relationship between teacher preparation and map instruction: two teachers in the second phase of this study, Ms. Carr and Ms. Link, were active in the geography professional development community. They also tended to approach map instruction in a richer, more creative way than the rest of the interviewees. Conversely, Mr. Semple, the teacher with the most academic preparation in geography, equated map literacy with place knowledge. Understanding the link between academic preparation, involvement in professional development, and good teaching would be a vital piece of information, regardless of content area.

Further, this study provides initial understanding of how teachers conceptualize the role of maps in geography and the social studies. How do their ideas of what a map is, the purpose of a map, and the information that can be obtained from maps compare to that of professional geographers? Research suggests that geographers encode spatial information differently than non-geographers (Anderson and Leinhardt 2002; Ormrod et al., 1988; Saku 1992; Underwood 1981). Understanding geographers' conceptualization of maps would seem an important step in closing the gap between how maps are used in the classroom and how maps are used by professional geographers.

Teachers' reliance on supplemental materials, such as workbooks and a variety of Internet sites, offers another avenue for future research. There has been little consideration of textbooks, let alone additional classroom materials, and yet these materials play an important role in a teacher's sense of what gets taught when and how it gets taught. These materials may include simple maps with limited detail; in a brief perusal of textbook maps by this researcher, the maps contain little detail beyond a small number of locations and sharply delineated boundary lines. It is also possible that these materials focus on map reading rather than interpretation and analysis, offering a potential reason why teachers in this study did not seem to go beyond reading of simple maps. At the same time, new materials, such as the Association of American Geographer's ARGWorld (Activities and Resources for the Geography of the World) offer Standards-based geography modules which could help improve Standards and TEKS implementation. These materials warrant further consideration.

Conclusion

This study investigated how teachers develop map literacy in their classroom. Maps are an integral tool for geography and the social studies. Outside of education, in the "real" world, the ability to read, analyze, and interpret maps is also important. The examples are limitless: epidemiologists use maps to understand the spread of disease; emergency management teams use maps to plan evacuation routes; businesses use maps to select the best location for a new shop; politicians use maps to decide political districts; visitors to amusement parks use maps to decide the most efficient route to each ride. To perform each of these tasks successfully, people must know *about* maps and be able to work *with* maps.

Based on this need, one might expect that instruction would follow suit: ideally, map learning would involve learning both *about* and *with* maps. Unfortunately, this study suggests otherwise. While this sample of teachers clearly include maps as part of their geography and social studies instruction, they generally do so in limited ways. Instruction about map skills is a product of teachers' conceptualization of maps and their uses, and how they are defined in the curriculum. The focus of instruction for this sample of teachers is largely on developing locational knowledge, learning map basics, and reading simple maps. Each of these are significant components of the TEKS related to map skills, but they do not represent the curriculum in its entirety. The effect of such a limited conceptualization is that students are rarely given the opportunity, particularly in later grades, to interpret, analyze, and solve problems using maps.

Research suggests that many people have difficulty using maps. True, they can muddle their way along and obtain basic information. However, they likely miss much of the vast information stored within a map. Proper instruction could illuminate the many uses of maps. This research offers evidence that such illumination is not occurring.

NOTES

1. Map learning is used interchangeably with map literacy and map skills: these terms refer to the varied skills involved in reading, interpreting, analyzing, and making decisions based on information derived from maps.

2. An aligned map is oriented in relation to the space it represents. For example, if a person with a map is standing on a street facing north, then the "top" of the map would also be pointing north—the features on the map would "line up" with reality.

3. A rotated map is turned, sometimes resulting in confusion for the map user because the map does not "line up" with reality. For example, if a person is standing on a street facing north and the map they are holding is rotated clockwise 90 degrees, west will be at the "top" of the map and north will be alongside her right hand.

4. The TEKS were adopted in 1997, and became effective for all content areas on September 1, 1998 (Texas Education Agency 1997).

5. The State Board of Educator Certification (SBEC) approves teacher preparation programs in Texas; there are three basic routes to certification: university-based programs, post-baccalaureate programs, or alternative/accelerated programs.

6. Maps stored in the mind are referred to as either mental maps or cognitive maps; *mental* and *cognitive* are interchangeable terms.

7. This research, known as *process product research*, has been criticized for being unscientific, as well as ignoring *content*; these criticisms are addressed by Gage (1994).

