Research In Geographic Education

Volume 1 *1999* *Number 1*

EDITORS
Richard G. Boehm
David Stea

The Gilbert M. Grosvenor Center
for Geographic Education

Welcome to *Research in Geographic Education*

The launching of a new enterprise is always accompanied with joys and expectations: joys in breaking new ground and expectations of success. So it is with a new academic journal: the joy of finding material to fill knowledge gaps as yet unbridged, the expectation of unprecedented discovery, and the attempts to add new dimensions to academic and applied knowledge.

Empirical and theory-based academic research in geographic education is still in its adolescence. The field has already passed through infancy and childhood: anecdotal reports of successful and sometimes not-so-successful innovations in K-12 and university-level courses, programs, teaching techniques, and curricula abound. Unfortunately, empirical, truly academic research in geographic education has yet to find a satisfactory outlet in an American publication. *Research in Geographic Education* was founded in an attempt to address that need, to provide the opportunity for researchers in all aspects of geographic education to present their findings.

Contributors to *Research in Geographic Education* come from different nations, different cultures, and often, from different disciplines. They address geographic education at various levels: the university, the traditional K-12 period, and even the informal geographic learning that occurs among pre-schoolers or the general public. Contemporary geographic education research focuses on wide spectrum of topics; curriculum, spatial cognition, geographic learning, gender, visual and non-visual representation, environmental cognition and education, special populations, mapping in all forms, assessment, and numerous other topics applicable to geographical pedagogy. Whatever the focus, whatever the perspective, whatever the origins, the common thread binding these research efforts together is the desire to fill in the substantial gaps that exist in the field of geographic education.

We are pleased to welcome you to *Research in Geographic Education*, and invite you to become an active participant in our efforts to contribute to the field of geographic education. Of course, launching a new journal requires the participation of many people, including those who contributed articles for consideration, those who graciously agreed to act as peer reviewers, and staff and students from the Department of Geography at Southwest Texas State University who assisted in all aspects of this venture. We offer our heartfelt thanks to everyone for their contributions to this inaugural edition and subsequent issues of *Research in Geographic Education*.

Richard G. Boehm
David Stea
Co-Editors

TABLE OF CONTENTS

Volume 1, Issue 1, 1999

Articles

Book Reviews

Assessing and Improving Geographic Belief: A Cognitive Approach

Norman R. Brown and Alinda Friedman

Over the past several years, we have conducted numerous experiments designed to assess what people know about world geography and to determine how new facts affect prior knowledge. Typically, participants first estimate the latitudes or longitudes of cities in different parts of the world. Next, they are given information about the actual location of a small number of these cities and provide a second set of estimates. These location estimates are converted to representations, called location profiles, which convey information about estimation accuracy, the subjective division of continents and countries into regions, biased beliefs about the location of these regions, and beliefs about the relations between regions both within and between continents. In addition, differences between the first and second estimates indicate how representations of global geography are updated when people learn new location information about individual cities. This article provides an introduction to this research, and summarises its main findings.

***Keywords**: subjective geography, location profile, bias, category, seeding*

In this article, we review an on-going laboratory-based research program that has provided new methods for assessing and improving geographical knowledge (Friedman & Brown, 1999 in press a, in press b). The approach has three key elements: (a) a task – the absolute location judgement task, (b) a representation – the location profile, and (c) a form of intervention – seeding the knowledge base (Brown & Siegler, 1993, 1996). In the typical experiment, subjects are presented with a set of city names and are required to estimate either the latitude or the longitude of each city in the set. Next, they are presented with information about the actual location a small number of cities – usually just one or two – called "seed cities." Finally, they provide a second set of estimates for the cities. The pre-seeding judgements are used to construct one location profile and the post-seeding estimates to construct a second. The profiles constructed from the first set of judgments convey information about estimation accuracy, the subjective division of continents and countries into regions, beliefs about the relative and absolute location of these regions, and beliefs about the relations between regions, both within and between continents. Importantly, these pre-seeding profiles reveal the extent and nature of pre-existing biases in geographical knowledge. Thus, differences between pre-seeding and post-seeding profiles can be examined to determine how representations of global geography are updated when people learn new location information about individual cities.

ABSOLUTE LOCATION JUDGEMENTS AND LOCATION PROFILES

In our research program, we have made heavy use of absolute location judgements. In most of these experiments, participants are required to estimate, as accurately as possible, the latitude or the longitude of the all cities in the stimulus set. To our knowledge, this research program is the first to collect these estimates in a systemic manner. Of course, a number of other methods have been used to study subjective geography. These include: map reproductions (Hirtle & Jonides, 1985; Saarinen, 1987; Tversky, 1981); compass-bearing estimates (Glicksohn, 1994; Tversky, 1981), in which people indicate the location between two geographical reference points; distance judgments (Holyoak & Mah, 1982); area estimation (Kerst & Howard, 1978); comparative location estimates (Lloyd, 1989; Maki, 1981); and travel time estimates (Montello, 1989). These methods have specific problems associated with them that absolute location judgments do not. For example, map reproductions are limited by people's ability to draw. Obviously, drawing ability is irrelevant to producing location estimates.

There is also a fundamental problem with distance estimates, bearing estimates, travel-time estimates, and comparative location judgments. Because all these tasks require knowledge of at least two cities, it is difficult, and at times impossible, to attribute performance unambiguously to a single source. In contrast, the location judgement task yields an individual numerical estimate for each test city. Thus, accuracy and bias can be assessed on a city-by-city basis, as well as at more global level, using conventional statistical methods. For example, the mean signed error (signed latitude error = estimated latitude – actual latitude) and the mean absolute error (absolute latitude error = |signed latitude error|) can be computed for each city, and compared to determine which cities elicit accurate, unbiased estimates and which do not. It is also possible to take means over cites within a region and to compute the correlation between estimated and actual location for these same cities. These measures indicate whether regional membership affects accuracy and bias, and whether participants have a good sense of the relative location of cities within a given region.

Aggregate measures computed over absolute location judgments are instructive, and lend themselves to inferential statistics. However, the main advantage of this approach is that it provides the estimates that are necessary for constructing location profiles. An example of a location profile is presented in Figure 1. The data presented in this figure were collected from 60 Canadian university students who were required to estimate the latitude of 30 New World cities and 30 Old World cities (see Friedman & Brown, 1999 in press b, Experiment 2, for further details). In this figure, latitude is represented on the ordinate and the names of the test cities along the abscissa, with the New World cities presented on the left side of the figure and the Old World cities on the right side. Within each panel, the cities are ordered according to actual latitude, with the most northern city in each set (i.e., Saskatoon and Oslo) listed at the far left and the most southern city in each set (i.e., Acapulco and Nairobi) listed at the far right. Each small marker indicates a city's actual latitude and each large marker, its mean estimated latitude (and the standard error of those estimates). For example, it is clear from this figure that Tijuana is actually located at 33° north and believed to be located at 4° north, and that the corresponding coordinates for Naples are 41° north and 23° north.

Figure 1 is an objective profile; we use this term because the test cities are ordered by their actual latitudes (and hence the curve connecting the cities' actual latitudes decreases monotonically from left to right in each half of the figure). Objective location profiles can be suggestive. In the present case, two things are clear: First, the rough correspondence between actual latitudes and estimated latitudes indicates that participants had some knowledge of the relative locations of the test cities in both hemispheres. Second, for most cities, the estimated latitude fell below the actual latitude. This indicates

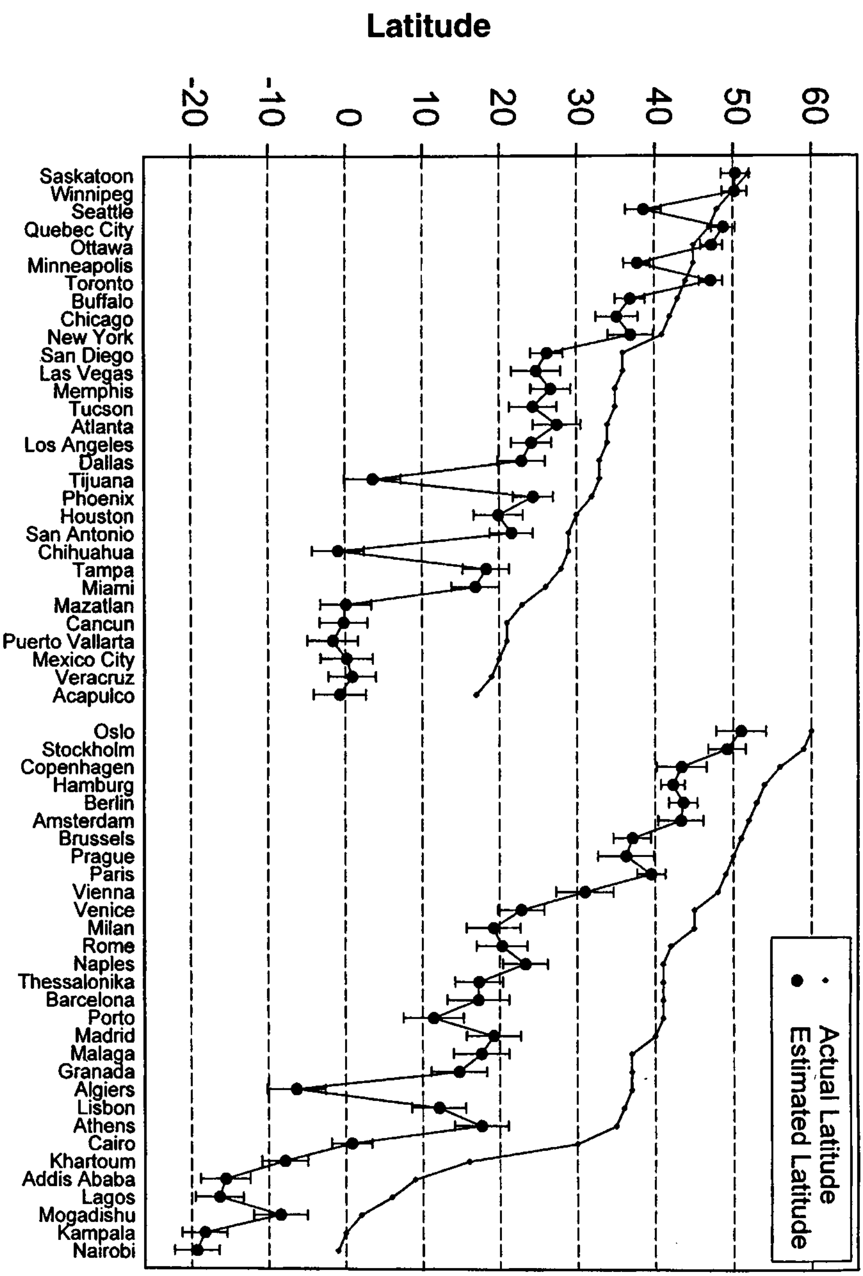

Figure 1. Objective latitude location profile for New World cities and Old World Cities (right panel). Data are ordered by the actual latitudes of the test cities.

that these Canadian subjects tended to believe that most test cities lie south of their actual locations. Consistent with these observations, the mean correlation between estimated and actual latitude was .83 for the 30 New World Cities, and the mean signed error was -11°; comparable figures for the Old World cities were .76 and -19°.

Figure 1 data are re-presented in Figure 2. In this subjective profile, cities are sorted by the latitude estimated by the subjects rather than actual latitude. Here, for each hemisphere, the test city that yielded the most northerly mean estimate is listed furthest to the left, and the one that yielded the most southerly mean estimate is listed furthest to the right. Like the objective profile, the tendency for estimated latitudes to fall below actual latitudes indicates that these subjects were biased to locate most cities south of their actual locations. More importantly, the sharp discontinuities apparent in these estimate curves (but not those in Figure 1) can be interpreted as boundaries between psychologically distinct regions and subregions. As a result, subjective location profiles can be used to identify subjective regions empirically, to determine whether these subjective regions are located correctly, and to infer the existence and the nature of between-region relations both within and between hemispheres.

More concretely, we interpret Figure 2 as follows. First, for our subjects, North America was composed of four correctly ordered regions: Canada, the Northern United States, the Southern United States, and Mexico. Second, these participants divided Europe into a Mediterranean region and a north-central region, and they drew a clear distinction between Europe and Africa. Third, there was a tendency to place warm regions (the southern US, Mexico, Mediterranean Europe, and Africa) far to the south of their actual locations. Fourth, there appeared to be a between-hemisphere correspondence between regions, with Canada and the northern United States aligning with north-central Europe, the southern US aligning with Mediterranean Europe, and Mexico with the Mediterranean Ocean. The general division of hemispheres into regions and subregions and the alignment of regions across hemisphere have been replicated a number of times (Friedman & Brown, 1999 in press a, in press b). In addition, we have been able to use a bearing judgment task and variety seeding manipulations to obtain converging evidence for these claims (Friedman, Brown, and McGaffey 1999).

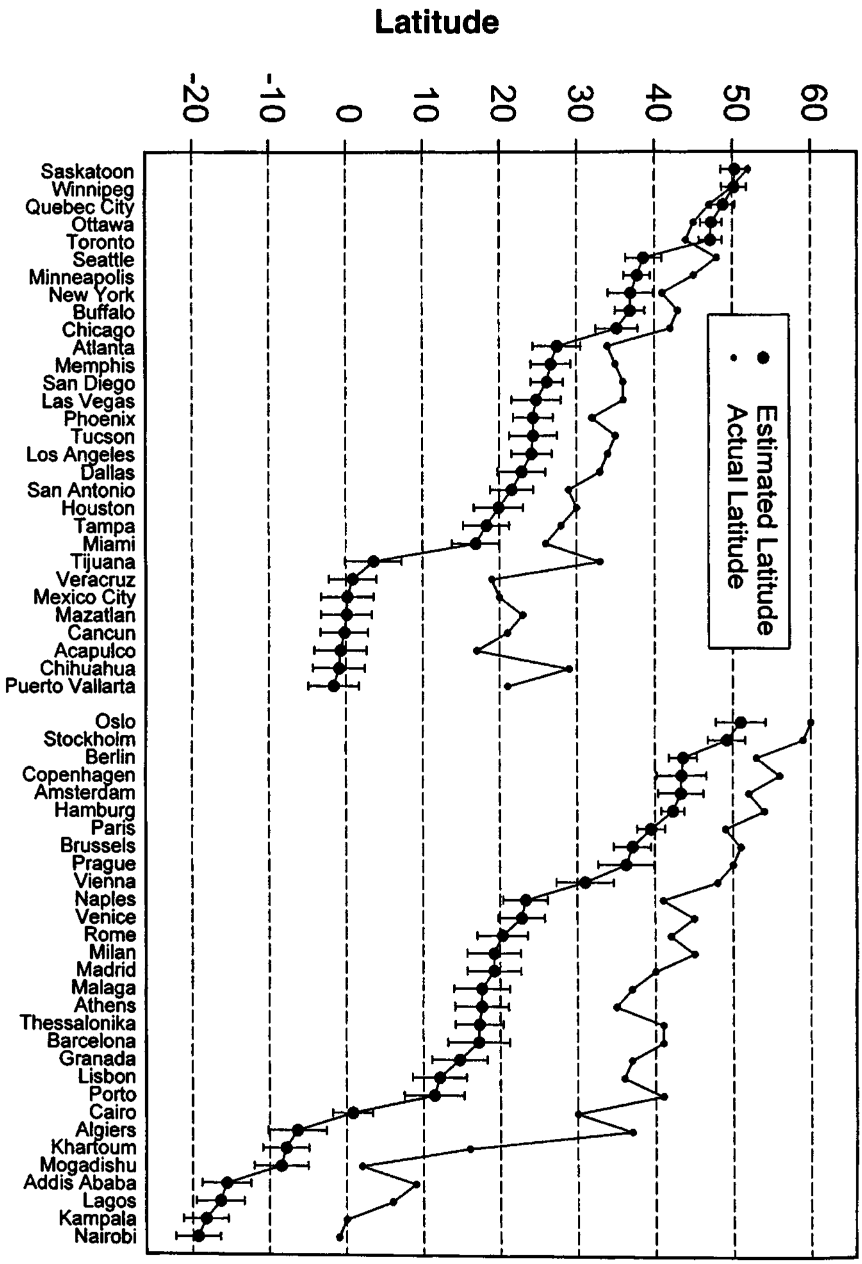

Figure 2. Subjective latitude location profile for New World cities and Old World cities. Data are ordered by the estimated latitudes of the test cities.

SEEDING LOCATION JUDGEMENTS

We have demonstrated how a location estimation task can be used to create location profiles, and how these profiles can be use to investigate subjective geography. The current research program also has demonstrated that exposure to seed facts can improve estimation accuracy, sometimes quite dramatically, and that the seeding method can also be used to probe the organization of geographical knowledge.

In this section, we present some data from a longitude estimation experiment to illustrate both points (for a complete description, see Friedman & Brown 1999 in press a, Experiment 3). In this experiment, 60 participants were first informed that the longitude scale begins at 0° in Greenwich, England, that it increases to 180° west, and that the dateline runs through the western Aleutians. Next, they were presented with the names of 13 North American cities and 15 South American cities, and were required to provide a longitude estimate for each. Following this initial estimation task, participants learned the actual longitude of one South American city, either Lima, Peru (77° west) or Rio de Janeiro, Brazil (43° west). Then, after learning one of these seed facts, participants provided a second set of longitude estimates for all test cities.

Figures 3 and 4 are the objective location profiles derived from these longitude estimates. In these figures, longitude is listed on the abscissa and the test city names along the ordinate; North American cities appear in the top panel and South American cities in the bottom panel. Within each continent, cities are ordered according to their actual longitudes, with the most westerly city appearing at the top of the panel and most easterly city appearing at the bottom. As in the prior figures, the small markers indicate a city's actual longitude and the large markers its mean estimated longitude.

The pre-seeding estimates, averaged over the 60 subjects (and excluding the seed cities) are the focus of Figure 3. As this figure suggests, these participants tended to locate all test cities to the west of their actual locations, though South American cities produced more biased estimates (mean signed error = 40°) than the North American cities (mean signed error = 23°). It is also clear from this figure that participants had a better sense of the relative locations of the North

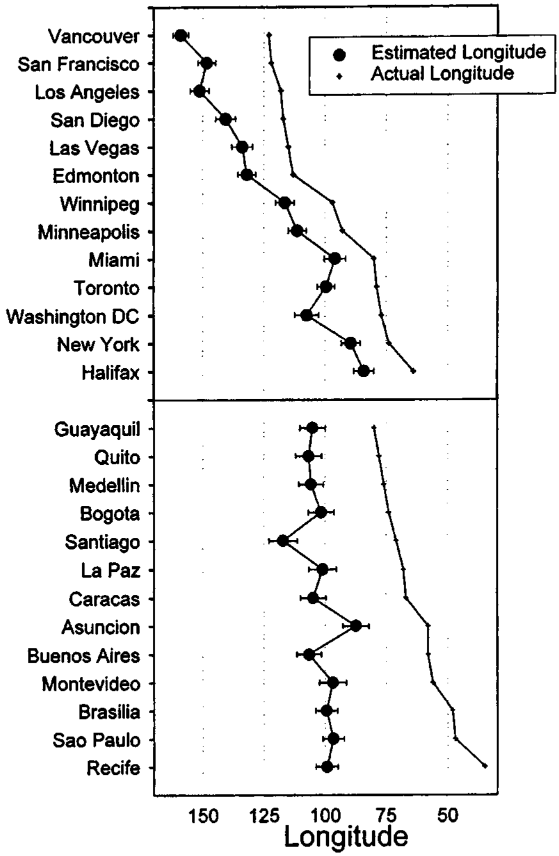

Figure 3. Objective longitude profile for North American cities and South American cities. Data are ordered by the actual longitude of the test cities.

