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ABSTRACT

This issue of the curriculum bulletin deals with the use of maps and globes. Eight topics are discussed in this publication: How Maps and Globes Are Used in Problem Solving, Inquiry, and Discovery Learning; Developing Skills Using Globes; Making Flat Maps; Guiding Concept Development of Map Symbolism; Guiding Development of Distance Concepts Related to Map Reading; Guiding Development of Directional Concepts Related to Map Reading; Guiding Development of Time and Motion Concepts Related to Map Reading; and Development of General Concepts Related to Map Reading. (PEB)

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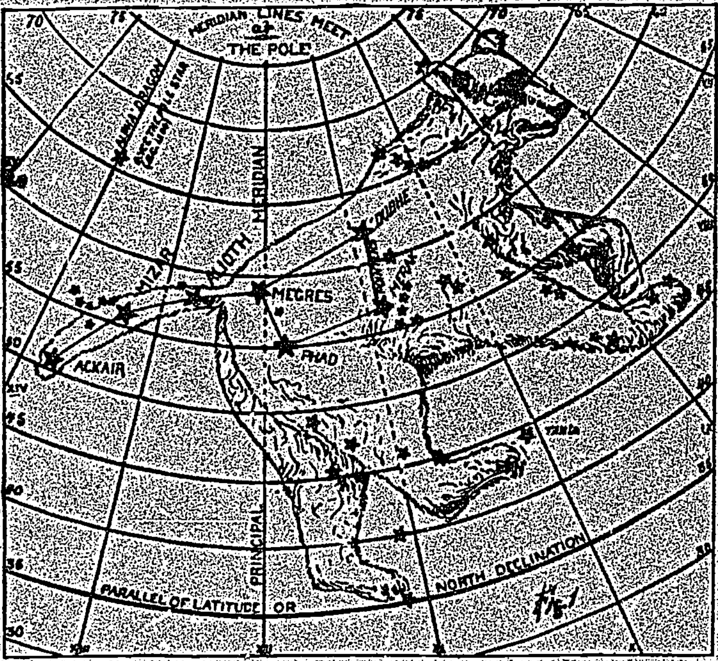

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MAPOLOGY: THE HOW MUCH OF WHAT IS WHERE?

Charles R. Gengler, D.Ed.

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Train maps, maps of
Wind and weather,
Road maps — taken
Altogether

Maps are really
Magic wands
For home-staying
Vagabonds!

DOROTHY BROWN THOMPSON

Home-staying vagabonds! Vicarious vacations! Exciting experiences! Delightful day-dreaming! All this and more can be a result of mapology (the author's "non-word" for the study of maps). Pleasurable trips of fantasy may be derived from the anticipation of travel. Maps are an integral part of the anticipation. When you plan to travel don't you hurriedly get out maps (and perhaps a globe) of several varieties — road map, physical-political map, relief map, historical map?

Your imagination is limited only by your map reading capabilities. This creates an imperative need for elementary school pupils to learn basic rudiments for understanding and interpreting maps and globes.

HOW MAPS AND GLOBES ARE USED IN PROBLEM SOLVING, INQUIRY AND DISCOVERY LEARNING

Of what value are maps for solving problems in everyday life?

How are maps interpreted through integration with the social studies?

When should map reading skills be introduced?

How should instruction for map reading and interpretation be planned?

Analyzing and perusing information proffered by maps and globes supplies the data collector with an abundance of knowledge, insight, and perceptions frequently not available from any other source. The study of maps and globes can answer the question, "How much of what is where?" — an extremely salient query in solving problems of everyday life. The type and location of wiring may be an important question to a person experiencing electrical difficulties in his home. A "map" of the wiring system will, in all probability, be an economic and time saving aid. An astronaut or an astronomer charts terrestial maps designed to show much of what is where pertaining to outer space. Persons involved with transportation of diverse variety — boat, airplane, automobile, truck, bus, or train — must answer the question how much of what is where. Maps are the keys which unlock the portals of information for these people. No matter what an individual's occupation — professional, semi-professional, skilled, semi-skilled, or non-skilled worker — maps may yield indispensable information needed for obtaining solutions to problems related to earning a living.