8. Core subjects are English, reading or language arts, mathematics, science, foreign languages, civics and government, economics, arts [theater arts, dance, music, and art], history, and geography (TEA 2003).

9. The Texas Assessment of Knowledge and Skills (TAKS) replaced the Texas Assessment of Academic Skills (TAAS) in academic year 2002–2003; it is meant to be a better assessment of students' knowledge and ability to think critically.

10. Two maps were used during the interviews: (1) a reference map of the Western Gulf Region of the United States from Goode's World Atlas (20th Edition, 2000, 122–3); and, (2) a thematic map of the economies of the United States from Rand McNally's *Classroom Atlas* (1998, 36).

11. Data about specific textbooks are not reported in this dissertation. A list of textbooks reportedly used can be obtained by contacting this researcher.

12. Numbers in brackets refer to the tag number assigned to individual survey respondents (as described in Chapter III).

13. The Five Themes of Geography were written by the Joint Committee on Geographic Education (1984). The themes are: location, place, human-environment interaction, movement, and regions. The National Geography Standards expand, and replace, the Five Themes.

14. The five components of maps is a modified version of TODALSIGS (title, orientation, date, author, legend, scale, index, grid, and source). The five components sometimes vary among the nine TODALSIGS, but most often refer to title, orientation, date, legend, and scale.

15. Because a world map stretches and compresses the three-dimensional earth onto a two-dimensional map, scale varies from place to place (Monmonier 1993, 32), so the scale around Texas could be different than the scale around Iraq, making comparison difficult.

16. Nesting is the idea that places fit within one another hierarchically, from small to large. For example, College Station is a city in the state of Texas which is in the country of the United States.

17. When students acquire skills enabling them to read, interpret, and produce maps, they are learning *about* maps; when maps are used to learn geographic concepts and relationships, students are learning *with* maps (Acheson and Bednarz 2003).

18. The continuum provides three levels of mastery (basic, proficient, and advanced) at three grade levels (elementary, middle, and high school). The categories of basic, proficient, and advanced build on one another, so that a student with proficient skills can perform the basic tasks as well as the proficient ones. In addition, grade levels build on one another, so that a high school student at the basic level can accomplish the *basic* criteria outlined at the elementary and middle levels as well.

19. FOSS, or Full Option System Science, is a research-based, K–8 science curriculum developed at the University of California, Berkeley.

20. Reference maps are used to determine the location of geographical features, distance, and direction. The map of the Western Gulf Region of the United States is a reference map. Thematic maps illustrate spatial variation of geographical distributions, usually containing one or two variables; the Economies of the United States map used in this study is a thematic map.

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APPENDIX A

Map-specific Geography Strands of the Social Studies Teks

Subchapter A. Elementary–113.2 Social Studies Kindergarten
B. Knowledge and Skills
(K.4) Geography: The student understands the concept of location.
(a) describe relative location
(b) locate places on the school campus and describe their relative locations

(K.15) Social Studies Skills
(b) obtain information about a topic using…maps
(d) identify main ideas from…visual and print sources

(K.16) Social Studies Skills
(b) create and interpret visuals including pictures and maps

Subchapter A. Elementary–113.3 Social Studies, Grade 1
A. Introduction
(1) ….Students make simple maps to identify the location of places in the classroom, school, and community….

B. Knowledge and Skills
(1.4) Geography: The student understands the relative location of places. The student is expected to:
(a) locate places using the four cardinal directions; and
(b) describe the location of self and objects relative to other locations in the classroom and school

(1.5) Geography: The student understands the purpose of maps and globes. The student is expected to:
(a) create and use simple maps to identify the location of places in the classroom, school, community, and beyond, and;
(b) locate places of significance on maps and globes such as the local community, Texas, and the United States.

(1.17) Social Studies Skills. The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:
(a) obtain information about a topic using…maps…
(b) identify main ideas from…visual, and print sources

(1.18) Social Studies Skills
(b) create visual and written material including…maps…

These strands are directly excerpted from the Texas Essential Knowledge and Skills Learning Standards, available at <http://tea.state.tx.us/teks/>.