American cities than the South American cities; the mean correlation between estimated and actual longitude was .85 for the former and .25 for the latter. Finally, it is interesting to note that that South American cities line up with the cities on the eastern seaboard of the United States. This suggests that at least these subjects mistakenly believed that South America lies due south of the eastern United States, though actually there is little horizontal overlap between the two continents (cf. Tversky, 1981).

In Figure 4 the post-seeding estimates from both the Lima group and the Rio group are presented along with the pre-seeding estimates and the actual longitudes. It is clear from this figure that even a single seed fact can have a large effect on subsequent estimates, and that

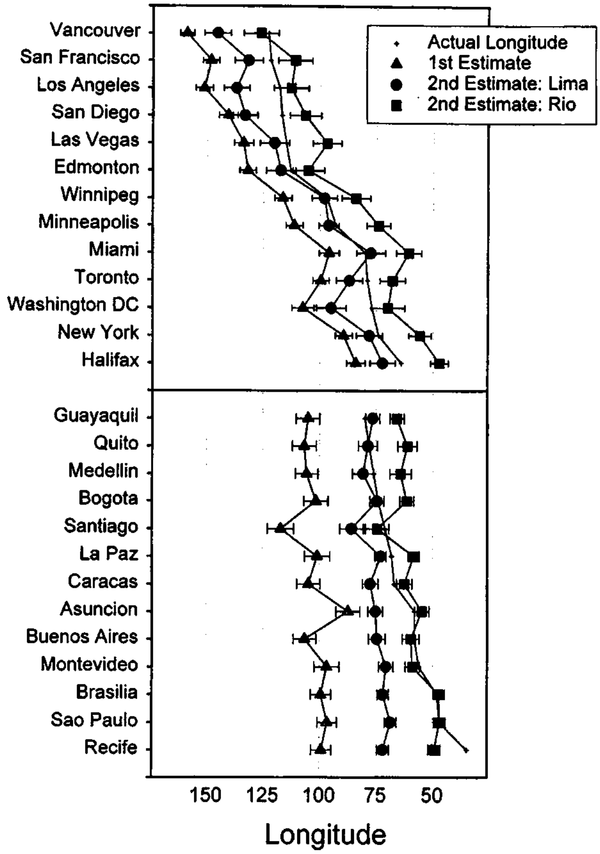

Figure 4. Objective longitude profile for North American cities and South American cities presenting actual longitudes, mean pre-seeding estimates, mean post-seeding estimates obtained from the Lima group and the Rio group. Data are ordered by the actual longitude of the test cities.

these effects can propagate from the seeded region (i.e. South America) to an adjacent, unseeded region (i.e., North America). In this case, the post-seeding estimates for both the South American cities and the North American cities tended to be significantly less biased (as measured by signed error) and more accurate (as measured by absolute error) then pre-seeding estimates (see Table 1).

As noted above, the initial longitude estimates suggested that this set of participants behaved as if they believed that South America were located due south of the east coast of North America. The data presented in Figure 4 indicate that this belief, in conjunction with the

	Pre-Seeding Absolute Error (SE)	Post-Seeding Absolute Error (SE)
Lima Seed Fact		
North America[c*]	33.68° (2.18)	28.21°(2.26)
South America[a]	49.64° (3.63)	19.07°(1.54)
Rio Seed Fact		
North America[n.s.]	31.20°(2.17)	31.78°(2.20)
South America[a]	48.84°(4.00)	18.60°(1.73)
	Pre-Seeding Signed Error (SE)	**Post-Seeding Signed Error (SE)**
Lima Seed Fact		
North America[b]	24.88°(3.99)	9.00°(4.42)
South America[a]	38.18°(6.19)	12.57°(2.33)
Rio Seed Fact		
North America[a]	20.85°(3.83)	-11.81°(5.90)
South America[a]	40.57°(5.72)	-4.00°(3.13)

Note *: All significance levels derived from paired t-tests ($df = 29$).
Note a: $p < .001$
Note b: $p < .01$
Note c: $p < .05$

Table 1. Mean pre-seeding and post-seeding absolute error and signed error as a function of region and seed fact.

South American seed fact, played an important role in determining the post-seeding estimates for the North American cities. More concretely, it appears that exposure to the South American seed fact compelled participants to recognize that South America was further east than they had assumed, and provided specific numerical information that was used to correct mistaken assumptions about South America's location. Then, in order to maintain an aligned representation of the Americas, participants had to shift the Atlantic coast of North America to east. As these claims imply, the set of post-seeding estimates was aligned in the much the same way as the pre-seeding estimates, with the post-seeding estimates provided by the Rio group falling furthest to the east and the pre-seeding estimates falling furthest to the west.

In addition to the present study, we have conducted a number of experiments designed to determine whether seeding effects can be obtained with longitudes as well as latitudes, and to ascertain when and how seeding effects propagate from a seeded region to physically adjacent and/or conceptually related ones. An exhaustive review of this work is beyond the scope of this article. Nonetheless, we should note that these studies have demonstrated that seed facts can improve the accuracy of latitude judgements, that seeding effects propagate to unseeded regions only when changes are required to maintain a coherent set of geographical beliefs, and that seeding per se does not guarantee improved performance – depending on the particular seed facts, post-seeding estimates can be more accurate than, less accurate than, or identical to pre-seeding estimates (Friedman & Brown, 1999a, 1999b).

CONCLUSION

In this article, we have presented some highlights from our on-going study of subjective geography. The work completed to date has demonstrated that it is possible to use absolute location judgements, location profiles, and seeding effects to investigate the nature and accuracy of peoples' geographical knowledge. This work has also established that exposure to a small number of carefully chosen seed facts can produce a marked improvement in estimation accuracy (Friedman & Brown, 1999 in press a, in press b). Admittedly, the selection of a good set of seed facts is, at present, as much an art as a science. Moreover, long-term effects of the geographical seeding have not been assessed (but see Brown & Siegler, 1996), and there are as yet no demonstrations that teaching seed facts facilitates school learning. Clearly, additional research will be required to establish guidelines that will take the guesswork out of creating an optimal set of seed facts, to demonstrate that seeding effects are long lived, and to determine whether these effects can be produced in children as well as adults. Although much work remains, we believe that these issues are both interesting and tractable. Thus, we are optimistic that the seeding approach may one day play a useful role in the geography classroom.

REFERENCES

Brown, N.R. & Siegler, R.S. 1993. Metrics and mappings: A framework for understanding real-world quantitative estimation. *Psychological Review* 100:511-534.

Brown, N. R., & Siegler, R. S. 1996. Long-term benefits of seeding the knowledge-base. *Psychonomic Bulletin & Review* 3:385-388.

Friedman, A., & Brown, N. R. In press a. Reasoning about geography. *Journal of Experimental Psychology: General.*

Friedman, A., & Brown, N. R. In press b. Updating geographical knowledge: Principles of coherence and inertia. *Journal of Experimental Psychology: Learning, Memory, and Cognition.*

Friedman, A., Brown, N., & McGarrey, A. 1999. A basis for basis in geogrpahical judgments. Submitted for publication.

Glicksohn, J. 1994. Rotation, orientation, and cognitive mapping. *American Journal of Psychology* 107:39-51.

Hirtle, S.C., & Jonides, J. 1985. Evidence of hierarchies in cognitive maps. *Memory & Cognition* 13:208-217.

Holyoak, K.J., & Mah, W.A. 1982. Cognitive reference points in judgements of symbolic magnitude. *Cognitive Psychology* 14:328-352.

Lloyd, R. 1989. Cognitive maps: Encoding and decoding information. *Annals of the Association of American Geographers* 79:101-124.

Kerst, S. M., & Howard, J. H., Jr. 1978. Memory psychophysics for visual area and length. *Memory & Cognition* 6:327-335.

Maki, R. H. 1981. Categorization and distance effects with spatial linear orders. *Journal of Experimental Psychology: Human Learning and Memory* 7:15-32.

Montello, Daniel R. 1989. Route information and travel time as bases for the perception and cognition of environmental distance. *Dissertation Abstracts International*, Vol. 50(1-B):336-337.

Saarinen, T.F. 1988. Centering of mental maps of the world. *National Geographic Research* 4:112-127.

Tversky, B. 1981. Distortions in memory for maps. *Cognitive Psychology* 13:407-433.

Norman R. Brown *is an Associate Professor, Department of Psychology, University of Alberta. He is trained as a cognitive psychologist. He was educated at the University of Chicago (B.A. in Linguistics, 1977; PhD in Behavioral Science, 1985). Prior to joining the Alberta faculty in 1992, Brown put in time as a Research Staff Member at IBM's Watson Research Center and spent three years as a post-doctoral fellow at Carnegie-Mellon University. Two general issues have been and continue to be central to Brown's research program: First, he is interested in how people acquire, represent, organize, and use real-world knowledge; second, he is interested in understanding how people generate numerical estimates.*

Alinda Friedman *received her PhD in Experimental Psychology from the University of Colorado, Boulder, in 1977, and has been a Professor in the Department of Psychology at the University of Alberta, Edmonton, since 1979. She is currently the Associate Chair for Graduate Studies. In addition to her research interests in geographical representation, reasoning, and decision-making, she conducts research on the factors that affect recognition, categorization, and memory of objects in 2-D and 3-D (virtual reality) contexts.*

Cross-Cultural Research in Geographic Education: Some Challenges and Realities

Rod Gerber

Geographic educators around the world are becoming increasingly interested in research work on similar topics that are being conducted in similar and contrasting settings around the world, e.g. in topics such as learning mapping skills, students' understanding of the world and environmental values. Of concern is the extent to which these comparisons are reasonable, considering the different contexts in which they occur. It is, therefore, important for geographic educators to appreciate the nature, challenges and benefits of cross-cultural research in geographic education. Key challenges such as language, methodology, stakeholders' values, the situation/context, cross-cultural versus cross-national research and extent of generalization of results need to be considered. In addition, the benefits of cross-cultural research in geographic education, including internationalization of outcomes, generalizability, collaboration amongst researchers, and improved curricular development are worth noting.

Keywords: *geographic education, cross-cultural research, research methodology*

I begin by reflecting on the following set of research studies which geographic educators have considered over the past decade in different parts of the world.

Study 1: An investigation in fifteen different countries of children's experience of place. A class of eleven year old students in each country completed a common written survey on how they felt about, used personally, appreciated, and knew about places in their own lifeworlds.

Study 2: A comparison of how the Indigenous people and succesive other human occupants interacted with a particular area over time. A research team combed the regional archives to unearth information about the use and modification of the area by these different groups over different time periods.

Study 3: Understanding the geopolitical reasons for interracial conflict in a country as portrayed in the media. The students and teachers in a geography classroom make a detailed observational analysis of print and visual media to ascertain the reasons for ongoing conflict between two cultural groups. The class searches for evidence of the conflict, underlying causes and examples of the impact of this conflict on human attitudes.

Study 4: An investigation of community involvement in solving a local environmental problem. A group of high school students interview local people from different social and cultural groups to find out their involvement in the recent community action over deciding where to locate a large shopping complex.

Study 5: A global investigation of demographic trends. A demo graphic Geographic Information System is used by a team of university undergraduates to investigate differ ent demographic trends by country, e.g. birth rate, life expectancy, and family size, to determine any evidence of relationships between national cultural groups and these different indicators.

Which of these investigations may be termed cross-cultural studies? If they can be so classified, then what are the challenges and benefits for geographic education from completing these studies? These, and other questions, will be addressed in this paper in order to illuminate the debate on cross-cultural research as it applies to geographic education.

WHY CULTURAL STUDIES IN GEOGRAPHIC EDUCATION?

Geographic education researchers have held a fascination for studies about people, cultural aspects and their environments for at least thirty years. For example, in the 1970s, Carnie (1972) investigated children's attitudes toward other nationalities and Boden (1977) analysed the promotion of international understanding through school textbooks. In the 1980s, Haubrich (1987) gathered data from children in twenty-eight countries on how they see their country, and Williams, Biilmann, Hahn and van Westrhenen (1984) reported on a cross-national study of children's attitudes. In the 1990s, Kent (1992) investigated images of people, environment and life, while Yangopoulos (1997) reported on students' understanding of the relationships between environment and development issues.

They have done so because of the emphasis that curricular and education policy documents have made on international and multicultural education through geographic education. For example, the International Charter on Geographical Education (IGU.CGE, 1992:6-7) emphasizes the role of geographic education to promote:

> ...understanding, tolerance and friendship amongst all nations, racial and religious groups and further[s] the activities of the United Nations for the maintenance of peace by actively encouraging:

a. an international dimension and a global perspective in the education of people at all levels:
b. understanding and respect for all peoples, their cultures, civilizations, values and ways of life; including domestic ethnic cultures and cultures of other nations;
c. awareness of the increasing global interdependence of peoples and nations;
d. ability to communicate with others;
e. awareness not only of the rights but also the duties incumbent upon individuals, social groups and nations towards each other;
f. understanding of the necessity for international solidarity and co-operation;
g. readiness on the part of the individual to participate in solving the problems of their communities, their countries and the world at large.

I suggest that the five studies mentioned in the introduction can each relate to at least one of the seven aspects mentioned in the International Charter. For example, Study 1 relates to (a) in the Charter; Study 2 relates to (b); Study 3 relates to (e); Study 4 relates to (g); and Study 5 relates to (c). While these studies highlight different approaches and types of cultural studies that geographic educators can undertake, they also raise a range of research issues that must be considered when making cultural studies. For example, in Study 1, how can the students be sure that the questions in their survey will be interpreted similarly by the children in each of the fifteen countries? In Study 3, how can the researchers be assured that the data that they are using are free from bias? In Study 4, if a range of students conduct their own interviews of local people, how do they know that the interviews have been conducted consistently? These, and other research questions, can be answered by reflecting on the nature of cross-cultural research, its challenges and benefits, and how it may be used to improve geographic education.

THE NATURE OF CROSS-CULTURAL RESEARCH

What constitutes cross-cultural research? Is it research that compares some phenomenon, e.g. the concept of environment, across two or more cultural groups? Is it a meta-analysis of the cultural attributes held by people in countries around the world? Is it research based on data obtained from different social groups in an area? Is it a cultural study done in one place and replicated in different and similar places around the world? Or is it research that is conducted in one or more places by an international team of researchers who come from different cultures?

These questions focus on the nature of the study and the backgrounds of the researchers. Table 1 introduces a sketch of the orientation type and scale of cross-cultural studies that geographic education researchers may consider. Under the heading of the orientation of the study, it is possible to think of :

1. Cross-cultural studies that search for the understanding of a phenomenon by different cultural groups in areas of differing scales;
2. Cross-national studies in which selected social and environ mental criteria are analyzed at a national level, e.g. Environmental awareness, landscape appreciation, and development edu-

cation;
3. Intra-regional/national studies that focus on human occupancy trends and activities;
4. Community-based studies in which a magnifying glass is placed on the human behaviors of cultural groups within a specific community; and
5. Socio-cultural studies that consider how the collectively available resources in a society for thinking and manipulating reality are shared by its people (Saljo, 1992:48). The choice of the specific study depends on the purpose of the research, but it also depends on the type of study that is being implemented.

Four types of cross-cultural studies are promoted: single cross-cultural studies which may consist of any of the above orientations; replications of a study in different social contexts within a country or in different countries; comparative studies of a single cultural group in different countries or regions or the direct comparison of different cultural groups in a region or across regions; and a meta-analysis of various cultural group in different countries.

The scale of cross-cultural investigation for geographic educators extends on a continuum from local studies through regional and international studies to global investigations. Choosing the scale for the study is influenced by the purpose of the investigation. For example, the investigation of the impact of Chinese people around the world on social and economic life is most meaningful if it is conducted on an international or global scale because different groups of Chinese people have settled in most parts of the world. However, a study of Inuit will be confined to Canada because this is where they live.

Cross-cultural studies may, therefore, consist of a mix of orientation, type and scale of study. These variations are detailed in Table 1 below.

We must, however, remember that cultural studies focus on the human-made part of the environment and they involve both objective elements, such as tools, settlements and artifacts, and subjective elements, e.g. norms, roles, and values. In addition, the different elements are linked together, and collectively they describe its function i.e. How the members of the group operate as a unit (Triandis,

Orientation of the Study	Type of Study	Scale of Study
1. Cross-cultural study 2 Cross-national study 3. Intra-Regional study 4. National/International study 5. Community study 6. Socio-cultural study	A. Single Study B. Replication of a study C. Comparative study D. Meta-Analysis	I. Local scale II. Regional Scale III. International scale IV. Global scale

Table 1. Orientation, types and acale of cross-cultural research studies.

1983:82). By extension, therefore, cross-cultural geographic research studies derive their meaning from considering these elements, structure, and function as they occur within different spaces across different cultural groups.

CHALLENGES FOR DOING CROSS-CULTURAL RESEARCH IN GEOGRAPHIC EDUCATION

Doing cross-cultural research in geographic education is a carefully planned and sensitive experience that brings with it a range of challenges for the researchers that must be taken seriously for the investigation to be successful. These challenges may be divided into two groups: (a) situational, and (b) methodological. Appreciating and addressing these challenges are essential for success in the research enterprise.

Situational Challenges

Situational challenges in cross-cultural research are those aspects that relate to the people being investigated and the context in which the research is conducted, including: the use of language, and stakeholders' values.

Collectively, they may be a direct part of the research, i.e. the language used by the researcher in an interview, or they may influence the research in an indirect way, i.e. the language spoken by the subjects in a study. Alternatively, these challenges may remain as insidious influences on both what the research yields by way of results and how the research is conducted. Either way, they offer an impact on the cross-cultural research conducted.

The challenge of research **context** for geographic educators is a direct outcome of the earlier work by ethnographers, e.g. Fetterman (1989), and more recent socio-cultural researchers, e.g. Lave (1988) and Rogoff (1990). Research enterprise is treated as a holistic experience in which the context or situation that the research takes place is as important as the research questions and analyses of the study because the context is immersed in cultural aspects, e.g. a valuing of the willingness or otherwise to share information, the willingness of adolescent boys and girls to talk freely to a "research" stranger. It may be argued that research that ignores the context in which it occurs ignores the bases for certain types of response and may not maximize the research question(s) in the study. Understanding the different cultural contexts for studies on children's learning about their environment could yield very differing results if they were located in Central Africa, Tibet or in the Australian desert. Some would argue that the context actually mediates the research experience and offers interesting cultural insights (e.g. Saljo, 1992). An example of the role of context on a geographic education study is exemplified by current research carried out by Lash (1999), who is investigating the influence of Egyptian culture on the American-model university in Cairo, Egypt.

The use of **language** can be an important side influence in cross-cultural research for different cultures. Tzeng (1983: 224) states that "Cultures differ in a variety of ways, ranging from inhabitant surroundings, and life styles to language usage". He draws our attention to a range of cross-cultural common semantic features as characterized by linguistic usage and context and suggests that an examination of them in different cultures yields considerable variations in the understandings of health concepts, colors and interpersonal relationships. If this approach was used for environments and places, it is reasonable to suggest that language would reveal another set of culturally-based variations. If this discussion is applied to a study of learning graphics in different cultural contexts, then the power of language can be addressed in two ways - using language to elicit responses and using language in making responses to data or research stimuli.

One example of these linguistic challenges is the study of Australian and Swedish adolescentsí experience of graphics based on quantitative information (Gerber, Ottosson, Boulton-Lewis, Bruce and Aberg-Bengtsson, 1993). Adolescents worked with seven different graphics-maps, graphs and charts ñ of an imaginary region ñ the GRAK world. The researchers reported the following linguistic challenges that were experienced by the children.