Even more frequently encountered are uses of maps and globes in solving life's problems outside the means of livelihood. Virtually all social problems may be associated in some fashion with a map or graphic materials. Whether the problem is related to the family or broadens into the community, state, country or international in scope, the map is a useful tool in aiding a person to solve his problems. Whether connected with anthropological problems such as evolution of the American Indian culture, political problems as stopping the spread of communism, sociological problems as urban renewal and civil rights, historical problems as the development of the western frontier in the United States, economic problems as the stock-market fluctuations or labor-management friction, or geographical problems as water diversion from the northwestern United States to southwestern United States; maps can be a handy guide for arriving at possible solutions and making decisions.

Children and adults in future generations will be more reliant on maps than ever before. Extensive travel is anticipated, travel including uncharted, unknown lands — the moon and, perhaps, other planets. World events are no longer far removed from the individual's immediate environment. To bring other parts of the world into the local habitat, maps are of inestimable value.

Limited ability in using maps and globes, limited knowledge of what information maps provide, and limited knowledge of where maps may be found are obstructions to highly efficient map usage. It is therefore the teacher's responsibility to pose the types of problems and situations which will bring children first-hand experiences with maps and globes.

NEED FOR MAPS IN EVERYDAY LIFE

Events occurring in places the world over involve readers and listeners whose curiosity and need to be informed leads them to further research. Maps and globes are a readily available reference. Daily newspapers report stories from literally hundreds or even thousands of places. To gain a meaningful concept of a particular news article, knowledge of place position lends considerable insight.

Maps and globes should be central tools for learning in the social studies. Elementary students need to become aware of ways in which maps, globes and graphic materials offer assistance in solving life's problems. Chart 1 is a sample listing of social situations in which maps are of utilitarian worth.

An infinite number of examples could be cited for reasons to read and interpret maps. Elevations, growing seasons, population, points of interest, national parks and monuments, state and county parks, property divisions, soil conditions, types of vegetation and natural resources are other examples of the need for map usage in day-to-day living experiences.

MAP INTERPRETATION AS AN INTEGRATED SKILL

Research in educational psychology rather conclusively discloses meaningful and purposeful experiences as necessary

- Locating business establishments in a strange city
- Locating houses of friends or acquaintances living in a new home. (Perhaps the friend has drawn the map free-hand.)
- Charting such items as water lines, sewage lines, electric and telephone or even oceanic cables
- Deciphering weather information from weather maps
- Planning trips through scanning road maps
- Charting a vacation trip by using road maps
- Checking an atlas for location of places after reading a news release or upon learning about an acquaintance in another place
- Locating camping spots
- Following map guides for hunting rocks
- Location of trails for hiking

Chart 1. Samples of how maps are used in everyday living experiences

concomitants for motivation and interest in learning. Meaningful experiences, likewise, help to provide for greater accuracy in delayed recall. Map drills, in and by themselves, may eventually destroy the interest for learning to interpret maps and globes. Therefore, it is necessary to integrate map reading and interpretation with ongoing activities in the classroom related to attacking and solving problems. In order to effectively integrate maps and globes with the study of a problem, curiosity of the student must be kindled. Students must be stimulated and aroused to inquire — that is, to ask questions.

Learning to interpret maps need not be a function solely connected with social studies instruction. Maps may provide information for solving mathematical or scientific problems as well as social problems. Whatever the problem being faced, map interpretation is better acquired through a problem in which the students feel personal ownership.

TIMING THE INTRODUCTION OF MAP READING SKILLS

When should various map reading skills be introduced? There are two aspects to be considered in the foregoing question: (1) When, maturationally, are students capable and interested in learning each skill, and (2) when is there a need for the student to learn the skills?

Capability of Students. There appears to be little doubt that children are capable of learning to read maps as early as they are able to understand the terminology for which map representations stand. If a three-year old child has developed a fairly adequate concept of a river through first-hand experiences, the map symbol of a river is ready, maturationally, to be learned. The teacher must not take it for granted the students know how to identify a river, or other geographical terms, on a map. A research study by Gengler[1] concluded that approximately one-third of sixth grade students could not identify the blue lines representing rivers on an atlas map.