Subchapter A. Elementary–113.4 Social Studies, Grade 2
B. Knowledge and Skills
(2.5) Geography: The student uses simple geographic tools such as maps, globes, and photographs. The student is expected to:
(a) use symbols, find locations, and determine direction on maps and globes; and
(b) draw maps to show places and routes

(2.6) Geography: The student understands the locations and characteristics of places and regions. The student is expected to:
(a) identify major landforms and bodies of water, including continents and oceans, on maps and globes
(b) locate the community, Texas, the United States, and selected countries on maps and globes; and
(d) compare information from different sources about places and regions

(2.17) Social Studies Skills: The student applies critical thinking skills to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:
(b) obtain information about a topic using a variety of visual sources such as…maps…
(c) use various parts of a source…to locate information
(e) interpret…visual, and print material by identifying the main idea, predicting and comparing and contrasting

(2.18) Social Studies skills: The student communicates in written, oral, and visual forms. The student is expected to:
(b) create written and visual material such as…maps

Subchapter A. Elementary–113.5 Social Studies, Grade 3
B. Knowledge and Skills
(3.5) Geography: The student understands the concepts of location, distance, and direction on maps and globes. The student is expected to
(a) use cardinal and intermediate directions to locate places such as the Amazon River, Himalayan Mountains, and Washington, DC on maps and globes
(b) use a scale to determine the distance between places on maps and globes;
(c) identify and use the compass rose, grid, and symbols to locate places on maps and globes; and
(d) draw maps of places and regions that contain map elements including a title, compass rose, legend, scale, and grid system

(3.16) Social Studies skills: The student applies critical thinking skill to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:
(a) obtain information, including…geographic data about the community…
(b) sequence and categorize information
(c) interpret…visual, and print material
(d) use various parts of a source…to locate information
(e) interpret and create visuals including…maps…
(f) use appropriate mathematical skills to interpret social studies information such as

maps and graphs

(3.17) Social Studies Skills: The student communicates effectively in written, oral, and visual forms. The student is expected to:
(b) create written and visual material such as…maps…

Subchapter A. Elementary–113.6 Social Studies Grade 4
(B) Knowledge and Skills
(4.6) Geography: The student uses geographic tools to collect, analyze, and interpret data. The student is expected to:
(a) apply geographic tools, including grid systems, legends, symbols, scales, and compass roses to construct and interpret maps; and
(b) translate geographic data into a variety of formats such as raw data to graphs and maps.

(4.22) Social Studies skills: The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:
(c) organize and interpret information in…maps
(d) identify different points of view about an issue or topic;
(f) use appropriate mathematical skills to interpret social studies information such as maps and graphs

Subchapter A. Elementary–113.7 Social Studies, Grade 5
(B) Knowledge and Skills
(5.6) Geography: The student uses geographic tools to collect, analyze, and interpret data. The student is expected to:
(a) apply geographic tools, including grid systems, legends, symbols, scales, and compass roses, to construct and interpret maps; and
(b) translate geographic data into a variety of formats such as raw data to graphs and maps;

(5.8) Geography: The student understands the location and patterns of settlement and the geographic factors that influence where people live. The student is expected to:
(a) identify and describe the types of settlement and patterns of land use in the United States;
(b) describe clusters of settlement in the United States and explain their distribution;
(c) analyze the location of cities in the United States, including capital cities, and explain their distribution, past and present; and
(d) explain the geographic factors that influence patterns of settlement and the distribution of population in the United States, past and present.

(5.25) Social Studies Skills: The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:
(a) differentiate between, locate, and use primary and secondary sources… [maps are not given as an example]
(b) analyze information…

(c) organize and interpret information in…maps
(d) identify different points of view about an issue or topic [this would be a great activity to do with maps]

Subchapter B: Middle School–113.22 Social Studies, Grade 6
(B) Knowledge and Skills
(6.3) Geography: The student uses maps, globes, graphs, charts, models, and databases to answer geographic questions. The student is expected to:
(a) create thematic maps, graphs, charts, models, and databases depicting various aspects of world regions and countries such as population, disease, and economic activities
(b) pose and answer questions about geographic distributions and patterns for selected world regions an countries shown on maps, graphs, charts, models, and databases; and
(c) compare selected world regions and countries using data from maps, graphs, charts, databases, and models.

(6.4) Geography: The student understands the characteristics and relative locations of major historical and contemporary societies. The student is expected to:
(a) locate major historical and contemporary societies on maps and globes;
(b) identify and explain the geographic factors responsible for patterns of population in places and regions;
(c) explain ways in which human migration influences the character of places and regions; and
(d) identify and explain the geographic factors responsible for the location of economic activities in places and regions.