1. Names of the countries in the GRAK world.

Swedish children did not feel that the country names including Daseland, Agrian and Bovenesia were strange, although they had trouble pronouncing these names. The Australian children experienced difficulty both with the names and their pronunciation. They preferred to code the countries A, B, C, D and E. Occasionally, children from both countries used the name to interpret the material, e.g. Daseland sounded like a desert area.

2. Difficulties with words used on the graphics.

Difficulties here were more associated with the age of the children rather than their cultural background. These difficulties included being able to read some works that appeared in titles, subtitles and legends, as well as being able to assign appropriate meaning to the words once read. For example, some Australian children had difficulty reading "population" and "agricultural", whilst one Swedish child read the word "value" ("varde" in Swedish) as "weather" ("vader" in Swedish). Their understanding of the meaning of these words was similarly problematic for some of the younger children. However, some of the older Australian children had trouble with the terms "GNP per capita" and "services."

When these linguistic challenges are linked to the children's knowledge base and varying understandings of the world around them, the children from both cultures experienced heightened challenge. In the end, the researchers concluded that there were more similarities between the two groups from differing cultures then dissimilarities.

The final situational challenge, **stakeholders' values**, certainly adds to the two challenges mentioned earlier. The stakeholders in a geographic education research study, as for most other empirical studies, consist of the researchers and the participants in the study. The values of researchers may vary depending on the cultural composition of the team. One might assume that research is research no matter where it is conducted. My suspicion is that it may not be the case across different cultural groups because of varying dominant research paradigms in particular cultures. The preference for deductive, positivistic paradigms over inductive and constructive research paradigms is evident in the competitive research grant schemes in some countries, e.g. in Australia, whereas a balance between positivistic and constructivist research is accepted in Scandinavian countries. There is considerable potential for tension amongst international research teams whose members come from cultures that prefer particular research paradigms.

Those researchers who promote a socio-cultural approach for investigations treat the research experience as an all-embracing activity that considers very carefully the values of the participants in the study. For example, geographic educators could expect quite differing responses in a study on perceptions of urban environments from children in a country that imposed heavy fines for littering, to one where a cultural group littered widely because they were used to all waste being biodegradable, to one that promoted the recycling of waste products. In such cultural variations it is worthy of the researchers to establish what environmental values are exhibited by the participants in the study and to relate these values to the results of the different cultural groups.

Hopefully, these three situational challenges offer a flavor of the sorts of variables that researchers should consider when designing cross-cultural studies. Such underpinning aspects are usually not the focus of the research enterprise, but they certainly can provide interest in the results from a cross-cultural perspective.

Methodological Challenges

Methodological challenges in cross-cultural research for geographic educators to consider include the following: epistemological issues, methodology of the research study, design issues and the extent of generalization.

Taking **epistemological** issues first of all, geographic educators should accept the point expressed by Starr and Wilson (1980) that "the conclusions reached by cross-cultural analysis are heavily dependent upon both the confidence that can be placed in the gathering of the data and the inferences made from such original data" (p. 146). They go on to say that this process can be considered as "the sifting of data through a series of classificatory filters to the point where generalizations remain" (p. 146).

By focusing on the phases in the research process, through data collection, data retrieval and analysis, these epistemological issues are elucidated. In the data collection phase, the status of the investigator in his/her own society and in the research setting are important. For example, a geographer from a Western country who investigates children's environmental values in several developing countries may be viewed as a threat by the participants, thus yielding incomplete or inaccurate data from the local children. Similarly, the choice of data-gathering techniques could present an intercultural challenge, e.g. the use of interviews may yield partially useful data because the children are not used to talking about issues that affect them personally. Another challenge for the data retrieval phase occurs when geographic educators involved in international cross-cultural studies do not collect all of their data themselves, e.g. it is collected by colleagues in another country. How can they be sure that there is comparability in the data gathered? Will the analyses show data from all cultural contexts in a similar light, especially if translations of the dataset are required? Similarly, if there are variations in coding data across different cultural groups then cross-cultural comparisons are a difficulty. In the analysis phase, the challenge for the geographic education researcher is to explain the results from different cultural groups. How have the different contexts influenced how the children's environmental values are exhibited? How will the researcher's biases and values influence his/her explanations of the findings?

Study methodology issues do impinge on the success of cross-cultural research in geographic education. Starr and Wilson

(1980: 148-150) identify the following issues for consideration: data quality control, multilingual comparisons, the role of the researcher, and coding construction. The concept of data quality control was developed by Naroll (1962) to account for the differing conditions under which data are collected in different cultural settings. He suggests the following tests to promote data quality control in cross-cultural studies:

1. Collection of specific case reports by the researcher.
2. Use of participant observation and personal participation in a cultural group as a key source of data.
3. The duration of time spent working with the cultural groups to conduct the research.
4. Familiarity by the researcher with the language(s) spoken by the participants in the study.
5. The role of the researcher amongst the group being studied.
6. The explicitness and generality of the report from the research (Naroll, 1962: 14-15)

This leads neatly into the consideration of different methods for making multilingual comparisons. Theorists such as Brislin et al. (1973) have drawn our attention to approaches such as back-translation (i.e. translating a passage from and back into a language), the search for response discrepancies amongst translators for particular data, and multiple translations of a single piece of data. In all of this translatory challenge, the translation must be both readable and meaningful. Therefore, geographic educators need to be sure that specific concepts, e.g. cliff, city, delta and transport network, can be translated across the languages that are used when researching adolescents' understanding of geographic concepts across various cultural groups. If not, then they will have difficulty in making cross-cultural comparisons.

Geographic education researchers who are operating with people in different cultural settings may allow their disciplinary bias, their values, and the nature of their relationship with the participants influence the results of their investigations. To reduce any such bias, it would be wise to collaborate with other researchers from different cultural backgrounds when conducting cross-cultural investigations. These collaborators can offer variety in data collection techniques and a check on the accuracy of the observations made by the research team. Personal biases by researchers can be exposed and more than one data-gathering technique can be used to cross-check the participants' responses. It may mean that the main researcher allows local collaborators to collect the data and he/she keeps at arm's length from the process until the analysis phase.

The challenge of how to introduce concepts into research in different cultural groups has to be faced by all geographic educators who engage in international research. Starr and Wilson(1980; 150) propose that one effective way to deal with this challenge is to use a series of categories rather than a researcher's judgement of the presence or absence of a particular form of behavior, e.g. in judging adolescents' wayfinding abilities. It could be better to have each participant draw a map of a route, actually complete the wayfinding task, and to describe the route verbally. Then, a more comprehensive judgement can be made of the adolescents' wayfinding ability. The process would also be assisted if the analysts interpreting these data had some previous experience (real or simulated) in making judgements on similar data.

DESIGN ISSUES

Geographic education researchers should encounter a variety of design issues when they are formulating their cross-cultural studies. These have been summarized by Triandis (1983: 28) as follows:

1. The appropriateness of the method to the culture and to the complexity of the research problem.
2. The accuracy of the research procedures used and issues of validity .
3. The replicability of the results across time, persons and measures.
4. The extent of contextual depth affordably the research instrument.
5. Sampling issues.

6. Ethical acceptability of the purpose, methods and proce dures used in the research, and the relationships amongst the research team.

Responding to these six issues usually results in some form of compromise in the selection of research methods. For example, there is little evidence available on which methods are best for researching in different cultures. However, data-gathering using interviews often works better in Western cultures, whilst data gathering using drawing works well in some Asian cultures who have complex written language systems. Contextual depth varies in experimental studies, which do not focus heavily on the research context to experiential qualitative studies that consider the context centrally in the research investigation. Sampling issues are central in experimental studies, but they are minimized in holistic qualitative studies. The replicability of results from the research investigation is important in positivistic, deductive studies, whereas it is much less important in situated investigations. There is no easy answer for geographic educators in this regard. Ostensibly, in cross-cultural investigations, these design challenges are addressed on a case-by-case situation. The importance of accepted principles relating to a research paradigm become important as the particular research study is conceptualized, designed and implemented in the different cultural settings.

What then is the extent of **generalization** in cross-cultural research? This question may be answered by focusing on dualistic and non-dualistic approaches to research. Using a dualistic approach, cross-cultural researchers concentrate on the systematic relationships in human behavior without considering the context of which the behavior occurs, e.g. studies in children's learning of environmental concepts. Generalizations are explained as:

1. Regularities and variations in behavior in different social contexts.
2. The testing of hypotheses about the relationships be tween these elements.
3. Explanations of the conditions in which particular configurations of elements are likely to occur (Starr and Wilson, 1980: 148).

In non-dualistic or holistic studies, the focus is on relationships that develop in a specific context when cultural groups behave in some way, e.g. the conceptions that adolescents have of globalization. While extremists would claim that every context is unique and hence no generalization is possible, a more realistic approach is to acknowledge the distinctiveness of the context and to seek out patterns across the various individual studies using triangulatory procedures. Such studies complement particular individual case studies.

Taken together, these challenges act as beacons to warn unwary geographic education researchers that there are pitfalls in cross-cultural research that must be taken seriously. Careful consideration of the context for the research, the language used in different contexts, the underlying values held by the researchers, together with epistemological and methodological issues all should be addressed for each cross-cultural study. If not, some potentially powerful studies will lose their impact and worth to the wider geographic education and research communities. However, there are benefits from doing cross-cultural research in geographic education that also need to be considered and valued. These are reasons why cross-cultural research in geographic education should be valued.

BENEFITS OF DOING CROSS-CULTURAL RESEARCH IN GEOGRAPHIC EDUCATION

For geographic educators, the benefits of cross-cultural research may be methodological, pedagogic and/or personal. An elaboration of these types of benefits follows.

Methodological Benefits

Methodological benefits from doing cross-cultural research in geographic education are derived basically from Brislin, Lonner and Thorndike (1973: 6-7) as follows:

1. A culture in which people live can be considered an experimental treatment. Using positivistic research approaches, the key elements of the culture in which a study is conducted may be treated as variables in an

experimental research design and their affects measured, and then related to other variables in the study. This will allow positivistic researchers to claim linkages between the context and the other variables being measured, e.g. the relationships between cultural elements and stu dents' performance in interpreting photographs.

2. The differential occurrence of a particular behavior or trait can be documented from culture . If an international investigation of fieldwork was conducted in countries such as Mexico, Finland, Ghana, Singapore and New Zealand, and different secondary schools were chosen in each of these countries, it is most likely that a cross-cultural study will result even if similar questions were asked in each school setting. The actual studies may be treated as separate cases of the central project aims and a search can be conducted through triangula tion of the common aspects of fieldwork across these countries. If the study of fieldwork was conducted through a survey of teachers in these different settings, cross-cultural variations can be achieved by completing comparisons across the data by cultural group.
3. Cross-cultural studies can indicate behavior patterns not present in the researcher's own country. A study of environmental conservation in different countries may produce variations in students' behaviors in practicing conservation in their local environment. If the results of these studies are compared to the results in the researcher's home country, they may offer alternatives for action that geographic educators may wish to use. Alternatively, these variations may cause the local students to reflect more powerfully on their behaviors and possibly to adjust them in their use of their environ ment.
4. The cross-cultural researcher can test hypotheses with existing sets of data. Providing there has been a consis tency in the collection of the data, it is possible for the researcher to analyze different cultural variables in the data across the different cultural groups to establish

linkages. The resulting analyses may be used to test particular hypotheses. For example, in the investigation of the regular use of their local environment by boys and girls in different cultures, a hypothesis may be tested that boys make wider personal use of their local environ ment than girls.

5. An *etic* approach to understanding cross-cultural studies is preferable. This approach studies behavior from outside of the system; examines and compares cultures; creates the structure of the structure by the analyst (i.e. offers the researcher a framework for organizing the research in the particular cultural situation); and seeks universal criteria (Brislin, Lonner and Thorndike, 1973: 164). This is opposed to the *emic* methods, which focus on the concepts, stimuli and behaviors that are common in a particular cultural group. Triandis (1983: 86) argues that researchers should use *emic* methods to measure *etic* constructs.

Pedagogic Benefits

Pedagogic benefits from doing cross-cultural research in geographic education can be substantial. Studies, for example, into children's mapping abilities - to draw and interpret maps - have demonstrated various understandings and guidance for geographic educators in different countries. For example, an investigation of the use of maps and graphics in geography textbooks, school atlases and teacher education in 14 varying countries e.g. China, Germany, Brazil, Canada, India and Uganda, demonstrated extensive variations to the use of maps and graphics in geographic education, which reflected the cross-cultural variations. For example, in regard to school atlases, a form-function analysis revealed these variations. Form characteristics focused on communication factors (e.g. purpose and figure-ground relationship); technical factors (e.g. map type, color and cartographic symbols); sequence; physical attributes of the atlas; and materials to support learning. Functional characteristics investigated included: skill development within the atlas maps; the extent to which the atlas performed a gazetteer function; the treatment of thematic studies; links to users' levels of cognitive development; and users' attitudes to the maps in the atlas. Using the examples of the purposes of maps in these atlases, at the lower secondary level of schooling, in India (67%) and Brazil (64%) most of the maps represented physical features. This percentage was 43% in Uganda, 42% in Germany, 40% in Australia, but lower in Canada (22%), Nigeria(32%) and the Netherlands (33%). The decrease in physical maps was generally replaced by more focus on social, economic and demographic maps. These variations reflect the differing emphases in the school geography curricula at the lower secondary level.

When all of the characteristics mentioned above have been analyzed, pedagogic implications can be proposed in the respective countries. These were presented as a set of case studies for countries including Hong Kong, Nigeria and the Netherlands (Gerber, 1992: 101-122). In Uganda, the focus is on interpreting topographic maps; in the Netherlands, the learning focuses on map analysis, map reading/interpretation and cross-country comparisons; and in Nigeria, the focus is on developing competence in the elements of maps prior to map interpretation exercises using mainly topographic maps.

These pieces of pedagogic advice, although varying across countries, reflect the types of guidance for curricular policy makers that is being given and often used to improve geographic education in the particular country. The benefits for geography **curricula** from cross-cultural research vary depending on the orientation taken by curriculum developers. A heavily environmental and economic approach to geography in the Russian secondary school curricula does not accentuate cross-cultural differences. A systematic regional approach to world geography in American high schools does by inference and some comparison draws out cross-cultural variations. More humanistic approaches to geography curricula do allow for greater emphasis on human and cross-cultural studies. One reason why geography is losing its place in school curricula in some countries is that too much emphasis is placed on cross-cultural studies and more integrative approaches, e.g. environmental education, become favored.

Personal Benefits

The personal benefits amongst geographic education researchers that derives from international research teams working together on specific projects offers an intangible, medium to longer-term benefit. All members of the research team, through working with data from different cultures, start to appreciate the various ways in which participants from different cultures address research questions, express themselves when describing their geographic experiences and interpret similar stimuli when engaged in research tasks. They bring differing values to the research experience, as do the researchers. Astute researchers will harness these variations to improve the way in which they design different cross-cultural research studies. The lasting friendships that develop amongst collaborating teams of international researchers should not be under-estimated in the development of cross-cultural research in geographic education.

AN EXAMPLE OF CROSS-CULTURAL RESEARCH IN GEOGRAPHIC EDUCATION

A brief illustration of constructive cross-cultural research is that conducted by Blaut, Stea, Spencer and Blades (1997) into mapping as a cognitive and cultural universal. These British and American researchers conducted a series of studies with young children (3 to 5 years of age) in Iran, Mexico, South Africa, the United Kingdom and the United States of America to consider how these children interpreted a large-scale vertical aerial photograph and how they carried out a simulated navigation task on the photograph. Essentially, these studies tested the hypothesis that "pre school-age children in all cultures can read and use air photos without training, hence can, in a fundamental sense, deal with maps." They concluded that the majority of the children in all five cultures were able to complete the mapping tasks set for them, e.g. name the air photo, identify features on it, and solve a navigation game involving car travel using a photograph (Table 2).The researchers also concluded that the modest feature identification scores in Iran and Mexico occurred because the children used air photos of unfamiliar English landscapes.

What is noticeable about these results is that they focus on the key aspects of map-reading for pre-schoolers, i.e. scale and perspective, rather than the semantics of maps. Since the children from the five different cultural contexts were able to achieve at least reasonable results, the researchers concluded that the results offered strong support for the following hypothesis: "map-reading abilities are present cross-culturally in pre-schoolers in urban communities with relatively high adult literacy rates" (p. 27). They declare that these findings contradict previous ones that indicated that non-Western children exhibit slower cognitive development than Western children of similar ages. Since no one had taught these children how to read maps, the results indicate that pre-school children do possess some mapping abilities, which the researchers claim is "a human adaptation to the need, found in all cultures since prehistoric times, to understand and communicate information about the geographic environment, its resources, routes, and dangers" (p. 5).

While the generalizability of these results is tempting and encouraging, the researchers acknowledge the need to conduct a wider number of cultural studies to empower those results obtained in the first set of studies.

THE PROMOTION OF CROSS-CULTURAL RESEARCH IN GEOGRAPHIC EDUCATION

The call for improved international understanding occurs monotonously in geographic education. While different advice is provided to achieve this, e.g. study different regions of the world, learn another language, know about more and varied places around the world, using the results from cross-cultural research to inform developments in geographic education is quite a powerful approach. What follows are some suggestions about how cross-cultural research can be both promoted and promoting in geographic education.

1. Harness the results of cross-cultural research and the interests of researchers in doing such research through relevant networks and professional bodies. The International Geographic Union Commission on Geographical Education is a very good example of how both a network and a professional body can use the results of cross-cultural research to promote geographic education. This group of geographic educators from countries around the world interacts interpersonally at confer-

Study Site	Number of Children	Mean Number of Correct Features Identified	Navigation Task (% correct)
York (UK)	20	5.2	70%
Durban (RSA)	20	6.6	60%
Teheran (Iran)	30	2.1	58%
Mexico City (Mexico)	20	3.0	80%
Evanston (USA)	24	4.1	88%

Table 2. Children's performance on mapping tasks. Source: Blaut, Stea, Spencer, Blades (1997;27).

ences in which the results of research, including cross-cultural research, are shared and discussed. Direct International comparisons are made and personal reflections abound. On occasion, the results of this research can emanate as a specialized publication that has a cross-cultural focus, e.g. Geography Education in Multicultural Societies (Smit, 1998). Also, the results can be used as a basis for major policy statements, e.g. the International Charter on Geographic Education (IGU.CGU, 1992).

2. Highlight the merits of teams of geographic educators from different cultural backgrounds working collaboratively on specific research investigations. The interaction amongst the researchers in this team say a great deal about cross-cultural differences being used to work out sound investigations in their different contexts, often involving the use of different languages, values, and geographic meanings for similar concepts. The dynamics amongst such research teams may be explained in socio-cultural terms as the development of shared symbols and understandings that enable a research study to be completed successfully and with quality. Such promotion will enhance the globaliz-

ation of cross-cultural research in geographic education.

3. Encourage geographic educators, in particular countries, to use one of their classes to interact (probably electronically) with the class of another geographic educator in another country. Using an action research methodology, the educators can develop comparisons of cultural differences in the three classes: 1) variations in ways of learning geography; 2) variations in geographic terminology; and 3) differing and/or similar perceptions of the world as seen by the students. The benefits of such interaction may include: the development of a wider geographic knowledge base; an empathy for the views of the students in the other class; an appreciation of differing lifestyles and uses of the environment; and better global understanding. Reflections by the educators, together or individually, can be used to refine the approach and to make judgements about the outcomes.
4. Improve the accuracy and quality of cross-cultural materials in geography textbooks. Cross-cultural studies demonstrate how different cultural groups use their environments, understand such usage and how it compares to the usage in other countries, and what the cultural symbols are that local inhabitants perceive, know and use, as opposed to the stereotypes that are painted by textbook authors, often through cursory investigations, direct or indirect, of particular cultural groups. More comprehensive understandings of different cultural groups by textbook authors can minimize bias and present geographic studies that capture local values rather than imposed values.
5. Encourage students in geography classes to become cross-cultural "researchers" by helping them to search for specific cultural elements when undertaking investigations. Such cultural elements may include: patterns of dress, methods of economy activity, the use of particular technological innovations, patterns of social interaction, beliefs and behaviors relevant to the regulation of the place of humans in the universe (region), and behaviors

that are required in communication (language). (Triandis, 1983: 83) Through linking these cultural elements with human occupance of places, spatial interaction, and aerial distribution patterns, the students can introduce culture into geographic studies.