(6.21) Social Studies Skills. The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:
(a) organize and interpret information from…maps
(e) use appropriate mathematical skills to interpret social studies information such as maps and graphs.

Subchapter B: Middle School–113.23 Social Studies, Grade 7
(B) Knowledge and Skills
(7.8) Geography. The student uses geographic tools to collect, analyze, and interpret data. The student is expected to:
(a) create thematic maps, graphs, charts, models, and databases representing various aspects of Texas during the 19th and 20th centuries, and
(b) pose and answer questions about geographic distributions and patterns in Texas during the 19th and 20th centuries

(7.21) Social Studies Skills
(c) organize and interpret information from…maps…

Subchapter B: Middle School–113.24 Social Studies, Eighth Grade
(B) Knowledge and Skills

(8.10) Geography. The student uses geographic tools to collect, analyze, and interpret data. The student is expected to:
(a) create thematic maps, graphs, charts, models and databases representing various aspects of the United States; and
(b) pose and answer questions about geographic distributions and patterns shown on maps, graphs, charts, models, databases

(8.11) Geography. The student understands the location and characteristics of places and regions of the United States, past and present. The student is expected to:
(a) locate places and regions of importance in the United States during the 18th and 19th centuries;
(b) compare places and regions of the United States in terms of physical and human characteristics; and
(c) analyze the effects of physical and human geographic factors on major historical and contemporary events in the United States

(8.30) Social Studies Skills
(c) organize and interpret information from…maps
(f) identify bias in written, oral, and visual material;
(g) evaluate the validity of a source
(h) use appropriate mathematical skills to interpret…maps

Subchapter C: High School–113.32, US History Studies Since Reconstruction
(C) Knowledge and Skills
(8) Geography. The student uses geographic tools to collect, analyze, and interpret data. The student is expected to:
(a) create thematic maps, graphs, charts, models, and databases representing various aspects of the United States; and
(b) pose and answer questions about geographic distributions and patterns shown on maps, graphs, charts, models, and databases

(25) Social Studies Skills.
(a) transfer information from one medium to another, including written to visual and statistical to written or visual, using computer software as appropriate; and
(b) create written…visual presentations of social studies information

Subchapter C: High School–113.33 World History Studies
(C) Knowledge and Skills
(11) Geography. The student uses geographic skills and tools to collect, analyze, and interpret data. The student is expected to:
(a) create thematic maps, graphs, charts, models, and databases representing various aspects of world history; and
(b) pose and answer questions about geographic distributions and patterns in world history shown on maps, graphs, charts, models, and databases.

(12) Geography. The student understands the impact of geographic factors on major historic events. The student is expected to:

(a) locate places and regions of historical significance such as the Indus, Nile, Tigris and Euphrates, and Yellow (Huang He) river valleys and describe their physical and human characteristics;
(b) analyze the effects of physical and human geographic factors on major events in world history such as the effects of the opening of the Suez Canal on world trade patterns; and
(c) interpret historical and contemporary maps to identify and explain geographic factors such as control of the Straits of Hormuz that have influenced people and events in the past.

(25) Social Studies Skills
(f) identify bias in written, oral, and visual material

Subchapter C: High School–113.34 World Geography Studies
(C) Knowledge and Skills
(6) Geography. The student understands the types and patterns of settlement, the factors that affect where people settle, and processes of settlement development over time. The student is expected to:
(a) locate settlements and observe patterns in the size and distribution of cities using maps, graphics, and other information; and
(b) explain the processes that have caused cities to grow such as locating along transportation routes, availability of resources that have attracted settlers and economic activities, and continued access to other cities and resources

(21) Social Studies Skills.
(a) use historical, geographic and statistical information from a variety of sources such as databases, field interviews, media services, and questionnaires to answer geographic questions and infer geographic relationships
(b) analyze and evaluate the validity and utility of multiple sources of geographic information such as primary and secondary sources, aerial photographs, and maps;
(c) construct and interpret maps to answer geographic questions, infer geographic relationships, and analyze geographic change
(d) apply basic statistical concepts and analytical methods such as computer-based spreadsheets and statistical software to analyze geographic data; and
(e) use a series of maps, including a computer-based geographic information system, to obtain and analyze data needed to solve geographic and locational problems.