6. Promote a stronger human focus in studies in geography. If a human orientation rather than a physical orientation was adopted in geographic education, the adoption of a cultural focus in the study of geography would almost be assured. The human-environment interaction would then become one in which human action, behavior and occupance would be underpinned but not dominated by the physical environment. This is not to downplay the effect of the physical environment on human occupance of land areas. It does, however, give an impetus to focus on the people rather than landforms.

Collectively, these suggestions encourage a stronger people focus for geographic education in the twenty-first century. It is a focus that students will require as they interact much more powerfully with communications technologies in familiar and unfamiliar human and physical environments.

REFERENCES

Blaut, J., Stea, D., Spencer, C. and Blades, M. 1997. *Mapping as a Cognitive and Cultural Universal.* Final Report to the National Science Foundation on Grant SBR-9423865. Chicago, IL: University of Illinois.

Boden, P. 1977. *Promoting International Understanding Through School Textbooks: A case study.* Brunswick: Georg Eckert Institute for International Textbook Research.

Brislin, R., Lonner, W. and Thorndike, R. 1973. *Cross-Cultural Research Methods.* New York: Wiley.

Carnie, J. 1972. Children's Attitudes to other Nationalities. In *New Movements in the Study and Teaching of Geography,* ed., N. Graves, pp. 121-134. London: Temple Smith.

Fetterman, D. 1989. *Ethnography: Step by Step*. Newbury Park, CA: Sage.

Gerber, R. 1992. *Using Maps and Graphics in Geography Teach ing*. Brisbane: IGU Commission on Geographical Education.

Gerber, R., Ottosson, T., Boulton-Lewis, G., Bruce, C. and Aberg-Bengtsson. 1993. *Towards an Understanding of How Children Understand Graphic Representations of Quantitative Data*. Paper presented to the 5th EARLI Conference, Aix-en-Provence, France, August 31 - September 5.

Haubrich, H. 1987. *How I See My Country: Personal Views of 15-Year-Olds From 28 Countries*. Freiburg: IGUCGE/ Padagogisch Hochschule Freiburg.

International Geographic Union Commission on Geographic Education. 1992. *International Charter on Geographic Educa tion*. Brisbane: IGU.CGE.

Kent, A. 1982. *Bias in Geographical Education*. Sheffield: Geographical Association.

Lave, J. 1988. *Cognition in Practice*. Cambridge, UK: Cambridge University Press.

Lash, J. 1999. *Higher Education and Cultural Change: An American-Model University in Cairo, Egypt*. Unpublished paper.

Naroll, R. 1962, *Data Quality Control - A New Research Technique*. New York: Free Press of Glencoe.

Rogoff, B. 1990. *Apprenticeship in Thinking: Cognitive Development in Social Contexts*. New York: Oxford University Press.

Saljo, R. 1992. Human growth and the complex society: Notes on the monocultural bias of theories of learning, *Cultural Dynamics*, 5, no. 1:43-56.

Smit, M. 1998. *Geography Education in Multicultural Societies*. Stellenbosch: University Press, University of Stellenbosch.

Starr, B. and Wilson, S. 1980. Some epistemological and method ological issues in the design of cross-cultural research. In *Research in Culture Learning*, eds., M. Hamnett and R. Brislin, pp. 143-153. Hawaii: The East-West Centre.

Triandis, H. 1983. Essentials in studying cultures. In *Handbook of Inter-Cultural Training, Vol. 1*. eds., D. Landis and R. Brislin, pp. 82-117. New York: Pergamon.

Tzeng, O. 1983. The use of the atlas of affective meanings in intercultural training. In *Handbook of Inter-Cultural Training, Vol. 1*. eds., D. Landis and R. Brislin, pp. 224-252. New York: Pergamon.

Williams, M. Biilmann, O., Hahn, R. and van Westerhenen, J. 1984. A cross-national study of children's attitudes. In *Perception of People and Places through Media, Vol. 1*., ed., H. Haubrich, pp. 137-163. Freiburg: IGUCGE/Padagogische Hochschule Freiburg.

Yangopoulos, S 1997. Developing sixth form students' under standing of the relationships between environment and develop ment issues. In *Education, Environment and Economy: Reporting Research in a New Academic Grouping* (Bedford Way Papers), eds., F. Slater, D. Lambert and D. Lines, pp. 135-156. London: University of London Institute of Education.

***Rod Gerber** is currently Dean of the Faculty of Education, Health and Professional Studies at the University of New England in Armidale, Australia. He is currently Chair of the International Geographic Union's Commission of Geographical Education and a member of the Australian national committee for Geography. Rod is co-editor of the journal International Research in Geographical and Environmental Education.*

A Functional Taxonomy For Mapping In Geographic Education

Henry W. Castner

A taxonomy of map use functions, and the map types associated with each, is proposed as a tool in developing more logical sequences of classroom activities that introduce students to maps, their various uses, and to the processes of geographic thinking. Awareness of the great variety of map types and functions is needed so that students can improve their skills in creating and using the appropriate map for inventory, navigation, measurement or analysis tasks. Traditionally we categorize maps on the basis of content, scale, or user group. But this fails to illuminate the different ways we design maps so as to address a variety of spatial problems. This paper discusses criteria that can be used to create such a taxonomy and applies them to a prototype taxonomy. It identifies four genera of map use tasks or questions and more than fifty species of specific models, drawings, and map types. A number of implications for geographic education are noted.

Keywords: *taxonomy, mapping in geographic education, tasks in map use, geographic thinking.*

INTRODUCTION

When we talk about mapping in a child's world, what kinds of maps are we talking about? What kinds of maps do they need in school? At play? Adults classify maps in many traditional ways: by content (e.g., soils maps), by scale (e.g., atlas maps, city plans), or by user group (e.g., mariners or blind people). Some of these map names have generally agreed upon definitions. But the logic of these classifications and the meaning of these names may not be known to school children or their teachers (1). If we want children to use maps as tools for thinking, analysis and argument, they will need to know what map types best solve what problems and how to design them.

A taxonomy of map functions for geographic education can assist in this in a number of ways. First, the very nature of a taxonomy establishes the functional differences and similarities between the various classified members. For young mappers, the basic distinctions in a taxonomy should pertain to the kinds of problems they may wish or need to solve. Second, a function-based taxonomy can suggest to curricula designers the kinds of visual and intellectual skills children need for solving different problems and how they relate to the skills children already possess. This should provide some guidance as to what problems are easier to address and thus what questions should be the object of children's first mapping activities. From this, designers may then be able to develop more logical sequences for introducing maps and mapping (2) in the school curriculum and for streamlining our educational agenda. Of course, a number of researchers in such fields as psychology and education are also inquiring into the perceptual and motor skills of children and their pace of development (3). At some point, the results of that research should be used to modify sequences that we develop. But until that time, we should have first considered the variety of map products from an intellectual point of view and established the basic functional relationships among them. Creating a taxonomy is one way of accomplishing these goals.

Finally, and in a more general way, a taxonomy can clarify what questions geographers ask that set them apart from other scientists who ask questions about the world, i.e., the questions that are fundamental to geographic thinking. This paper discusses some criteria that can be used to create such a map taxonomy and applies them to a prototype taxonomy.

ON CLASSIFICATION

In studying any phenomenon, scientists want to be able to group individual representatives in some meaningful ways. This is done so that the relationships between these individuals are clearly defined and understood. Taxonomy is the science of classification. The most complex classifications are in the plant and animal worlds where scientists must contend with some 1,500,000 species. Perhaps the best-known taxonomic classification is the one by the 18th Century Swedish naturalist Carolus Linnaeus. It is a hierarchical system in which individuals are grouped on the basis of similar observable characteristics into seven nested categories or taxa: kingdom, phylum, class, order, family, genus and species (McKnight, 1984,194-5). Most familiar to us are the species, the basic unit of the classification, followed by the genus, the next level of organization. Each genus includes a number of species.

Taxonomists ask such basic questions as, for example, "What constitutes spiderishness?" It usually involves a critter having eight legs, silk-spinning organs, and whether they spin orb, funnel, rectangular or cobweb type webs (Hubbell, 1996). By asking these kinds of questions, primitive traits emerge that define levels or taxa within the hiearchy. The higher the taxon, the broader and more inclusive are the groups. The lower the taxon, the more closely related are its members and the more characteristics they have in common. In this way, a conceptual framework is created for clarifying the relationships among all individuals and groups of organisms.

It should be clear, however, that the purpose of any classification involves organizing our knowledge about some group of things with a specific purpose in mind. Thus there can be as many classifications as there are purposes. In considering maps or map use tasks, we clearly do not have the numerical problem of the natural scientists but we do make the kinds of groupings that might be found in a formal taxonomy. For example, we distinguish between maps that are large and small scale, thematic and reference, choroplethic and isometric, etc. Even though these categories are not mutually exclusive or comprehensive, they work relatively well as generalizations among knowledgeable mapmakers. Perhaps this is why there have been few formal attempts at producing a comprehensive taxonomy of maps. But in education, the terminology describing map types is often vague and not universally understood and their distinctions are more likely made on the basis of form or scale, and not of purpose.

For example, the curriculum for North Carolina (Teacher Handbook, 1992) makes reference to maps of the classroom and of the child's room at home, to county maps, state maps, and globes. While these maps are of quite different scales, they will likely be used by children to search for and locate specific features in them. Thus they share the common functional use of being used to record all objects in an area. The inventory or reference function is an important use of maps, but not the only one. More critically, decisions about content, generalization, and design for inventory maps are not the same as those decisions made for other kinds of maps. Unless children are given opportunities to produce a variety of maps as tools, not just inventory or reference maps, they may get a one-sided view of what maps might look like and what they can do (4).

As a result, children may fail to recognize the intellectual and functional distinctions between various kinds of maps. For children to solve problems with maps, they must know how each type of map differs structurally so that in creating their own maps appropriate steps can be taken in the selection of content, its generalization and symbolization. To assist in this, a taxonomy of map functions should describe the kinds of problems we can solve with maps and what types of maps are appropriate to each. In creating such a taxonomy, we may also discover the intellectual (and technical) difficulty of producing and using associated map types. This knowledge could then be used to develop a sequencing approach not only for introducing maps and mapping, but also to the geographical problems they may best address.

In examining curriculum materials, elementary textbooks, and atlases I have never seen such a taxonomy (5). Rather than attempt to deduce a taxonomic relationship between the rather narrow range of maps named in the curriculum, this paper considers some ideas that might be useful in creating a taxonomy based on map function.

QUESTIONS OF INVENTORY AND WAY FINDING

The essential and simplest intellectual question in mapping asks "What is there?" This provokes an inventory of the area in question and the recording with symbols and labels all features that the map scale allows. As a result, a map of a classroom and the globe can have a common inventory function but the details will be different: e.g., desks, wastebaskets, and bookcases in the former; oceans, continents and major cities in the latter. But we may wish to carry out a basic inventory at many scales; the map scale, however, will usually determine what things are noted. In a sense, this *scale-dependent generalization* allows us to manage the graphic complexity that comes with trying to show all objects at smaller and smaller scales. Thus a city plan, a topographic map at scale 1:250,000 and a continental reference map in an atlas can all be considered inventory maps but at various scales. We do not, however, normally make this connection and group them in this way.

A second basic question addressed by maps involves navigation and way finding. For this we select features that are appropriate to the mode and speed of our movement and that provide the necessary landmarks for that method of locomotion. For example, orienteering maps have quite different designs and exist at quite different scales from aeronautical and hydrographic charts. We might not think to include globes and city plans in this list, but they too include features appropriate to way finding by different means of travel. The former will include parallels and meridians (and thus reference to cardinal directions) whereas the latter makes use of specific buildings, boulevards, and nodes (such as important intersections or subway stations) as landmarks.

For both these questions, it is clear that scale defines "*species*" within the functional "*genus*" of "inventory" but "sub-species" within the functional "genus" of "way finding" or navigation. What other "*genera*" might we find useful? The measurement of angles, distances, and areas is a need traditionally met with sufficiently large-scale maps or those with special characteristics, e.g., conformality or equivalence. There are also various tasks of analysis for which we need to be particularly selective about map content and careful in the ways we classify, generalize, and display that information. Thus we can consider two other "genera" as the needs of measurement and of analysis. From the evidence of school texts and children's atlases, we seem to regard the first of these needs as the more important. But given the necessity of understanding abstract concepts about scale, distortion, and map projections, the skills of measurement are far less accessible to children than those of information selection and generalization, unless we restrict ourselves to very large scale maps. I would argue that the needs for analysis skills are just as valuable, and much more accessible. Perhaps they should even be given preference in our curricula.

QUESTIONS OF ANALYSIS

Inventory maps of small areas are perhaps the simplest maps we can have children produce. Everything in an area, such as their classroom, is included because it is there — no questions asked. Such maps allow us to address the simplest of "Where is...?" questions. But to answer the more difficult "Why...?" questions, we must be selective in what is shown just as we are selective with words when verbalizing a problem. To be selective, children must recognize the role that particular pieces of information play and learn to ask, in their map making, "Why do I need this?" and "How will it be used to illuminate my problem?" Denis Wood (1993, 51-2) would probably pose the additional question of: "What change do I wish to bring about in another's mind?" The consideration of such mapping questions, what I call *function-dependent generalization* (Castner,1983), is the more important concept than scale-dependent generalization for all questions of information manipulation and emphasis in graphic design revolve around it.

To understand *function-dependent generalization*, envision a continuum of maps that begins with those depicting individual things or *objects*. For example, in a neighborhood inventory map we may wish to differentiate the individuality of each house, e.g., "my house" from "your house." To do this, we need a separate symbol or label for *every* house. But to show why a school might be located in a particular place we need only to see the distribution of each house with school age children. To represent them, we need but one uniform symbol for we are now representing my house and your house as members of a class of things called "houses with school age children." For adults, this may not be a difficult distinction. But I wonder if it isn't too subtle an intellectual leap for children without some preparation? If they do not understand this distinction, then their ability to isolate a problem or illuminate a situation, i.e., to state a spatial proposition, will be limited.

But the problems of scale-dependent generalization, i.e., of dealing with graphic complexity, are relatively straightforward compared to those of function-dependent generalization, i.e., of intellectual complexity. This is because in the latter we need to eliminate, classify, or aggregate information appropriate to the questions to be addressed or the problems to be solved. This operation is at the heart of purposeful map use.

A continuum of maps which begins with one of individual things or objects can extend into many different directions. One important direction is in making spatial generalizations, what we call regions. The map of school districts, that was suggested above, is an example of a one-criterion region. It is perhaps the simplest kind of region that children should make. As they progress, more and more criteria can be used to make regions more reflective of reality. Land use maps are among the most complex where the distribution of many selected factors leads us to declare that some areas are significantly different from others. We may describe them with such general and ill-defined terms as residential, commercial, or industrial. But whatever the label, these are among the most useful products of map analysis.

QUESTIONS OF MEASUREMENT

Envision a continuum of mappable spaces that range from those that are too small to get into or are small enough to hold, to rooms, buildings, neighborhoods, communities, counties, states, countries, continents, and to the earth in its entirety. Each entity suggests successively a scale and thus an area of increasing coverage from what we call personal to large to medium to small (scale). But the calculation and use of a mathematical statement of the scale relationship of a map to the world involves arithmetic and measurement skills that the very youngest students may not have. Thus the introduction of the simplest measurement tasks should follow the lead of the mathematical readiness of the students. For example, with the acquisition of multiplication skills, children can begin to measure distances on maps and convert them to miles on the earth using simple verbal statements of the scale, e.g., one inch on the map represents one mile on the earth. But these activities are complicated by two other problems.

First, our ability to make precise measurements from maps as we move along this continuum of mappable spaces is influenced successively by the effect of the spherosity of the earth. The changes induced in the geometry of our maps affects directly the nature and amount of distortion in the structure of the space depicted. At the largest map scales the distortion is negligible. At smaller scales, as long as we don't attempt to measure distances, areas, or angles and directions, these changes in geometry present few problems in map use. But if we want to make measurements as map scale decreases, we must increasingly be aware of the nature and pattern of distortion in a given map projection and make use of its standard lines in order to keep errors of distance measurement at a minimum. But these ideas are complex, abstract, and often difficult to get across in school. Our pedagogic effort should lie in making it clear to children that distances, areas, and angles *can* be measured on very large scale maps or on the globe — two places where geometric distortion is not a problem. But, at the same time, they must be warned, if not allowed to discover, that extending these activities to medium and small scale maps may result in significant and unfortunate errors. They must come to understand what conditions must be met before such measurements can be taken. But this understanding of map projections and scale variation should not be a first hurdle to using maps (6).

Second, as we move from large to small-scale maps, we also are influenced by the reduction in space in which to display our symbols. We must therefore become more selective in what we map and more involved with the generalization of that information selected. This is a process we can call *"scale-dependent" generalization.* These problems suggest the educational strategy of starting children working with large-scale maps and progressing toward smaller ones so that any problems of geometric distortion and scale-dependent generalization are postponed.

On the other hand, as long as we don't attempt to make distance measurements, a certain level of structural control can be provided at all scales by the rivers or political boundaries in outline maps. With them children can analyze other questions, such as those relating to topological relationships, or examine patterns within and among various categories of information mapped by the enumeration areas shown, e.g., states (7). These are analytical activities, which can be accomplished before measurements even though they will involve problems of selection, classification, and aggregation. These will be considered momentarily.

Besides distance, we are also concerned with the measurement of area and angles. As with distance, we must first obtain a map of an appropriate large-scale or projection. It is critical to have knowledge of the tributes of the geographic graticules, which suggest conformality or equivalence. These can be used to deduce these attributes from small-scale maps and thus in deciding whether one can measure angles or areas on a map. Once an appropriate projection and scale is chosen, there are various techniques that can be used for measuring areas (8). There are also techniques and instruments for measuring angles and directions on appropriate map projections (9). This need will also show up as a part of way finding and analysis.

Finally, there are also needs for measuring elevations. For this, there are special skills and concepts such as the reading of profiles, form lines, contours, and inclined contours. Of these, we seem to pay special attention to contours but rarely to the intellectual steps, which lead to their understanding and applications elsewhere, e.g., in statistical mapping with various isolines. Photo and line anaglyphs would seem to be unfortunately neglected tools in this process. Since we also measure "elevation" when describing the surface of volumes, both real and imagined, this need may also be an aspect of way finding and analysis and someday may suggest a way of linking these map use tasks in school activities.

CONSTRUCTING A TAXONOMY

The above discussion suggests a rationale for four *genera* of map use tasks or functions for the *family* of graphics that we call maps. Clearly, there are other *families* of graphic displays on which some of these questions might be addressed. It is important, I believe, that we clarify for students the place of maps within and the distinctions between other kinds of graphic images such as abstract and pictorial art, advertising, photographs, and engineering and architectural plans. These other members can be differentiated by aesthetic criteria, requirements for accuracy, or simply on how well they replicate or resemble reality. But the four questions of map use suggested above seem the best criteria for the *family* of maps for education. Figure 1 describes 1) four *genera* of tasks in map use (in ALL CAPITALS), 2) specific map types (in all lower case letters) that best serve them, and 3) defining activities (in Caps and Lower Case Letters) which differentiate *subdivisions* within certain areas of the taxonomy. As will become evident, we do not have a full array of names in our map lexicon so that some awkward or verbose ones have been created in order to fill out the taxonomy. We may eventually come to some consensus over shorter, more succinct forms for them.