(22) Social Studies Skills.
(a) design and draw appropriate maps and other graphics such as sketch maps, diagrams, tables, and graphs to present geographic information including geographic features, geographic distributions, and geographic relationships
(b) apply appropriate vocabulary, geographic models, generalizations, theories, and skills to present geographic information;
(c) use geographic terminology correctly

(23) Social Studies Skills

(a) plan, organize, and complete a group research project that involves asking geographic questions; acquiring, organizing, and analyzing geographic information; answering geographic questions; and communicating results
(b) use case studies and geographic information systems to identify contemporary geographic problems and issues and to apply geographic knowledge and skills to answer real-world questions.

APPENDIX B

TEACHING MAP SKILLS SURVEY

This survey asks how you teach map skills to your students. Your responses will be important in designing instructional strategies to improve map learning. Provide as much detail as you can. Please return the survey in the attached postage-paid envelope. All responses will be kept strictly confidential.

Directions: Please answer the following 21 questions in the space provided. If you need more space or would like to add comments, use the back of the page.

1. What course(s) do you teach?

□ geography/social studies □ geography only □ other_____

2. What grade(s) do you teach?_____

3. How many years have you been teaching geography/social studies?_____

4. What textbook do you use to teach geography/social studies?_____

_____

5. Are map skills a component of the TEKS at your grade level?

□ Yes □ No

6. Do you teach map skills?

□ Yes (proceed to question 7) □ No

6b. If no, please explain (check all that apply; and, proceed to question 7):

□ Map skills are not required/specified at my grade level.

□ My students already have adequate map skills.

□ I don't feel comfortable teaching map skills.

□ Other:_____

7. If yes, how often do you use your textbook to help plan your map skills lessons?

□ Always □ Very Often □ Often □ Rarely □ Never

8. What other sources (in addition to the textbook) do you use to develop lessons on map skills?

□ TEKS □ Internet □ Map/Globe Skills Workbooks (please specify below)

□ Other (please specify)_____

_____

9. Do you use technology-based resources (such as Tom Snyder's Map Machine or a GIS) to teach map skills?

□ Yes □ No (proceed to question 11)

10. If yes, please explain what technology-based resources you use (and proceed to question 12):

_____

_____

11. If no, please explain why you do not use technology-based resources to teach map skills (check all that apply):

□There is limited access to technology in my school or classroom.
□ I would not feel comfortable using technology-based resources to teach map skills.
□Technology-based resources are inappropriate for my grade level.
□I am unsure about what products are available.
□I do not have enough time to learn to use such materials
□other (please explain):_____

_____

11b. Of the items you selected above, which is the most significant reason that you do not use technology-based resources?_____

12. What guidelines determine your geography curriculum? (Check all that apply.)

□ State Standards □ National Standards □ School District □ Text

13. Approximately what percentage of total class time during the entire school year do you spend

teaching map skills?_____**%**

14. Which statement best describes the frequency of map skills instruction in your class?

□ I teach map skills at the beginning of the year.
□ I teach map skills throughout the year at regular intervals.
□ I teach map skills on an as needed basis (For example: If students are having difficulty understanding map symbols during a lesson about Chile, I will teach a lesson on symbols.)
□ Other (Please specify)_____

_____

15. What topics (e.g., scale) do you cover when you teach map skills?_____

_____

16. What is the most important map skill students learn from your lessons?_____

_____

17. What activities do you think improve students' understanding of maps?_____

_____

18. Why do you think the activities described in Question 17 are effective?_____

_____

19. In your opinion, what is the role of map skills in geography and the social studies?_____

_____

_____

20. In order to read and interpret a map, a person must understand: (Check all that apply)

- ☐ **symbols**
- ☐ **cardinal directions**
- ☐ **scale**
- ☐ **projection**
- ☐ **latitude & longitude**
- ☐ **that a map is a flat representation of the spherical earth**
- ☐ **use of color/shading**
- ☐ **other (please specify)**_____

21. How would you define the broader concept of geographic literacy?_____

_____

_____

The following information is optional, but your additional help would be greatly appreciated! If you would be willing to participate in a follow-up interview, please leave the following information:

Name:_____ **E-mail:**_____

Phone Number:_____ **Good Time To Call:**_____

THANK YOU FOR YOUR TIME!