Maps for Inventory and Way Finding

The simplest map intellectually, and the most flexible in handling all map use tasks, is the one in which there are only individual, labeled and relatively unclassified things within some small familiar area, as with the map of a classroom, Figure 2. If its coverage is restricted to small areas of the earth's surface, students can make measurements from it, navigate within it, and ask analytical questions of it although not in the most efficient or effective way. For these non-inventory activities, more specialized map types are required.

For the *genus* of inventory tasks, the scale of the map to the things we might inventory and label we are restiricted by. Thus *species* of maps within this *genus* are scale determined. And we have quite well known and accepted names for most of these maps; the same will not be true for some of the other tasks. A selection of these are listed in sequence, from small scale to large scale, in Figure 1.

For the *genus* of navigation tasks, the *species* of useful maps must reflect the mode of travel. For each, landmarks and aids to navigation are determined by the means of (or restrictions to) locomotion and the speed of that movement. Navigation by foot occurs in many different places. Thus public area maps include such things as mall maps, theatre and stadium seating charts, and parking lot diagrams. Within each of these *species*, there will be a number of *sub-species* that are differentiated by map scale.

Maps for Analysis

Unfortunately, the tasks involved in analysis are not nearly so clear or easily defined. The problem can be seen in Figure 2. There, the desks share uniform shaped symbols but their uniqueness is determined by their label: e.g., Jill, Paul, etc. But if we want to consider a specific distribution, for example of brown-eyed children, we must change our map design in fundamental ways (Figure 3): we eliminate unnecessary information (e.g., the flag, the waste baskets, and all the labels); the desks become simple squares referring to indi-

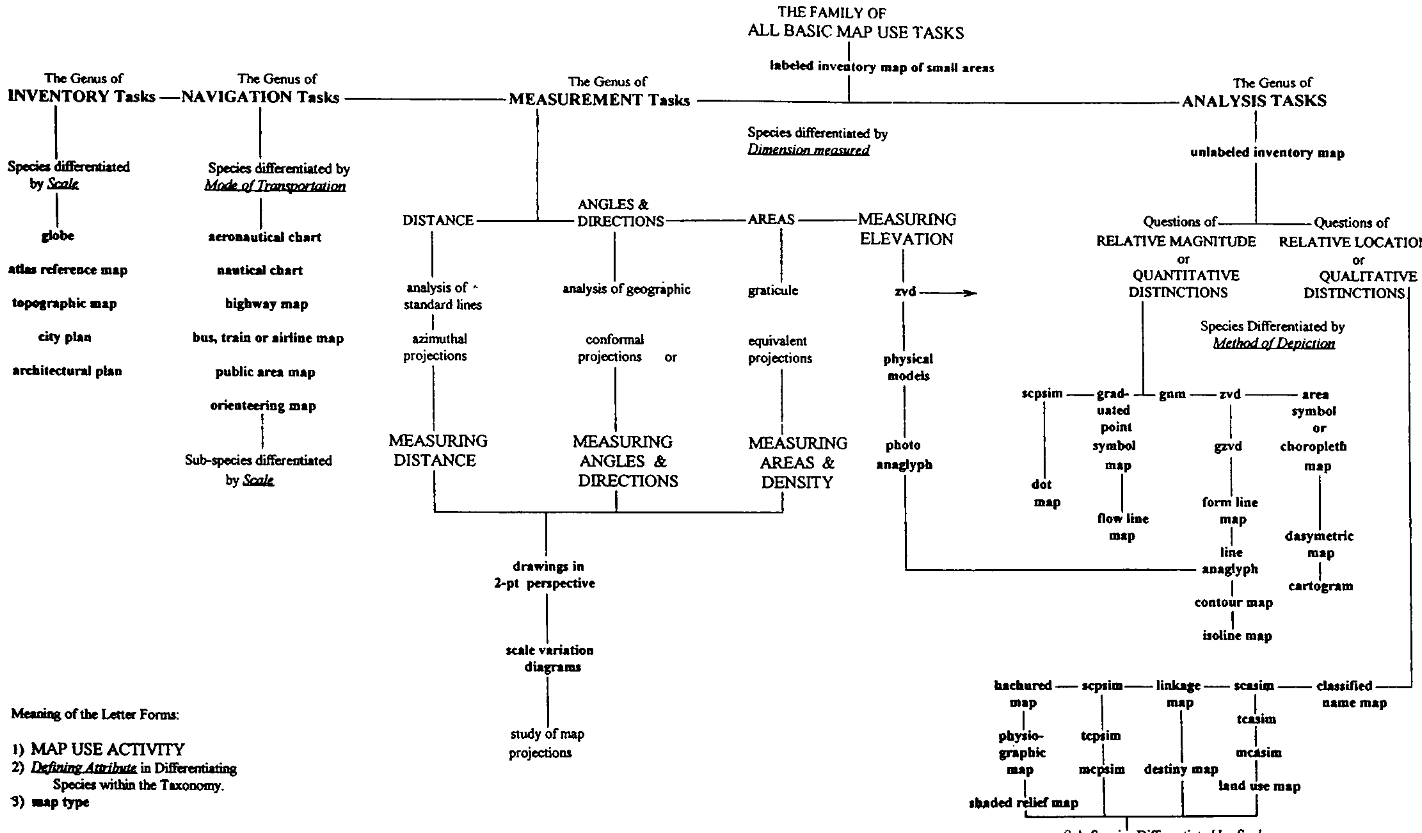

Figure 1. A taxonomy of map use tasks.

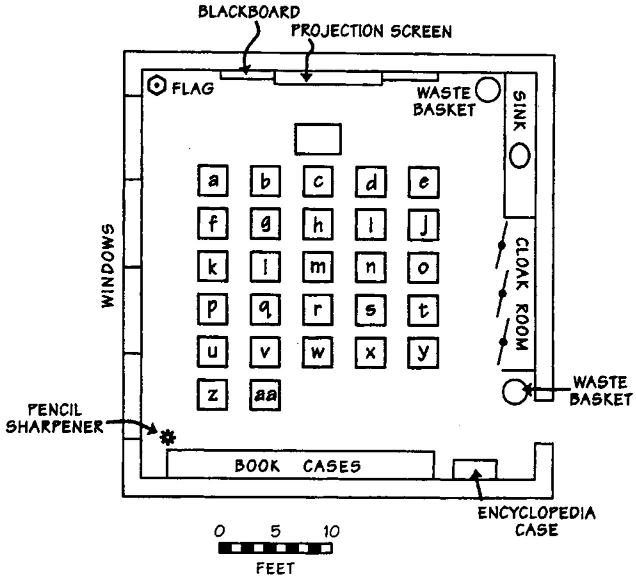

Figure 2. A labeled inventory map. A fifth grade classroom after one from *Thinking About Ontario*, p.11. Each letter stand for the name of a student sitting at that desk.

viduals who sit there; and attribute information (the color of the child's eyes) is used to indicate (by shading the corresponding desk symbol) which students fit into this category.

In doing this, we transform the *labeled inventory map* of Figure 2 into an *unlabeled inventory map*, Figure32. It is representative of all maps of this *genus* of analysis. But to be of practical use, we must define its *species* in more specific terms. The basic division involves questions of relative location and qualitative distinctions and questions of relative magnitude and quantitative distinctions. Let us examine each of these.

In Figure 3, we have mapped all occurrences of a single phenomenon (in this case, brown-eyed children) using one common point symbol, a square, for each. We can ask a number of questions of this latter image as it relates to total number, place occurrence, or relative location of this single phenomenon. But there is a subtle divide here for if we want to examine the density of the symbols, we are suddenly considering a question of relative number or magnitude from place to place. In other words, we must recognize two classes of

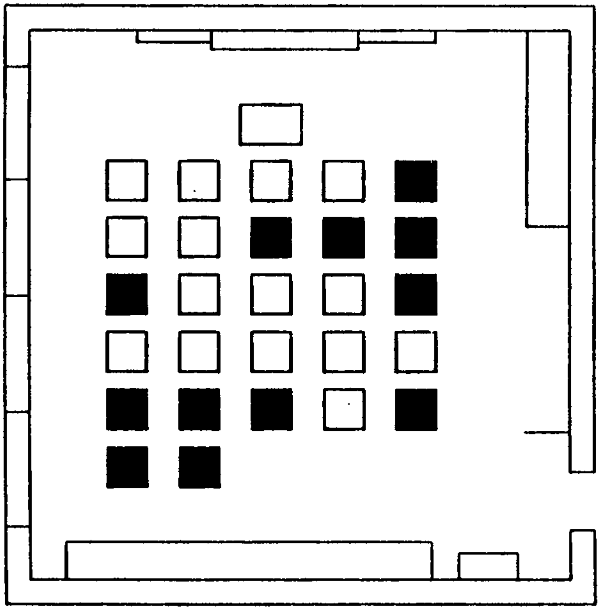

Figure 3. An unlabeled inventory map using dark point sysmbols to indicate which students have brown eyes. After a map from *Thinking About Ontario*, p. 12.

analytical questions: those which consider qualitative questions in things and those which address quantitative ones. In both cases, the *species* are best differentiated by the kinds of information examined and the symbols used to display it, i.e., the method of depiction.

1. Maps for Examining Relative Location or Qualitative Distinctions

A map using POINT SYMBOLS to represent occurrences of a single category of *point or discrete phenomena* might be called an "unlabeled point symbol inventory map," or "upsim" as in Figure 3. Since it displays the distribution of individuals with particular qualities, it is more specifically a *single category point symbol inventory map* (or for convenience here, *scpsim*). We might be tempted to call it simply a *dot map* but this name has strong connotations with the quantitative mapping of information collected within enumeration areas. There, each point symbol represents more than one unit of the phenomenon.

Figure 4. A linkage map showing the origins of materials and workers that were brought to Edmonton, Alberta to design and publish a children's atlas.

More complex distributions can be analyzed when two or more categories are shown in a *two-category* (*tcpsim*) or *multiple-category point symbol inventory map* (*mcpsim*). For example, each desk square in Figure 3 could be colored to match the color of the child's eyes (i.e., blue, brown, dark brown, or green), we would have a four category example. Another example of using multiple categories is the tourist map that uses various pictographic symbols to represent different services of interest to travelers, e.g., hotels, golf courses, and scenic views (10).

We can also ask questions about the relative location or qualitative distinctions among *linear features* by simply mapping them with LINE SYMBOLS. But the primary question we are asking involves where the lines are going, i.e., what are the origins and destinations of these routes. In mapping these, *linkage maps* describe topological relationships or connectivity. A small-scale example, Figure 4, shows the origins of materials and workers which came together in Edmonton, Alberta for the design and publication of a children's atlas.

We can also study questions of connectivity, either when it is potential (as with a road system in which we are only effectively linked when we make the drive in one direction or the other) or actual (as with scheduled bus, train, or airline service, as in Figure 5 (11).

A *destiny map* is a *linkage map* which shows the movements of materials or people when there are stops at intermediate locations between origins and destinations. In other words, it is a *linkage map* with intermediate stops. They are particularly interesting when applied in genealogical studies where, for example, we connect on a map the birthplaces of a child's grandparents and parents with the child's birth town.

We can also ask questions about the nature of *defined AREAS* such as states or countries. In the simplest case we could use a *single-category area symbol inventory map* (*scasim*) to show some quality or attribute that is common to certain areas. During Presidential elections, we might see maps showing, for example, states won by one of the candidates. More often we would see *two-category area symbol inventory maps* (*tcasim*) which show states that were won by Republicans and those that were won by Democrats. When more than two categories are shown, we would have a *multiple-category area symbol inventory map* (*mcasim*) as in Figure 6. While a form of inventory mapping, the purpose is to describe classroom *areas* characterized by the languages one might hear spoken within them — an attribute that extends beyond the desk itself, and connotes the language the child speaks at home. A smaller scale example might show the types of business practiced in each shop in a mall or the type of government or economy in various countries. Making any of these maps for different times allows for comparisons and the detection of trends. The most sophisticated maps of this *genus* are the *species* of *land use maps*. In all cases, *sub-species* would be determined by variations in map scale or coverage.

The NAMES found in different places can also be selectively mapped for analysis. A *classified name maps* can address many questions about culture, natural history, and economic activity (See Gritzner, 1987-88). In another case, Jouris (1994) shows how names that have some particular theme may, when mapped, reveal interesting patterns across the United States. Two examples are mineral

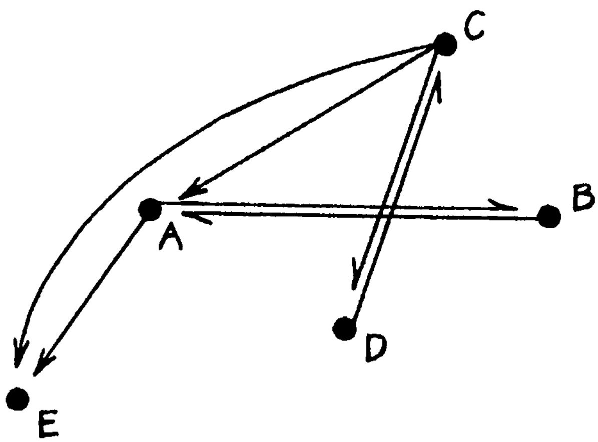

Figure 5. A linkage map showing the available airline service between five Northeastern cities, symbolized by the first letter of their names. It is clear that there is not return air service between some paris of cities. From Castner 1995, 148.

resources from places like Tin City, NC and references to the Bible, as with Bethlehem, PA. Dick (1996) examines the occurrence of women's names in the Kentucky landscape.

I have also listed three kinds of maps that can answer questions about the form of the land; hachured maps, physiographic diagrams, and shaded relief maps. They do this in visual, not mathematical, terms so that they answer qualitative questions of relative elevation and surface complexity.

2. Maps for Relative Magnitude or Quantitative Distinctions

As with questions of relative position and qualitative differences, there are five *species* of maps related to the types of symbols used. The simplest quantitative, unlabeled inventory map would be one using a SINGLE POINT symbol to represent each occurrence of a phenomenon. Such maps are, in fact, quite rare. They show, by changes in dot density, quantitative variations across the map. They are the same in form as the previously described *scpsim*, only the

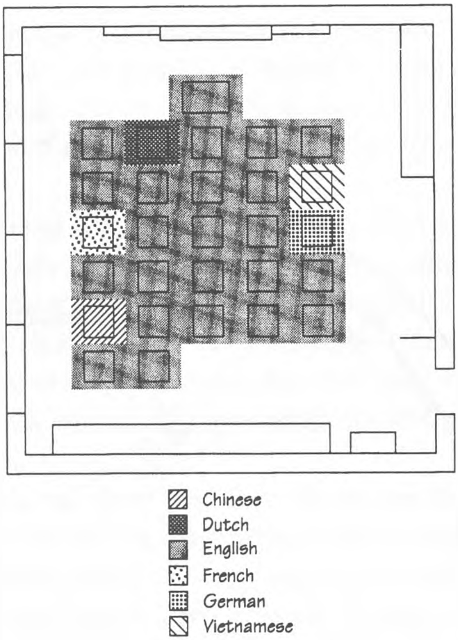

Figure 6. A mcasim map. Areas in a classroom where languages spoken in the student's home might be heard. After a map in *Thinking About Ontario*, p. 12.

question addressed is different. A logical educational sequence would have children make simple, one phenomenon dot maps (*scpsim*) (12) as a first step in learning about data classification and analysis. Once they have faced the inevitable problems of dot size and symbol crowding in cluttered areas, they can explore other solutions.

One is where many point symbols are used, each representing some constant value, e.g., 50 bushels of corn or 100 cows. These are true *dot maps* that are commonly found in textbooks and atlases and are based usually on data derived from *counting* the total number of *discrete objects* within an enumeration areas.

Another solution, when children run out of space to put legibly all their dots no matter what their value, is to make *graduated point symbol maps* where the *size* (usually the *area*) of the symbols is made proportional to the magnitude of the phenomenon being represented: the greater the value, the larger the symbol. The logic behind the construction of various sizes area symbols should be explained by some obvious construction process (13). An alternative is to use a *graduated number map* where the actual number applying to the point or area is enlarged so that the number's height is proportional to its value. Viewers of these maps are able to respond to two graphic clues — the size of the symbol and the number value itself. While actually rare, such maps may be a valuable first step, before graduated point symbol maps, in illustrating the graphic principle (14).

We often wish to analyze phenomena that are quite different because they are distributed *continuously* across an area. To analyze them we must first *measure* them at various places. An example of such a phenomenon, water depth, can be seen in the soundings on a nautical chart. We might call such a display a *z-value display* (zvd) for it represents changes in the elevation or depth (the z-dimension) of the phenomenon that we consider to vary continuously from place to place, like soil fertility or atmospheric temperature. In these cases we are mapping the surface of geographic volumes. The "surface" values of the phenomenon are measured from some datum plane.

By graphically selecting a range or some extreme values in such a display, we can call attention to map areas where the values are critical to some activity. In the case of depth soundings, we might wish to emphasize waters of insufficient depth for a particular vessel or class of ships. There are few examples of such *graduated z-value* displays but they have educational value in providing an opportunity for students to solve a variety of problems by creating some alternate designs (see Castner, 1995, 174-5).

But most often, we wish to use such data to represent the continuous surface from which such data was derived, usually because we cannot see such surfaces -- they may be under water or simply an intellectual abstraction. For this we have developed several representative techniques. The simplest technically involves enclosing or isolating with a continuous LINE — a *form line* — soundings of particular values, as in Figure 7. They might relate, for example, to the draft of a particular vessel. Such a *form line map*, while not as accurate or sophisticated as a contour map, easily isolates areas of specific values or shows a general trend of slopes, not only for a mariner but also for a school child and at a fraction of the intellectual cost. Ultimately, we will want young mappers to study and master *contour maps* and various *isoline maps* (15). But perhaps they should first have more opportunities to study the map tools noted above. Two other tools would probably be useful in this introduction: three-dimensional *physical models* (Brian, 1994); and *photo* and *line anaglyphs* (16). These latter demonstrate dramatically how contours are supposed to be seen and what they show.

Flow line maps also use lines of various widths to depict the volume of movement between connected points. These symbols are made proportional in width to the data they depict. Understanding them would seem to be an extension of the idea of both linkage maps and graduated point symbol maps.

Finally, we can make use of AREA SYMBOLS to depict a number or range of values found within individual enumeration or counting areas. The darker the area symbol, the greater the magnitude of the variable. Because coloring in areas is so easy to do, we rarely consider the erroneous or misleading impressions such maps can give to users. For this reason, we should develop a logical sequence of *area symbol quantitative maps* (*asqm*) to illustrate the various problems that arise from 1) the unequal sizes and different shapes of the enumeration areas, 2) the uneven distribution of the data within them, and 3) the choice of the number of data classes and their numerical boundaries. Only with the understanding of these problems can children begin to use true *choropleth maps* and eventually *dasymetric maps*. Gersmehl's "pixel-coded maps" (1991, 132) are perhaps a good place to begin by mapping within simple grid-square overlays. By enlarging the size of squares in successive grids, we can begin to wrestle with the neglected problems of error and generalization.

Maps for Measuring Distance, Area, Angles, and Elevation (17)

For making these kinds of measurements, both *globes*, *topographic maps*, and any very large scale maps are useful because scale variations are either zero or relatively small for most non-engineering purposes. Each of these four different kinds of measurement tasks, however, suggests a different pedagogic procedure.

For measuring *distances* on any graphic image, we need to know where the scale is uniform and the same as that indicated by the scale of the drawing. In the simplest case, this means finding the *standard lines* — lines drawn at a consistent scale relative to the object. In the case of map projections, the earth's equator or two

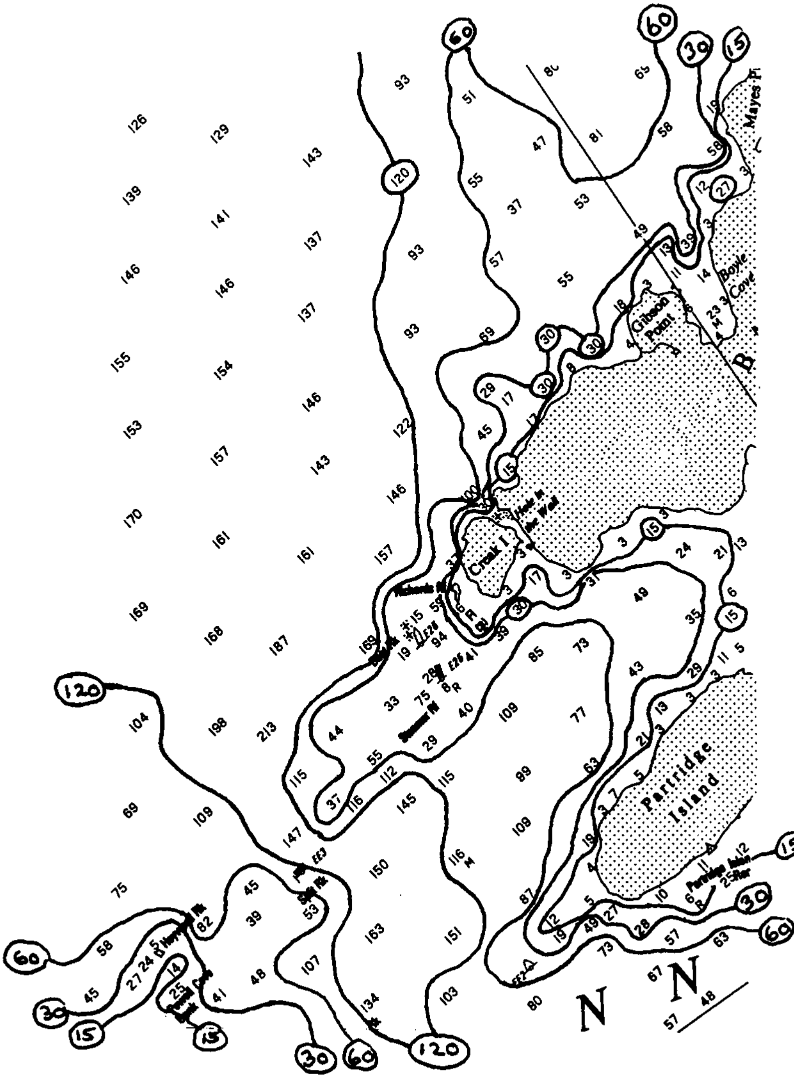

Figure 7. soundings of water depth and hand-drawn form lines isolating various depth zones. Modified from Castner 1995, 175.

standard parallels and perhaps one or more meridians are most often standard lines. If we know the pattern of these standard lines, then measuring distances near them or aligned to them can be reasonably accurate; elsewhere we can make considerable errors. Most of the family of azimuthal projections provide for measuring distances along a larger number of standard lines.

For measuring areas and angles or directions, we need to known if the projection is *equivalent* or *conformal*, that is, do they preserve area relationships or angular relationships on the globe. For extensive areas, two simple tests give some insight into this question. Do the grid lines cross at right angles? Is Greenland the same size as Mexico? If the grid lines don't everywhere cross at right angles, then it can't be a conformal projection. If Greenland is larger than Mexico then it isn't an equivalent projection. An examination of the Mercator (conformal) and Gall-Peters' (equivalent) projections will show how preserving one trait (shape or area) often severely distorts the other. There are, of course, a number of projections for world maps that attempt to find some compromise between these extremes, e.g., Robinson's.

Having considered these questions, it should become clear that scale is a variable and ever changing quality of any given map. Students can discover this by making *drawings in two-point perspective*. In interior locations, constant sized vertical lines in walls (corners, door jams, etc.) are all drawn at different lengths relative to the one closest to the viewer, the "standard line" (18). The study of such drawings lays the groundwork for understanding the various *scale variation diagrams* (see, for example, Robinson et al., 1995, 77f) which show us the "best," i.e., least distorted areas of any map projection, no matter what its *aspect*, i.e., on what point or graticule line is it centered. Finally, students may then be ready to study in meaningful ways the various *map projections* available. But even if this study comes at the end of a sequence of activities, those activities will have given students useful experiences in the concepts involved in making various kinds of measurements from maps and to learn about some of the limitations in making them.

The *description* of elevation change on maps begins with ordinal distinctions. *Physical models*, *anaglyphs*, and the series of relief depicting maps mentioned above are among the simplest tools for this. But for interval and ratio *measurements,* we will need elevation information at points above some absolute or relative *datum plane*. Thus a logical sequence of instruction starts with an array of z-values (zvd) and continues down the column described in the taxonomy. One wonders, however, whether children really need ratio or even interval elevation information to solve their problems? I suspect *contour maps* can be introduced much later in the curriculum than has been our practice, and that these other simpler forms should take precedence in our talk about elevation and relief.

CONCLUSIONS AND IMPLICATIONS

This preliminary or prototype taxonomy, Figure 1, names over fifty *species* of models, maps or drawings which perform four *genera* of map use tasks (19). Collectively they describe sequences of questions which students can ask of geographic or spatial information using these associated products. If children are to become facile in using maps and graphic images for thinking, analysis, and argument, then they must be given experience and expertise in all of these areas. Since few schools may be willing or able to teach all of these areas systematically, it may be necessary to consider the relative importance we place on the various map functions. In addition, it may be useful to develop classroom activities that integrate some of these functions and sequences and so provide both hindsight (what lessons ans concepts it build upon) and foresight (what lessons and concepts it anticipates). With this, elementary and middle school teachers can better come to know and understand how the particular step(s) fit together and why they may wish to engage in them. These decisions will ultimately be moderated by teachers with the knowledge of their students' skills and past experiences and the curriculum goals they wish to pursue. It is my contention that most of these steps and sequences are missing from our geographic and cartographic curricula and thus their logic and conceptual bases are also missing. We should guarantee that they are there.

The development of the taxonomy suggests that in planning purposeful mapping in schools we should consider:

1) continuing to first introduce mapping to children with inventory

tasks using very large scale maps, and so avoid problems of distortion brought on by the increasing influence of the earth's spherosity as scale decreases;
2) limiting at first the measurement tasks to very large scale maps; avoiding these at medium and small scales with the exception of using the globe itself;
3) introducing way finding and navigation tasks in very small environments, experienced by children on foot, where they can establish the meaning and use of local landmarks;
4) working with questions of relative location and qualitative distinctions among geographic information before considering those of relative magnitude and quantitative distinctions;
5) beginning with maps that have the necessary structural control built in or on which no angular or distance measurements will be made; and
6) beginning with maps with unclassified information or unaggregated data.

NOTES

(1) As a result, it is difficult to discuss the problem of map types because most any name mentioned will have meanings to individual readers that are not shared by all. The reader is asked to accept the terms used in the initial discussions with some flexibility until the taxonomy is developed. At that time, it will be appropriate for the community of cartographers and educators to consider better names for the longer, but sometimes rather clumsy, descriptive names and acronyms that are found in the taxonomy.

(2) In an earlier work, I tried to make the case for mapping as a more inclusive and useful term than simply map making to describe the cartographic contribution to geographic thinking. There (Castner,1990,11) I describe mapping as: THINKING about the world and some aspect of it or phenomenon in it; DETERMINING the essential characteristics of that aspect or phenomenon; ESTABLISHING a communication goal, i.e., the use(s) to which a representation will be put, or the problem to be solved; CONSIDERING the various forms and modes of representation that can speak to that goal; and only then EXECUTING some representation that best addresses that communication goal or problem solution.

(3) For a recent commentary on this research, see Downs and Liben, 1997, pp. 21-45.

(4) In fairness, the North Carolina curriculum also mentions "primary maps," route maps, wall maps, physical resource maps, reference maps and "shoe box dioramas." One wonders, however, if these maps are categorically different? Except for their scale or area of coverage, I suspect they are not. In other words, they may all be variations on the basic inventory map.

(5) Muehrcke and Muehrcke (1992) has created a three-part "taxonomy" based on the cognitive processes of reading, analysis, and interpretation: of extracting information from a map; of manipulating that information to create new information; and adding non-map information to establishing meaning and interpretation. These processes can be applied to all maps, regardless of how they were designed. Since there is no way to predict what other information might be brought to a map using encounter, the taxonomy developed in this paper is related only to reading and analysis and is based on map use function for this makes a critical impact upon any design.

(6) Since the special limitations on measurements can be overcome by the choice of one's map projection or of using only certain parts of a projection, a function-based taxonomy might not include any special types of maps for these purposes. On the other hand, it may suggest some logical sequences for introducing these ideas. In this case, knowledge about the existence and position of standard lines (i.e., those along which map scale is true and uniform) is the most useful information in determining where distances can be measured on a map.

(7) A secondary question asks "Do we want children to construct their own control?" At the simplest level, an alpha-numeric grid could be taped on the classroom floor to correspond to a grid on a convenient sized outline map. The "control" is provided by the grid squares and mapping involves transferring information, square by square, from the room to the map. The size of the grid also determines the accuracy of the map. A more complex approach would involve using a simple plane table and alidade outside the school building to establish the positions of prominent landmarks in relatively restricted areas, such as the school campus or a nearby park. Other information is triangulated in reference to these landmarks.

If you think about it, we can control both the degree of structural control and the degree of classification or aggregation by manipulating the area of coverage of our maps. But the critical issue seems to lie with the type of questions we wish to address with maps. If they involve the measurement of distance, area, or angles, then special care must be taken in assuring an appropriate degree of structural control, or in restricting our mapping to relatively small areas or to the globe. For all other questions, the need to be selective in what information is used and how it is generalized becomes paramount. In my view, this side of mapping has been almost completely ignored. We have, instead, favored describing map projections and how they are constructed without addressing the concepts which underlie their meaningful use. Thus a taxonomy of maps should reflect the basic divisions of map use.

(8) For example, various forms of the dot planimeter (which call for counting dots or grid intersections) are simpler to use than instruments such as a polar planimeter. But a third approach, using a chemical balance, may have more educational advantages than either of these. A map is cut up into its constituent areas. These pieces of paper are carefully weighed and then the weights are reduced to percentages of the total weight (area) of the map at its scale. For medium and small scales, the map must be on an equal area or equivalent projection.

(9) For measuring angles at medium and small scales, any of the conformal projections are required, e.g., the stereographic or the Mercator. Only the Mercator was constructed to allow the construction of lines of constant compass direction. But if we are also considering travel of great distances across continents or oceans, we would want to follow the shortest routes along great circles. Only some oblique version of the gnomonic projection will allow these travel routes to be plotted as straight lines.

(10) Unfortunately, such maps often use different shaped, equal sized point symbols but of only one color. This was probably done as a convenience to the map maker and not the map user. As Bertin (1983,156-8) illustrated some time ago, this practice makes it difficult for readers to discriminate and thus sort the various symbols. For purposes of visual analysis, perceptual research suggests that using symbols of different hues to represent different classes of tourist information would be easier to decipher (Williams, 1971).

There is also an unfortunate practice of using point symbols to represent area phenomena, e.g., a single, out-of-scale image of a cow to represent a region of dairy farming of unspecified extent. Given the confusing logic of representing the quality of an undefined area with a single point symbol (which stands for only one of many that might actually be seen in that region) suggests that we should not recognize this as a useful map type in a taxonomy.

(11) For linkage maps illustrating problems of connectivity, congestion, and individual behavior, see Castner, 1995, Chapter 6.

(12) Gersmehl (1991, 122) calls them "repetitive-symbol maps."

(13) See Castner et al (1981, 16) for an example.

(14) See Dickinson (1963, 90 and 96) for examples.

(15) The category of isoline map includes all the great variety of specialized maps that use isotherms, isochrones, isohyets, etc.

(16) Line anaglyphs are made of two sets of slightly offset contours, one in magenta and one in cyan, which are viewed through lenses of these two colors so that each eye sees only one set. The brain then creates a virtual image of the undulating surface. The photo anaglyph does the same thing but by using offset photographic

images.

(17) The task of measuring density can be accomplished in several different areas of the taxonomy. To measure it *in absolute terms*, one must map sites on an equivalent projection or one of large scale. Measuring it *in relative terms* means estimating physical clustering by eye with a scpsim or a dot map or with an area symbol map where densities have been calculated and viewers differentiate between the value of various area tone symbols.

(18) Drawings in two-point perspective are not maps but they provide a useful pedagogic tool in bridging the gap between how we see objects and surfaces around us and map projections. Such drawings do this by exhibiting many of the characteristics of map projections. For example, the noticeable and measurable linear distortion can be used to analyze scale distortion across the drawing just as we do with map projections.

(19) We can now go back and examine the map types found in the North Carolina Curriculum as listed at the beginning of the paper and in footnote #4. Of the eleven types of maps mentioned, eight are inventory in nature and are represented in the taxonomy by five maps. A ninth relates to navigation (presumably by road — the route map). A tenth answers a question about the relative location of physical resources (a mcpsim?), and the eleventh (the shoebox diorama) which might be related to physical models. Thus, over forty of the images in the taxonomy are not represented in that Curriculum.

REFERENCES

Bertin, Jacques. 1983. *Semiology of Graphics*. Trans. William J. Berg. Madison: U. of Wisconsin Press.

Brian, Sam. 1994. *Geography and Mapping from Terrain Models*. New York: Geography and Mapping Institute, Bank Street College of Education.

Castner, Henry W. 1983. Research in cartographic communication: any implications for introducing maps and mapping to young children? *The Operational Geographer*. 2: 13-16.

Castner, Henry W. 1990. *Seeking New Horizons: A Perceptual Approach to Geographic Education*. Montreal & Kingston: McGill-Queen's University Press.

Castner, Henry W. 1995. *Discerning New Horizons: A Perceptual Approach to Geographic Education*. Pathways in Geography Series Title #13. Indiana: National Council for Geographic

Education.
Castner et al. 1981. *Thinking About Ontario: A Hosford Study Atlas.* Toronto and Edmonton: Hosford Publishing.
Dick, Lalie (1996). From Hazel to Nancy, women are on the map. *All Around Kentucky.* Official Publication of the Kentucky Farm Bureau Federation, LX (#6, Nov), 10-11.
Dickinson, G.C. 1963. *Statistical Mapping and the Presentation of Statistics.* London: Camelot Press.
Downs, Roger M. and Lynn S. Liben. 1997. Geography and the Development of Spatial Understanding. In *The First Assessment: Research in Geographic Education*, eds., Richard G. Boehm and James F. Petersen, pp. 21-45. San Marcos: The Gilbert M. Grosvenor Center for Geographic Education.
Gersmehl, Philip J. 1991. *The Language of Maps.* Pathways in Geography Series #1. Indiana, PA: National Council for Geographic Education.
Gritzner, Charles. 1987-88. The geographic landscape of place names. *The Social Studies Teacher.* 9, no.9: 3,8.
Hubbell, Sue. 1996. How taxonomy helps us make sense out of the natural world. *Smithsonian,* May:140-151.
Jouris, David. 1994. *All Over the Map. An Extraordinary Atlas of the United States.* Berkeley: Ten Speed Press.
McKnight, Tom L. 1984. *Geography: A Landscape Appreciation.* Englewood Cliffs: Prentice-Hall.
Muehrcke, Phillip C. and Juliana O. Muehrcke. 1992. *Map Use*: 3d Edition. Madison: JP Publications.
Robinson, Arthur H. et al. 1995. *Elements of Cartography, 6th Edition.* New York: John Wiley.
Teacher Handbook. 1992. Raleigh: North Carolina Department of Public Instruction.
Williams, L.G. 1971. Obtaining information from displays with discrete elements. In Map Design and the Map User, *Cartographica,* II:29-34.
Wood, Denis. 1993. The fine line between mapping and mapmaking. *Cartographica.* 30, no.4:50-60.

Henry Castner *is Emeritus Professor of Geography, Queen's University, Canada where he spent 25 years teaching and conducting research on map design and production, map perception, and most recently on the relationship between mapping and geographic education. This latter interest led to the publication in 1990 of Seeking New Horizons: A Perceptual Approach to Geographic Education and its sequel Discerning New Horizons in 1995, several papers, and numerous workshops and presentations in schools and professional meetings. He has also published two books on the history of Russian cartography, a children's study atlas of Ontario, and written on a variety of topics including tactual mapping, photomaps, tourist mapping, nautical charts, color charts, and maps in television news. Dr. Castner is a Past President of both the Canadian Cartographic Association and the North American Cartographic Information Society. He is now living in North Carolina where he continues his research and writing interests and developing educational workshops. He is currently the Co-Chair of the Cartography and Children of the International Cartographic Association (ICA).*

60984 81800

A Schema Theoretical Approach to Understanding Map Readings

Joan Maier

This two-year study employed a modified grounded theory research methodology. Two questions guided this study: 1.) Could schema theory explain map reading? 2.) Could schemata and processing strategies for map reading be identified and characterized? The subjects voluntarily interpreted a familiar and then an unfamiliar map followed by probing questions that query the subject to think "out loud" in order to clarify their voluntary responses. Individual subjects' protocols were compiled for constant comparative analysis. These procedures resulted in (1) evidence that supports the application of schema theory to explain map reading; and the development of schemata and processing strategies categories.

Keywords: *schema theory, map reading, comprehension, geographic literacy, processing strategies*

Geographic educators believe that geography is the content that provides the knowledge and skills necessary to compete in the world's "global community." In previous decades results of numerous studies indicated that United States elementary, high school, and college students were achieving geographic knowledge at levels below expectation of geographic educators (Barrows, 1981; NAEP, 1979, 1988). The 1994 National Assessment of Education Progress (NAEP) geography assessment provided solid, extensive base-line data of United States students in grades 4, 8, and 12 that indicated the need to continue improving geographic literacy. One direction geographic educators are pursuing to improve geographic literacy is an application or development of learning theories supported by research that could explain how geographic knowledge and skills are learned. They believe that this approach would provide information that could aid the designing of more effective geography curricula, instruction, and assessment to employ with students, which in turn could improve geographic literacy.

Several of the geographic education studies that have been conducted are focused on map reading ability and are traditionally based on the psychology of the learner as described by Piaget's models of spatial concept development and cognitive development (Cooke, 1979; Downs, Liben & Daggs, 1988; Eliot, 1972; Pufall & Shaw, 1973). However, theorists and researchers in various fields (Chi et. al., 1982; Downs & Liben, 1991; Tomlinson-Keasey, 1982; Torney-Purta, 1991) have identified apparent shortcomings of Piaget's cognitive development theory and spatial concept development model. As a consequence, they have begun to utilize more inclusive explanations that focus on cognitive processes (e.g., assimilation, accommodation, and equilibration) of the learner and learning.

Schema theory from cognitive psychology is one of the approaches theorists have used to explain why and how humans go beyond the given in sensory input to bring order and meaning to the processes of perception, comprehension, learning, and remembering (Anderson & Pearson, 1984; Ausubel, 1960; Bartlett, 1932; Shank & Anderson, 1977). Schema theory is based on the following assumptions. It is assumed that learning is a cognitive process of giving personal meaning to public information. Second, it is assumed that every individual constructs a somewhat idiosyncratic meaning for information. Third, the knowledge and conceptions (and misconceptions) the learner brings to the learning task have substantial influence on learning. Prior knowledge, particularly that specific to the domain being studied, is important. Fourth, the process of acquiring meaning from text, oral discourse, or the social world and of remembering information is related to knowledge structures called schema (plural-schemata). Fifth, meaningful learning entails encoding oral or written discourse by relating it to existing knowledge structures (Torney-Purta, 1991).