APPENDIX C

Correlation of the Map Literacy Continuum to the TEKS – Elementary Level

	Continuum	Corresponding TEKS
Basic	**a. use a map to find information** **b. identify locations** **c. read simple maps, map keys & legends** **d. draw simple maps, map keys, & legends** **e. identify, describe basic map elements**	**a. K.15b, K.15d; 1.17a-b; 2.17b-c** **b. 1.5a; 2.6a-b** **c. 2.17e; 3.16c-f; 4.6a** **d. K.16b; 1.18b; 2.18b; 3.17b** **e. 1.5b; 2.5a; 3.5a-b**
Proficient	**a. (read &) interpret maps** **b. use number/letter grids to plot locations** **c. understand relative location terms** **d. draw sketch map of observed landscapes** **e. observe the distribution of features on maps**	**a. 2.17e; 3.16c-f; 4.6a** **b. 2.5a; 3.5c** **c. K.4a-b; 1.4a-b** **d. 2.5b; 3.5d; 3.17b; 4.6b** **e. [none identified]**
Advanced	**a. solve simple problems using information found in maps, atlases** **b. draw sketch maps of places** **c. describe and compare differences, similarities, and patterns of change in landscapes** **d. determine the impact of change in one place on another place**	**a. 4.22 c-d** **b. 3.17b; 4.6b** **c. [none identified]** **d. [none identified]**

Notation: Example for grades K8, 2.6a represents second grade, standard 6, sub-point a; USH-US History since Reconstruction, WG-World Geography, WH-World History.

Correlation of the Map Literacy Continuum to the TEKS – Middle School Level

	Continuum	Corresponding TEKS
Basic	**a. possess fundamental knowledge and vocabulary of distance, direction, scale, boundary, site, and situation** **b. solve fundamental locational questions using latitude and longitude** **c. interpret simple map scales** **d. identify locations** **e. explain differences between maps, globes, aerial photos, satellite images** **f. find a wide range of information using an atlas or almanac.** **g. draw sketch maps (& compare with atlases for accuracy)**	**a. 5.6a** **b. 6.21e; 8.30h** **c. 4.22f; 6.21e; 8.30h** **d. 5.8a; 6.4a; 8.11a** **e. [none identified]** **f. 5.6a; 5.25a-c** **g. 5.6b**
Proficient	**a. solve locational questions requiring integration of information from two or more sources, such as atlases or globes** **b. compare information presented at different scales** **c. choose appropriate maps to answer particular questions; evaluate the goodness of maps (e.g. select best projection for purpose)** **d. use map information to describe the role that regions play in influencing trade, migration patterns; cultural, political interaction** **e. create thematic maps using data, symbols, color** **f. explain why *x* is located where it is**	**a. 2.6d; 8.10b** **b. [none identified]** **c. 8.30f, g; WG21b** **d. 5.8a-d; 6.3b; 6.4b; 7.8b** **e. 6.3a; 7.8a; 8.10a** **f. 5.8c; 6.4d**
Advanced	**a. use case studies for spatial analysis and to develop maps and other graphics** **b. use one category of a map or aerial photograph to predict other features of a place such as vegetation based on climate or population density based on topographic features.** **c. analyze & explain patterns of land use; consider human-environment interaction**	**a. [none identified]** **b. [none identified]** **c. 5.8a-d; 6.3a-c; 6.4b-c; 7.8b; 8.11b-c**

Notation: Example for grades K8, 2.6a represents second grade, standard 6, sub-point a; USH-US History since Reconstruction, WG-World Geography, WH-World History.

Correlation of the Map Literacy Continuum to the TEKS – High School Level

	Continuum	Corresponding TEKS
Basic	**a. solve simple locational problems using maps and globes (using applicable units of measurement)** **b. read maps** **c. identify several basic types of map projections** **d. use maps to illustrate spatial patterns (e.g. regional boundaries change)**	**a. [none identified]** **b. WG.22a-c** **c. WG.22a-c** **d. WG.6a**
Proficient	**a. interpret maps to analyze spatial phenomena; discuss economic, political, & social factors that define, interpret space (using geographic concepts)** **b. design maps based on descriptive data** **c. report both historical and contemporary events within a geographic framework using tools such as special-purpose maps and primary and secondary source materials.** **d. collect, compare, explain the significance of maps from different sources, points of view**	**a. USH.8b; WH.11b; WG.6b; WG.21c** **b. 4.6b; USH.8a** **c. WH.12a-c; WG.21a** **d. WH.25f**
Advanced	**a. apply a wide range of map skills;** **b. develop maps using fundamental cartographic principles including translating narratives about places and events into graphic representations** **c. compare maps of the world using different projections, perceptions of space to draw conclusions about factors that influence mental maps**	**a. WH.11a; WG.21a-e** **b. USH.25a-b; WG.21e** **c. 4.22d; 5.25d**

Notation: Example for grades K8, 2.6a represents second grade, standard 6, sub-point a; USH-US History since Reconstruction, WG-World Geography, WH-World History.

APPENDIX D

Map Literacy Proficiency Standards – Elementary School

Directions: The following list represents a variety of map skill standards for a variety of different grade levels. Highlight the skills you have your students do.

I have students:

1. **use a map to find information.**
2. **identify locations.**
3. **read simple maps, map keys & legends.**
4. **draw simple maps, map keys, & legends.**
5. **identify, describe basic map elements.**
6. **interpret maps.**
7. **use number/letter grids to plot locations.**
8. **understand relative location terms.**
9. **draw sketch map of observed landscapes.**
10. **observe the distribution of features on maps.**
11. **solve simple problems using information found in maps, atlases.**
12. **draw sketch maps of places.**
13. **describe and compare differences, similarities, and patterns of change in landscapes.**
14. **determine the impact of change in one place on another place.**
15. **create thematic maps using data, symbols, color.**
16. **explain why *x* is located where it is.**
17. **analyze & explain patterns of land use; consider human-environment interaction.**
18. **collect, compare, explain the significance of maps from different sources, points of view.**

Map Literacy Proficiency Standards – Middle School

Directions: The following list represents a variety of map skill standards for a variety of different grade levels. Highlight the skills you have your students do.

I have students:

1. **use number/letter grids to plot locations.**
2. **understand relative location terms.**
3. **describe and compare differences, similarities, and patterns of change in landscapes.**
4. **determine the impact of change in one place on another place.**
5. **possess fundamental knowledge and vocabulary of map elements (e.g. distance, direction, scale, boundary, site, and situation).**
6. **solve fundamental locational questions using latitude and longitude.**
7. **interpret simple map scales.**
8. **identify locations.**
9. **explain differences between maps, globes, aerial photos, satellite images.**
10. **find a wide range of information using an atlas.**
11. **draw sketch maps & compare with atlases for accuracy.**
12. **solve locational questions requiring integration of information from two or more sources, such as atlases or globes.**
13. **compare information presented at different scales.**
14. **choose appropriate maps to answer particular questions; evaluate the goodness of maps (e.g. select best projection for purpose).**
15. **use map information to describe the role that regions play in influencing trade, migration patterns; cultural, political interaction.**
16. **create thematic maps using data, symbols, color.**
17. **explain why *x* is located where it is.**
18. **use case studies for spatial analysis and to develop maps and other graphics.**
19. **use one category of a map or aerial photograph to predict other features of a place such as vegetation based on climate or population density based on topographic features.**
20. **analyze & explain patterns of land use; consider human-environment interaction.**

Map Literacy Proficiency Standards – High School Level

Directions: The following list represents a variety of map skill standards for a variety of different grade levels. Highlight the skills you have your students do.

I have students:

1. **understand relative location terms.**
2. **describe and compare differences, similarities, and patterns of change in landscapes.**
3. **determine the impact of change in one place on another place.**
4. **possess fundamental knowledge and vocabulary of map elements (e.g. distance, direction, scale, boundary, site, and situation).**
5. **solve fundamental locational questions using latitude and longitude.**
6. **interpret simple map scales.**
7. **identify locations.**
8. **explain differences between maps, globes, aerial photos, satellite images.**
9. **find a wide range of information using an atlas.**
10. **use scale to solve simple locational problems using maps and globes**
11. **read maps**
12. **identify several basic types of map projections**
13. **use maps to illustrate spatial patterns (e.g. regional boundaries change).**
14. **interpret maps to analyze spatial phenomena; discuss economic, political, & social factors that define, interpret space (using geographic concepts).**
15. **design maps based on descriptive data.**
16. **report both historical and contemporary events within a geographic framework using tools such as special-purpose maps and primary and secondary source materials.**
17. **collect, compare, explain the significance of maps from different sources, points of view.**
18. **apply a wide range of map skills;**
19. **develop maps using fundamental cartographic principles including translating narratives about places and events into graphic representations.**
20. **compare maps of the world using different projections, perceptions of space to draw conclusions about factors that influence mental maps.**