For at least the past three decades, reading educators applied schema theory to the process of comprehension for reading written discourse. Research in reading education demonstrated that what is critical for comprehending written discourse is activated schemata (Anderson & Pearson, 1984; Anderson & Prichert, 1987; Devine, 1986; Johnston & Pearson, 1982). If schema theory, as applied to reading comprehension, is supported empirically to explain how students comprehend maps, then the interactive relationship between what the map-reader brings to the map reading task and the very nature of the map text itself is very important. The map-reader's schemata govern the map text that is comprehended, learned, and remembered. The map text delimits the activation and construction of the map-reader's schemata. A schema-theoretic view of map reading would mean that map-readers do not comprehend graphic and linguistic information from maps a bit at a time until each bit finally comes together as understanding. Instead, they make sense of whatever they know about a map from the very beginning. Thus, without substantial prior knowledge to build on, the comprehension of and learning from maps is likely to be superficial, fragmentary, difficult to apply, and quickly forgotten.

According to Abler, Marcus, and Olson (1992), "maps have traditionally been connected to the core of geography in three ways: they are products of geographic inquiry, they are analytic tools, and they are themselves objects of study as a means of conveying information" (p. 3). Many geographers view maps as complex texts that convey information by using both linguistic and graphic symbols to represent particular spatial environments of Earth (Downs & Liben, 1991a; Natoli & Bond, 1985). Some geographic educators describe map reading as a cognitive constructive process that involves both spatial and linguistic knowledge (Castner, 1990; Downs, Liben & Daggs, 1988; Hardwick, McIntyre & Pick, 1976; Lynch, 1960; Mandler & Johnson, 1976; Okabayashi, 1983; Patton, 1997; Shimron, 1975; Thorndyke & Stasz, 1979). When maps and map reading are viewed from these perspectives, then the comprehension process as defined by schema theorists in reading education would be related to map reading.

While a review of the literature indicated the significant role of schema theory for explaining comprehension of written text, the research that related schema theory to the comprehension of map text is sparse. A schema-theoretic view of map reading would mean that map reading curriculum, instructional strategies, and the assessment of map reading would be based on a "learning theory model." This learning theory model would emphasize teaching map reading for understanding instead of simply "map skills." Teaching map reading for understanding could mean that more information on maps would be comprehended, learned and remembered. This research applied a schema-theoretic view to an understanding of map reading, which provided data for further studies and useful information for educators seeking to improve the geographic literacy of their students.

RESEARCH DESIGN

The purposes of this study were (1) to discover if schema theory, as applied in reading education could explain map reading, (2) to discover if map-readers' schemata (prior knowledge structures) and processing strategies can be identified and characterized.

The following operational definitions, which were derived from an analysis of the literature, applied throughout the study.

A. Map – A text that uses both complex linguistic and graphic symbols to represent particular spatial environments of Earth.
B. Map reading – An interactive cognitive process between the map-reader and map text that involves interpretation by the map-reader of the linguistic and graphic symbols on a map.
C. Schema (schemata-plural) – An abstract prior knowledge structure that summaries information and represents the relationships among components for procedural, semantic, and episodic knowledge.
D. Comprehension process – The interaction of prior knowledge with new information for the purpose of making sense.

A qualitative research design that employed modified grounded theory techniques, as described by Glaser and Strauss (1967), was chosen. This approach was chosen because the independent variables that could affect map comprehension had not been identified or characterized through previous research. It was assumed that the basic assumptions of schema theory could be applied to all categories of memory systems. It was assumed that although the form of written discourse and maps are different, both written discourse and maps function to communicate particular information and thus are comparable for investigating the cognitive process of comprehension.

A pilot study was conducted in Spring of 1992. In Spring of 1993, data for this study were collected. The sites for collection were rural, urban, and suburban schools in Illinois that provided subjects who were socio-economically diverse. Across all three sites, 104 seventh grade students were selected and administered the Geography Map Reading Test (Maier, 1993). Based on the test results and specified criteria a pool of 48 possible subjects from all three sites were identified. During teacher interviews the pool of 48 possible subjects was narrowed to the 24 subjects, 8 from each site. The 8 subjects identified from each site represented 4 males and 4 females. Average age of all subjects was 12 years and 6 months.

The 24 subjects participated individually in a map tasks session in which they were asked to interpret two previously selected physical-political maps (e.g., thematic maps depicting basic natural features and political boundaries) from the seventh grade Glencoe textbook, World Geography: A Physical and Cultural Approach (1989). The Glencoe, 1989, textbook was selected because the subjects or teachers in all three sites did not use it for instruction. The subjects' teachers rated six different physical-political maps from the Glencoe, 1989, geography textbook to determine the subjects' familiarity of maps. The two maps, one familiar and one unfamiliar, which received a near total of 95% consensus among all teachers, were used in the map tasks session. The teachers rated the United States maps as the "most familiar" and the map of South Asia as the "least familiar."

The use of familiar and unfamiliar maps represents an adaptation of a research model utilized in reading research to determine the effects of prior knowledge structures on comprehension (Wilson and Anderson, 1986). The two physical-political maps from the Glencoe, 1989, textbook were virtually identical in spatial and linguistic cartographic structure. The only manipulation was subjects' familiarity with the map content. It was assumed that the role of prior knowledge structures as applied to comprehension was operative during map reading if map content familiarity accounted for variance in map comprehension during both voluntary and probed responses of each subject.

The map tasks sessions were approximately 40 minutes in length, and each subject's responses were video tape and audio tape recorded for later transcription and analysis. The subjects were told that the purpose of the study was to learn how seventh graders read maps. They were provided the following map task directions in verbal and written format:

1. You will be given a map to read.
2. As you read, at anytime, say aloud what you would tell someone this map is mainly about?
3. Discuss anything about the map or how you are reading it.
4. You will not be stopped or assisted once you begin.
5. When you finish reading and talking about the map, I will ask you some questions about the map.

Next, they were given an opportunity to practice responding to "think aloud" questioning techniques on a topic other than geography. The above directions were repeated and then the subject was shown the familiar map.

The map of the United States was presented first to the subjects for their unassisted and uninterrupted response. When ready, the subject began talking about the map. The researcher recorded the length of time for uninterrupted and unassisted reading (voluntary responses) of each map. After the subject finished voluntarily telling the researcher about the United States map, the researcher asked the subject probing "think aloud" type questions related directly to the subject's initial responses. When the subject finished answering the "think aloud" probing questions for the United States map, the map of South Asia was then presented and the previously described procedures were followed.

The researcher employed "think aloud" questioning techniques as a metacognitive approach to access the schemata and procession strategies the subjects used to assimilate or accommodate the meaning of the map. These "think aloud" questions related directly to the subject's voluntary, uninterrupted responses for both maps. The framework for the researcher's "think aloud" questioning with each subject for both maps was:

Extending Understanding

What do you mean by __________?

You said __________, tell me more?
How did you figure ______________?
Tell me how you made _________ decision?

Elaborating Understanding

What helped you understand this map?
Would you change anything on this map? Why?

The constant comparative method (Glaser & Strauss, 1967) was used to analyze and reduce the data into codifiable categories and properties. The techniques of constant comparative method that were employed included analytic induction, axial coding, negative cases, memoing, constant comparison, and taxonomic analysis. This researcher conducted the in-field and post-field analysis. Then, 88 randomly selected quotes were highlighted and left embedded in eight randomly selected subject protocols to be analyzed by an independent panel of experts. The panel of experts was instructed to analyze the quotes for prior knowledge structures' categories and processing strategies that were identified and characterized previously by the researcher. A modified Delphi method was used to reach a consensus with consensus being defined as agreement by 2 of the 3 members of the panel. Interrater reliability was recorded as percents that represent 2 out of 3 agreements on all categories and processing strategies.

FINDINGS AND IMPLICATIONS OF THE STUDY

Data from this study supports the interpretation of schema theory applied in this study, in that, the process by which written discourse is comprehended is analogous to the process by which maps are comprehended. In common parlance with written discourse one "reads" a map. The role of prior knowledge structures as applied to comprehension of written discourse was operative during map reading because map content familiarity accounted for differences in map comprehension.

The greater frequency and median of correct information units that all subjects expressed for the familiar map compared to the greater frequency and median of confused information units and no information units that all subjects expressed for the unfamiliar map provide evidence of the effects of prior knowledge structures on map comprehension (Table 1). Correct information units, confused information units, and no information units were coded and calculated by subjects' idea units expressed while reading the United States and South Asia maps.

The definition of idea units that emerged from the data was a dependent or independent clause with a stated or understood subject that, together with its modifiers, formed a single idea (see, Pritchard, 1990 p. 278). Subjects often did not speak in complete sentences but rather in strings of clauses connected by the conjunction "and". For example, Subject 5 said, "It's the United States and it shows regions, and it shows big cities and capitals, and rivers, lakes, and oceans and there's the Atlantic Ocean, Pacific Ocean and the Great Lakes." This string of clauses was analyzed for the stated or understood subject(s), together with modifiers that formed a single idea unit. The example provided above was coded as having four idea units.

The correct information units category involves subject responses that were accurate idea units about the maps. For example, the verbatim subjects' responses listed below were codified as correct information units:

Subject 1	This is a physical and political map of the United States.
Subject 6	The key show (that) the white color is the highest land.
Subject 24	Capitals is where the government is located.

The confused information units category involves responses that range from completely incorrect information to partially correct information or correct information that lacks a salient focus. These verbatim subjects' responses provide an example of idea units that were codified as confused information units:

Subject 2	...the scale tells you what the map is about.
Subject 8	The Hawaiian Islands at one time was connected to the mainland of the

	United States, but an earthquake caused them to drift away out into the Pacific Ocean about 90 miles away from the west coast.
Subject 24	The dots mean it was a capital before.

The no information units category represents when subjects were unable to give any information during follow-up probes. The subjects either gave no reply or stated that they "did not know."

Differences were found among the correct information units, confused information units, and no information units categories between the United States map and the South Asia map reported by all subjects in Table 1. Even though the minimum correct information units for the United States map was 12 idea units, all subjects reported more correct information units for the United States map than the South Asia map. The difference of the correct information units median of 36 for the United States map and the median of 18 for the South Asia map represented a 2:1 ratio. The subjects expressed more confuse information units for the South Asia map than the United States map. The difference of the confused information units median of 7 for the United States map and 14 for the South Asia map was a ratio of 2:1. The subjects' expressed 119 total no information units for the South Asia map as compared to a total of 48 for the United States map. The no information units difference between the median of 1 for the United States map and the median of 4 for the South Asia map was a ratio of 3:1.

The frequency with which correct information units, confused information units, and no information units were used differed according to whether the subjects were reading the familiar map (United States) or the unfamiliar map (South Asia). The greater number and median of correct information units subjects expressed for the United States map compared to the greater number and median confused information units and no information units subjects expressed for the South Asia map provide evidence of the effects of prior knowledge on map comprehension. When reading the familiar map, readers were more likely to use their prior knowledge to comprehend more accurately map information. These findings suggest that having relevant prior knowledge for a map facilitate the comprehension process. The greater number of confused information units and no information units in the subjects' interpretation of the unfamiliar map also supports the importance of schemata in map comprehension. These findings suggest that having non-relevant or no prior knowledge for a map limits the comprehension process. Predicted by schema theory, comprehension occurs when the map-reader evokes prior knowledge structures that explain the whole map message (Table 1).

The second finding was that similar domain-specific prior knowledge structures and processing strategies used by these subjects while reading two physical-political maps could be identified and characterized. As the subjects talked about the maps and responded to probing "think-aloud" questions, they revealed "what" (knowledge structures) they understood and "how" (processing strategies) they understood the whole map message. Two classifications developed represent the core categories of domain-specific knowledge structures and processing strategies used across all twenty-four subjects at least three times on both maps. Accuracy of the information or effectiveness of the schemata and processing strategies were not a property for identifying these core categories. What schemata and processing strategies did the subjects have and use was the initial focus of interest for developing two of the classifications. The other two classifications developed represent the core categories that characterized the accuracy, quality, and extent of the knowledge structures and processing strategies used across all 24 subjects at least three time on both maps.

Because the classifications were developed from the subjects' map reading, they do not represent all possible knowledge structures and processing strategies to comprehend physical-political maps or different types of maps. Nevertheless, they do represent a list of the schemata and processing strategies, which emerged from these subjects attempting to construct their individual interpretations of the two physical-political maps used in this study. These findings suggest that map reading is a content-specific activity; that is, when the content of map materials changes, different knowledge structures and processing strategies could emerge. Together these classifications provide a starting point for understanding knowledge structures and processing strategies used to comprehend physical-political maps.

Correct Information Voluntary & Probed Responses		Confused Information Voluntary & Probed Responses		No Information Only Probed Responses	
United States Familiar	South Asia Unfamiliar	United States Familiar	South Asia Unfamiliar	United States Familiar	South Asia Unfamiliar
Sum 960	523	250	386	48	119
Range 12-83	9-60	0-29	1-40	0-7	0-15
Median 36	18	7	14	1	4

Table 1. Coding frequencies of idea units expressed for United States and South Asia maps.

As an example of the classifications that emerged from the data, the domain-specific prior knowledge structures used by these subjects along with representative subject quotes is reported in this paper. Domain-specific knowledge structures are identified in this study as the schemata that summarize information and represent the relationships among components of procedural, semantic, and episodic knowledge. In other words, "what" the subjects know to make sense of the information represented on these maps. The interrater agreement on 88 embedded excerpts from subjects' protocols on domain-specific schemata across all three panel of experts members was 82 percent.

DOMAIN-SPECIFIC KNOWLEDGE STRUCTURES FOR TWO PHYSICAL-POLITICAL MAPS

Listed below are the six core domain-specific knowledge structures that emerged from the data along with representative quotes from subjects' protocols.

(1) Spatial configuration and location knowledge,

A. Initial Spatial configuration on Earth

Subject 5 "It's the United States."

B. Existence on Earth

1. Name recognition

Subject 11 "...I've heard of St. Louis..."

2. Visual recognition

Subject 12 "I've seen maps of the U. S. before..."

3. Direct experience

Subject 16 "Since I've lived here..."

C. Relative location

Subject 1 "Well, it's (U.S.) by the Pacific Ocean and the Atlantic and it's between Mexico and Canada."

(2) Place Knowledge

A. Cultural features- type, configuration, purpose

Subject 8 "...India has people on it with different languages, different cities, and there's three capitals.

B. Physical features- type, configuration, purpose

Subject 16 "The Rocky Mountains are right here and they're the biggest in the United States."

(3) Map Structure Knowledge

A. Symbolic representation of place

1. Linguistic

Subject 24 "Reading the words Rocky Mountain hit me first and I know the Rockies are in United States..."

2. Graphics

Subject 11 "...the most important mountains are bolded out..."

(4) Map elements- scale, title, legend, directional indicators

Subject 4 "...the scale shows..."

Subject 9 "...the title...says South Asia"

Subject 11 "...the key it shows a dot stands for..."

Subject 18 "...this has N right here, means north..."

(5) Map function

Subject 16 "...this map could tell me where different places are located...and I could see where to mail something..."

(6) Personal Perspective Knowledge- viewpoint, opinion
Subject 12 "...I think most Americans are Christian and Jewish...I think Indians are a different religion..."

THEORETICAL IMPLICATIONS AND RECOMMENDATIONS FOR RESEARCH

The study extended the scope of the application of schema theory, as it is used to explain the comprehension of written discourse, to the comprehension of physical-political maps by twenty-four seventh grade students. Comprehending a map is a matter of activating or constructing knowledge structures that provide an explanation of the whole map message. This view of map reading underscores the importance of the map-reader's prior knowledge and the incomplete nature of any map text.

A schema-theoretic view of map reading suggest that "map skills" (e.g., skills for using symbols, skills for measuring distance, skills for noting directions, skills for using scale) are integrated in the comprehension process of reading a map and are probably only a portion of the prior knowledge activated to comprehend a map. That is, defining map reading as "map skills" alone does not provide a comprehensive explanation of the information, skills, and processes needed to comprehend, learn, and remember information represented on maps. The more inclusive nature of schema theory to explain map reading as comprehension should help provide insights into the issues of geographic illiteracy as future research is conducted on this topic.

Future investigations need to address different populations and types of maps. A great deal remains unexplained regarding the relationship between the knowledge structures and processing strategies map readers use and the comprehension they achieve. Results suggest that four domain-specific knowledge structures are utilized to comprehend these maps, but their significance in terms of importance is not suggested by these data. Preliminary results from this study suggest that differences in comprehension may be related to the differences in the quality and extent of knowledge structures and processing strategies map-readers activate and employ. However, if future research continues to support this schema-theoretic view of map reading as comprehension, then, curriculum, instruction, and assessment of map reading and possibly the design of maps should be impacted. A more extensive understanding of how students comprehend, learn, and remember geographic information represented on maps could potentially influence geographic literacy.

PEDAGOGICAL IMPLICATIONS AND RECOMMENDATIONS FOR RESEARCH

Teaching map reading for understanding would mean that successful map reading programs should include at least three components: (1) large amounts of time for actual map reading, (2) learning experiences to facilitate the activation and construction of knowledge structures used to comprehend maps, and (3) occasions for students to talk with a teacher(s) and one another about their responses to map reading.

The first benefit of more time for map reading is the opportunity to manage the knowledge, skills, and processing strategies that are important to comprehend, learn, and remember map information. It appears from this study that the more map information one already knows, the more one comprehends; and the more one comprehends, the more one would probably learn new knowledge to enable comprehension of an even greater array of different maps. Thus, the more time spent reading maps may be largely attributable to the knowledge base that grows through map comprehension. How much time should be devoted to map reading to improve map comprehension is a question for future research. But, of the time set aside for map reading instruction, students should have more time to actually read maps than the time allocated for learning about map reading.

Second, to improve map reading, teachers need to focus instruction on the prior knowledge that students use to make sense of maps. In order to accomplish this goal, teachers should develop curriculum and instruction for map reading based on these questions: (1) What prior knowledge and experiences will the students need in order to comprehend this map?, (2) What information on the map, that is not explicitly presented, will the students need in order to comprehend this map?, (3) What learning experiences will activate or construct the students' prior knowledge to comprehend this map? A couple of instructional strategies from the field of reading education that relate to these questions that teachers could adapt to map reading instruction are Question-Answer Relationships (QAR) Method (see Pearson & Johnson, 1978) and Reciprocal Questioning (ReQuest) Method (see Manzo, 1969).

Finally map reading programs should allow time for students to express to a teacher(s) and other students what they comprehend about information represented on a map. When students engage in meaningful discussions about their comprehension of a map, they should have an opportunity to: use literal to critical and evaluative questions and responses; clarify the basic meaning of the map; and use the opinions of others to help clarify their thinking about a map. Repeated opportunities in which students explain their understandings of a map will internalize effective map comprehension strategies. Internalizing effective map comprehension strategies would affect positively map comprehension, which in turn should affect positively what is learned and remembered. All three of the components described here should improve map comprehension. It is through such map reading programs that students can experience successful learning that will motivate future map reading and geographic understandings of Earth.

REFERENCES

Abler, R. F., Marcus, M. G., and Olson, J. M. 1992. Contemporary American geography. In eds., R. F. Abler, M. G. Olson, & J. M. Olson, *Geographer's Inner World: Pervasive Themes in Contemporary American Geography*, p. 3. New Brunswick: Rutgers University Press.

Anderson, R. C., and Pearson, P. D. (1984). A schema-theoretic view of basic processes of reading. In ed., P. D. Pearson, *Handbook of Reading Research*, pp. 268-289. New York: Longman.