APPENDIX E

Interview Protocol

I just want to remind you that I'm interested in how you teach maps to students. I'll ask you a series of questions about maps and map skills. There are no studies that tell us how map skills are currently taught. We have standards and curricula that say what "should" be taught, but no real understanding of what is taught. And there should be some kind of understanding of what teachers do in the classroom and know to be appropriate for their students.

So that means I might ask you questions that seem odd given the grade level you teach or because its too easy or too difficult. Again, I'm just asking because your responses will give geographic educators an idea of what's being done at a particular grade level. If I ask a question that seems inappropriate at your grade level or you don't know the answer, just say so – it's no big deal. I understand that teaching is a very personal endeavor, and I just want you to keep in mind throughout this interview, that you are the expert. You can always give me examples to clarify your responses.

Background information:

What type of preparation have you had in geography – college courses, professional development?

When you started teaching geography, did you feel prepared to do so?

To what extent did college course work prepare you teach geography? To teach map skills specifically?

RQ 1b

What is a map?

What do you use a map for?

If you had to name the primary use of a map, what would it be?

We're going to look at some maps, and I would like you to tell me some information about them. Here's where I might ask you some questions that seem really easy or difficult.

Can you tell me about this map (western Gulf Region of US & Mexico, partial)

- What type of information does it tell you?
  - what information can you find from this map?
  - what do the variations in color mean?
  - can you give me an idea of the distance between Houston & New Orleans?
  - if someone knew that population in Texas tends to be concentrated in Dallas-Ft. Worth, Houston, and San Antonio, could she use this map to help explain why?
  - this map is a conic projection – what does that mean?
- Is there information from this map that you think should be included?
- Would you use this map with your students?
  - If so, how?
  - If not, why?
- Would the average student in your class be able to:
  - use this map to identify locations?
  - use this map to predict other features (like vegetation) found in this landscape?
  - suggest why Dallas-Ft. Worth is located where it is?
  - interpret the map scale?
  - identify the map projection?

Can you tell me about this map (economies of the US)?
What type of information does it tell you?
what information can you find from this map?
what do the symbols mean?
so, can you tell me where in the US you find “little or no economic activity”?
and, why do you think there is very little going on there?
tell me about the economic activities on the east coast as compared to the west coast?
there are a number of cities designated on this map – why do you think these cities are named while others are not?
Is there information missing from this map that you think should be included?
Would you use this map with your students?
If so, how?
If not, why not?
Would the average student in your class, be able to use this map:
To find information (where in the US you find “little or no economic activity”?)
explain why there is little going on there by using the map of climate & population?
To describe & compare differences in landscapes (compare the east coast w/ the west coast)
explain why manufacturing centers are located where they are?

On a scale of 1-5, how comfortable are you at evaluating the goodness of a map.

When you select a map to use in your classroom, what kind of criteria do you use to select it (sharp contrasting color, size, purpose)?

RQ 2

How important are map skills at the grade level you teach?
TEKS
textbook
personal

Describe what students are expected to know about or be able to do with maps at your grade level.

RQ 1a

Are maps easy to understand? Why, why not?

What do kids find difficult about maps?

Why teach map skills (other than being required by the curriculum!)?

RQ 3

What kind of access do students have to maps, globes?

How often do they use them (daily, once a week, monthly)?

On your survey, you noted the following items were needed in order to read/interpret a map, could you tell me why you think those are important?

Again, on the survey, you said you teach the following topics, give me an idea of what/how you teach these items (e.g. you listed projection – what about projection?).

Give me an idea of how you would teach a student to read a map – walk me through it.
- Is this the same way that you would present it to the class?

Do you have kids construct maps?
- Why?
- What do you think they learn from constructing maps?
- When they construct maps, are students required to:
  - include map elements (TODLSIGS)?
  - check their map against an atlas or wall map?
  - draw to scale?
  - include lines of latitude/longitude?

When students (average ability) leave your classroom at the end of the year, what should they be able to do with maps?

VITA

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