Anderson, R. C., and Prichert, J. W. 1978. Recall of previously unrecallable information following a shift in perspective. *Journal of Verbal Learning and Verbal Behavior*, 17:1-12.

Ausubel, D. 1960. The use of advance organizers in the learning and retention of meaningful verbal material. *Journal of Educational Psychology*, 51:267-262.

Bartlett, F. C. 1932 *Remembering*. Cambridge: Cambridge University Press.

Barrows, T. S. 1981. College students' knowledge and beliefs: A survey of global understanding (the final report of global understanding project). *Educational Testing Service*. New Rochelle: Change Magazine Press.

Boehm, R. G., and Swanson, J. L. 1989. *World Geography: A Physical and Cultural Approach*, pp. 402, 602-603. Glencoe, Macmillan/McGraw Hill.

Castner, H. W. 1990. *Seeking new Horizons: A Perceptual Approach to Geographic Education*, p. 5. Kingston: McGill-Queen's University Press.

Chi, M. T., Glaser, R., and Rees, E. 1982. Expertise in problem solving. In ed., R. J. Sternberg, *Advances in the psychology of human intelligence, Vol. 1*. Hillsdale: Lawrence Erlbaum Associates.

Cooke, K. G. 1979. The relationship between spatial cognition development levels and the achievement of map skills and concepts. (Doctoral Dissertation, State University of New York at Albany, 1978). *Dissertation Abstracts International*, 39:2023-A.

Devine, T. G. 1986. *Teaching Reading Comprehension: From Theory to Practice*. Newton: Allyn and Bacon.

Downs, R. M., Liben, L. S., and Daggs, D. G. 1988. On education and geographies: The role of cognitive developmental theory in geographic education. *Annals of the Association of American Geographers*, 78, no. 4:680-700.

Downs, R. M., and Liben, L. S.. 1991. The development of expertise in geography: A cognitive-developmental approach to geographic education. *Annals of the Association of American Geographers*, 81, no. 2:304-327.

Downs, R. M., and D. Stea 1977. *Maps in Minds*. New York: Harper & Row.

Eliot, J. 1972. Some research possibilities. *Journal of Geography*, 71:366-375.

Glaser, B. G., and Strauss, A. L. 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research.* New York: Aldine Press.

Hardwick, D. A., McIntyre, C. W., and Pick, H. L., Jr. 1976. The Content and manipulation of cognitive maps in children and adults. *Monographs of the Society for Research in Child Development*, 41: 1-55

Lynch, K. 1960. *The Image of the City*. Cambridge: M.I.T. Press.

Maier, J. N. 1993. A Qualitative Study of Adolescent Students' Comprehension of Maps: An Application of Schema Theory to Map Reading, (Doctoral Dissertation, Illinois State University, 1994). *Dissertation Abstract International,* A 55/11, p. 3606.

Mandler, J. M., and Johnson, N. S. 1977. Remembrance of things parsed: Story structure and recall. *Cognitive Psychology*, 9:111-151.

Mandler, J. M., and Parker, R. E. 1976. Memory for descriptive and spatial information in complex pictures. *Journal of Experimental Psychology: Human Learning and Memory*, **2:**

Manzo, A. V. (1969). The request procedure. *Journal of Reading*, 11:123-126.

National Assessment of Educational Progress. 1979. *Summaries and Technical Documentation for Performance Changes in Citizenship and Social Studies Assessment, 1969-1976.* Denver: U.S. Department of Education.

National Assessment of Educational Progress. 1988. *The Geography Learning of High-School Seniors.* Washington, DC: U.S. Dept. of Education, Educational Testing Service.

National Council for Geographic Education Test Development Committee. 1980. *The National Council for Geographic Education Competency-Based Geography Test, Intermediate Level Parts I, II, and III.* National Council for Geographic Education.

National Assessment Education Progress Geography Consensus Project. 1994. Washington, DC: Council of Chief State School Officers, National Council for Geographic Education, National Assessment Governing Board U.S. Department of

Education.

Natoli, S. J., and Bond, A. R. 1985. Geography in internationalizing the undergraduate curriculum. Association of American Geographers. State College, PA: Commercial Printing.

Okabayashi, H. 1983. Spatial Memory: Recall of map information. (Doctoral Dissertation, University of Georgia, 1982). *Dissertation Abstracts International*, 44/08, p. 2420-A.

Patton, D. 1997. The effects of prior-knowledge on the learning of categories of maps. *Professional Geographer*, 49:126-36.

Pearson, P. D. & Johnson, D. 1978. *Teaching Reading Comprehension*. New York: Holt, Rinehart and Winston.

Pufall, P. B., and Shaw, R. E. 1973. Analysis of the development of children's spatial reference systems. *Cognitive Psychology*, 5:151-175.

Schank, R., and Abelson, R. 1977. *Scripts, Plans, Goals, and Understanding*. Hillsdale: Lawrence Erlbaum Associates.

Shimron, J. 1975. *On Learning Maps*. Technical report, La Jolla: University of California, Center for Human Information Processing.

Thorndyke, P. W., and Stasz, C. 1979. *Individual Differences in Knowledge Acquisition From Maps*. A report for Office of Naval Research. Santa Monica: Rand Corp.

Tolman, E. C. 1948. Cognitive maps in rats and men. *Psychological Review*, 55:189-208.

Tomlinson-Keasey, C. 1982. Structures, functions, and stages: A trio of unresolved issues in formal operations. In S. Modgil, & C. Modgil, *Jean Piaget: Consensus and Controversy*. New York: Holt, Rinehart, & Winston.

Torney-Purta, J. 1991. Schema theory and cognitive psychology: Implications for social studies, theory and research on social education. *The College and University Faculty Assembly of the National Council for the Social Studies*, 19, no. 2:189-210.

Wilson, P. T. and Anderson, R. C. 1986. What they don't know will hurt them: The role of prior knowledge in comprehension. In ed., J. Orasanu, *Reading Comprehension: From Research to Practice*, pp. 31-48. Hillsdale: Lawrence Erlbaum Associates.

Joan N. Maier *received her Ed.D. in Curriculum and Instruction from Illinois State University. She is currently an Assistant Professor of Curriculum and Instruction at the University of Houston-Clear Lake in Houston, Texas. She teaches curriculum and instructional design, elementary and secondary social studies methods, and global geography. She also is the director of the Space Image Institute for Geography and Earth Science teachers.*

Book Review

Wilson, Frank R. 1998. *The Hand: How Its Use Shapes the Brain, Language, and Human Culture*. New York: Panteon Books.

Geographic educators interested in more experiential approaches to learning will find much of interest in Frank Wilson's neurologic perspective on *The Hand.* There he examines what he calls the "hand-thought-language nexus" – the connection between object manipulation, the mediation of the brain, and the development of symbolic ways of communication. The role of the hand in learning is paramount in his inquiries. He presents evidence that the deeply personal creative impulse "...is a critical element at the core of all learning. It requires that information be gathered, ideas explored and tested, and decisions made so that progress can be made toward a personally valued goal." No object or action is automatically excluded so that the creative product could be a cabinet, a hot-rod engine, a painting, or indeed a map or other reconstruction of some spatial reality!

Wilson's time scale is anthropologic and biologic. In it he reviews a variety of research on social behaviors (such as grooming and tool making) among primates. Along with other obvious factors such as walking erect and evolving hand structure, these provided not only the incentive but also a stable context for symbolic interpersonal communication. The more complicated the tool manufacturing, the more complicated the language and social organization, over a long period of time. In this process, both the hand and the eye develop as sense organs through practice, which means that the brain *teaches itself* to synthesize visual and tactile perceptions by *making* the hand and eye learn to work together. Associated with this were changes in and growth of the brain.

But Wilson's goals are in the present by asking: "What might be the connection between tool use, language, and thinking during the span of a single human life?" "Could anything we have learned about the hand be used to improve the teaching of children?" He explores these questions with further reviews of research and in interviews with a number of people who have achieved very refined control of their hands: from back hoe operator to surgeon, from magician to musician. In this he questions the premise that intelligence is a purely mental phenomenon, that the mind can be educated without the participation of the body.

He illuminates this dichotomy by considering intelligence itself as the capacity to discover, weigh, and relate facts in order to solve problems." In prehistory he notes that: "...improvisational problem-solving, and with it what we can begin to identify as intelligence, begins with monkeys, increases in apes, and..." so on. Bipedality also created unprecedented opportunities and dangers for the hominids moving away from the protection of the disappearing forest. Throughout this evolutionary sequence, there is evidence of increasingly varied use of the hand and to exploit its manipulative capabilities. In the present, a similar development begins in infancy before the baby can (or should) stand and walk, when the brain must develop and integrate a multisensory reference system to track limb movements on an ongoing basis. "The nervous system must know at all times where each hand is with respect to the midline..." "Inevitably, this same process helps to establish a coordinate system for external objects located in three dimensional space." In other words, this perspective regards the body as an extension of the mind.

As a result, he believes that these issues bring into relief a fundamental premise of Darwinian though, that structure and function are interdependent and co-evolutionary. The brain kept giving the hand new things to do and new ways of doing what it already knows how to do. In turn, the hand afforded the brain new ways of approaching old tasks and the possibility of undertaking and mastering new tasks. That means the brain, for its part, can acquire new ways of representing and defining the world. Is that not what Geography is all about?

The hand-mind connection also contributes to the development of language. Wilson considers the proposition that the human brain organizes and oversees the child's interactions with objects almost exactly the same way it organizes and oversees the production of speech. These two specific skills (manipulating objects and manipulating words), and the developmental chronology associated with the child's mastery of those skills, proceed in such transparently parallel fashion that the brain must be: (a) applying the same logic or procedural rules to both; and (b) using the same anatomic structures as it does so. Thus "...the hand is involved form the beginning in the baby's construction of visuomotor, kinesthetic, and haptic representations of the world and the objects in it."

Obviously all this supports the general notion of geography as an experiential science (and geographic education as a process of personal discovery) rather than the mastery of a bounded set of facts and figures. In particular, it would suggest quite different introductions to basic geographic concepts – activities that can bridge the gap between what children see and what they are taught. This would seem especially so, in light of the previous paragraph, for the topics of orientation and position in geographic curricula which are often introduced with the abstractions of cardinal directions and latitude and longitude.

Wilson acknowledges the need to learn other manipulating skills, but he contends that the historic role of the hands in the acquisition of knowledge and skill during the apprenticeship remains and continues to feed the dynamic processes of the imagination. In one example, he makes reference to a senior geographical-research designer who still works regularly with a pencil and paper – tools that, ironically, he considers more interactive than the computer, because they force him to think implications through. He also reports that Hewlett-Packard rarely hires people who are predominately computer experts, favoring instead those who have a talent for teamwork and are flexible and innovative. Hewlett-Packard is such a believer in hands-on experience that since 1992 it has spent $2.6 million helping forty-five school districts build math and science skills the old fashioned way – using real materials, such as dirt, seeds, water, glass vials, and magnets. Recruiters in film and computer-game animation share much the same perspective. They see a certain "...stiffness or a flatness, a lack of richness and depth" in work by artists who have spent a lot of time on computers. "With traditional art training, you train the eye to pay attention to body movement. You learn attitude, feeling, expression." In geographic education, we have the opportunity in designing symbols to consider the essential attributes of objects, ideas and actions, and their representation – activities which enhances these same hand-mind connections.

From his studies of surgeons, he notes manual dexterity is not the major dimension distinguishing proficient from mediocre surgical performance. Rather, it is the ability to rapidly analyze and organize perceptions based on multisensory information, to "see" the relevant anatomy of the operative site, to quickly identify important "landmarks" in the incision; and to mentally organize multisensory data and actions at any given point of the procedure so as to allow a smooth and efficient sequence of responses." It is hard not to associate these perceptually based cognitions about complex spatial information with our experiences in reading landscapes and analyzing various spatial images.

Wilson warns that sitting our children in front of computers when they are three years old may be misplaced if it assumes that they can then skip the "pointless" experiences of childhood during which they find out what a baseball, or a puppet, or a toy car, or a swing can do to their body, and vice versa." He wonders how the fully computerized kid may turn out when they have replaced haptics with vision as the primary arbiter of reality and have substituted virtual baseball of the old fashioned kind – all this at an age when the brain's sensorimotor system hasn't settled on the time constraints it will use for its own perceptual-motor operations.

According to Wilson, "The clear message from biology to educators is this: The most effective techniques for cultivating intelligence aim at united (not divorcing) mind and body." And, he reminds us, "Intelligence, the capacity for innovative response to the world, is also an aspect of the entire organism." "The brain does not live inside the head, even though that is its formal habitat. It reaches out to the body, and with the body it reaches out to the world." The basic inquisitiveness of the human mid serves the fundamental desire of the human to establish meaningful relations between himself or herself and the world, and (intrinsic to that process) to "put his or her personal stamp on some aspect of the surround." This seems a most useful basis for any pedagogy.

Henry W. Castner is Emeritus Professor of Geography, Queen's University, Canada.

Guide for Authors

Research in Geographic Education is an international peer-reviewed journal of research published twice a year by the Gilbert M. Grosvenor Center for Geographic Education at Southwest Texas State University. The journal board is interested in receiving research manuscripts in geographic education or closely related areas, including but not limited to:

- spatial cognition
- map learning
- learning theory
- curriculum
- gender issues
- distance/non-traditional learning
- environmental psychology
- environmental education
- cross-cultural spatial learning
- teaching methodologies

Submit manuscripts to *Research in Geographic Education*, The Gilbert M. Grosvenor Center for Geographic Education, Southwest Texas State University, 601 University Drive, San Marcos, Texas 78666, USA. The editor(s), two external reviewers, and one or more members of the journal's Editorial Board review each manuscript. Accordingly, authors should provide five copies of their manuscript, along with a diskette in Word or ASCII format. Manuscripts accepted for publication must exemplify the highest standards of scholarship in geography or related fields.

ETHICS. An author submitting a manuscript to *Research in Geographic Education* should not submit the same or a related manuscript elsewhere until our review process is completed. In accordance with copyright law, the manuscript must not duplicate substantial portions of previously published materials.

MANUSCRIPT. Manuscripts must be typewritten, double-spaced, and in a 10- or 12-point font on one side only of 8.5-inch by 11-inch white paper (letter, not A4), not to exceed 20 pages, including illustrations, tables, and references. A 1-inch (2.5-cm) margin should be used throughout.

TITLE PAGE. The title page must include the paper's title, and author(s) name(s), affiliation, address, phone number, e-mail address, acknowledgements (if any), and a brief biographical sketch. Do not include any identifying information anywhere else on the manuscript.

ABSTRACT. A 100-word abstract should accompany each manuscript. The abstract should also include the paper's title and up to five key words.

REFERENCES. References in the paper should be cited parenthetically in the text in this order: author's last name, year of publication, and page number, where appropriate. For examples of current style for various sources, see the *Chicago Manual for Style* or current *APA Guidelines*. The list of references should begin (double-spaced) on a separate sheet immediately after the text and notes. Entitle this section "References." List all references alphabetically by the author's last name, then chronologically. Provide full, unabbreviated titles of books and periodicals.

NOTES. Substantive notes amplify arguments in the text. Please keep notes to a minimum. They should be brief and addressed to a single point in the manuscript. Notes should be numbered sequentially in the text and will appear under the heading "Notes" at the end of the text. They should be typed, double-spaced, in the same font size as the text.

TABLES. Tables should be discussed in the text. All tables should be typed, double-spaced, on separate sheets in the same font size as the text. Each table should have a descriptive title as well as informational column headings.

ILLUSTRATIONS. Maps, graphs, and photographs should convey ideas efficiently and elegantly. Graphics should be legible, clean, and clearly referenced. Sound principles of design should be employed in the construction of graphic materials, and the results should be visually interesting and tastefully executed. Illustrations should be designed to fit the page and column format of *Research in Geographic Education* (18.75 cm x 11.25 cm [4.5" x 7.5"]). Camera-ready, black-and-white copy should be submitted. We cannot redraw illustrations and we do not reproduce in color.

PERMISSIONS. If your manuscript uses previously published material of substantial length, it is the author's responsibility to obtain written permission from the holder of the copyright and to bear all costs for the right to use copyright materials. The copyright for all information published in *Research in Geographic Education* is held by the Gilbert M. Grosvenor Center for Geographic Education, Southwest Texas State University, 601 University Drive, San Marcos, Texas 78666, USA.

Guidelines for Electronic Submissions

The editors ask that you submit your manuscript in digital form when submitting a hard copy manuscript. You may also initially submit your manuscript electronically via e-mail. Regardless of which form you choose the following guidelines must be followed when submitting a digital copy.

IDENTIFICATION. Floppy diskettes should be clearly labeled with the author's name, and the title of the paper. The manuscript file should be identified with the author's last name: Blank.doc or for a text file: Blank.txt. Illustrations should be identified with a figure number followed by a suffix indicating the graphic format: Fig1.jpg or Fig2.gif.

TEXT MATERIAL. The written portion of the manuscript should be submitted according to the usual hard copy guidelines of *Research in Geographic Education.* The manuscript should be submitted in either *Word or ASCII* format and should utilize *12-point Times New Roman* font. If a unique font must be used (e.g. Greek or Latin characters), then a postscript font file should be placed on the disk along with the other files and its presence noted on the diskette label. Illustrations are not to be embedded in the text.

GRAPHIC MATERIAL. Maps, graphs, and photographs must be sent in black-and-white digital format. Material may be submitted in graphic formats common to major graphics packages such as CorelDraw, Adobe Photoshop, and Freehand, or in more generic formats such as EPS or PICT. Raster formats such as TIFF should only be used with photographs. We cannot redraw illustrations and we do not produce color. Anyone submitting artwork in a digital format should have a hard copy produced locally before submitting the material to *Research in Geographic Education.* Often what is seen on a monitor is not what is rendered by an image setter. For example, because a monitor has a coarse resolution, the finest line will be visible, but will disappear on an image setter due to the much higher resolution of that device.

SUBMISSIONS AND INQUIRIES. Electronic submissions should be sent to Judy Behrens at JB42@ swt.edu. Inquiries may be directed to *Research in Geographic Education*, the Gilbert M. Grosvenor Center for Geographic Education, Southwest Texas State University, San Marcos, TX 78666, USA. Telephone: (512) 245-1823; Fax: (512) 245-1653.

The Gilbert M. Grosvenor Center for Geographic Education
Southwest Texas State University

The Gilbert M. Grosvenor Center for Geographic Education has been established to provide leadership in the movement to increase the quality of geographic education in America's schools, at all levels. This will be accomplished by innovative activities related to how students, and the general public, learn geography. Through these efforts, changes in public policy will be manifested that will elevate the importance of geography in American society, as well as the educational system.

The name of the Grosvenor Center is designed to "honor the vast contributions that Gil Grosvenor and the National Geographic Society have made in advancing the national reform movement in geography." As Mr. Grosvenor points out

> *As the world grows smaller and more interdependent daily, our country's future absolutely depends on our ability to see the connections between ourselves and our global neighbors.*

The Grosvenor Center has been organized to carry out several specific functions, including the promotion of research in geographic education; production of various publications; planning and hosting conferences; sponsoring public lectures in the form of the Annual Grosvenor Distinguished Lecture Series; and the development of summer institutes and workshops. The Center sponsors, coordinates, and facilitates research efforts in the following areas: teaching methodology; student and public learning of geography; curriculum; assessment; cognitive mapping; distance education; and, the uses of technology in geography.

Director: Richard G. Boehm, Jesse H. Jones Distinguished Chair in Geographic Education
Associate Directors: Susan W. Hardwick, James F. Petersen, David Stea

IN THIS ISSUE...

Articles

Book Review

The Gilbert M. Grosvenor

GCGE

Center for Geographic Education

ISSN 1529-0085