As an additional example, when school children obtain insight about the meaning of a day equalling 24 hours, they are ready for learning why there are twenty-four hours in a day rather than 40 or 28 or 15 hours. Timing instruction, from a maturational viewpoint, is limited basically by the child's experiences, vocabulary developmental and, perhaps, complexity of the symbolic map representation. The latter limitation may be counteracted if teachers emphasize symbolic map representations while teaching geographical terminology. If a primary student knows the definition of a cliff he is ready to learn the symbolic representation on a map. The time for instruction is ripe, maturationally. The **need** for learning the map representation of a cliff may be lacking.

Need of Students. The need for students to learn map reading and interpretation is more difficult to determine than the maturational readiness. The teacher's role in providing the need is significant. Consider the following situation: Elementary school children normally have no need or incentive for resorting to highway maps since they, legally, cannot drive a car. Most children, aged 10-15, when asked to locate a place, perhaps a city, on a highway map will begin to search randomly. After wildly scanning the highway map, some may realize there is a map guide available which will aid them in locating the city. Others may absolutely quit searching. Upon finding the city listed in the alphabetized guide the students become lost because they find after the name of the city a peculiar, strange marking such as a B-7 or E-3. What action must be taken at this point? Most children will "give up." The attitude on the part of the student will likely be, "It was a silly assignment anyway!" But wait a minute! What happens if the students have a reason for locating the city? The teacher then has an opportunity to teach the students how map guides are used to locate cities. Perhaps a fellow student recently moved from another state to the present locality. Classmates may be interested in locating that state and city. Similar situations in classroom environs enable a teacher to promote skills which will be permanently imbedded as a part of the students map reading abilities. A teacher, principal, or parent visiting an out-of-state or other distant locality provides incentive for locating cities. Actual happenings involving the students or persons closely associated with the them provide the best motivation for developing map reading skills. Current events, weekly news magazines, or other vicarious experiences are other ways to impress upon students the need for map reading skills.

What can the teacher do to provide both the need and the means for learning to read the map guides? Employing *problem-solving, discovery, or inquiry processes* the teacher can provide experiences which will entice, encourage and otherwise awaken curiosity and furnish a need for learning. Teachers may provide a need for learning many geographical terms by timing instruction to coincide with involvement of the students in problem-solving activities. What better time is there to develop the concept of a cliff than during the study of cliff-dwelling Indians? Pueblo is a term which the students should find a need for learning during the study of the Pueblo Indians. The need for learning a term such as sand dune might be provided through the study of life along the seashore.

Pose a problem situation such as the following: "Your home is located in Cicero, Illinois. During February you are making a two week vacation trip. You wish to travel to a warmer, drier climate. You have $800 (or other amounts). Where will you go on your two week vacation?" Ask the students to chart their vacation journey on a map or draw their own maps.

Reading a story about a foreign land or an historical event

[1]Gengler, Charles R. **A Study of Selected Problem Solving Skills Comparing Teacher Instructed Students with Librarian-Teacher Instructed Students,"** Eugene, Oregon: Doctoral Dissertation, University of Oregon, 1965, pp. 129-132.

may act as the motivational force which will encourage others to locate places on a map or globe and perhaps chart the course for traveling to that particular site. Attacking a problem such as, "Why do many farmers in South America continue to use rudimentary equipment when modern machinery is available," may be the key to unlock student inquiry into all sorts of reference materials, including maps and globes. Planning an imaginary trip to Disneyland, the United Nations' Building or the Six Flags of Texas may encourage many youngsters to work with maps, with teacher's help, in determining how one uses map guides and keys. Each of the aforementioned activities creates a meaningful situation which enables children to secure skills in solving problems as well as acquiring knowledge.

PLANNING INSTRUCTION FOR DEVELOPING MAP READING SKILLS

The process of discovery, inquiry, problem-solving and scientific method are often unduly criticized as being loosely constructed, unorganized and undisciplined methods of study. Not so! Allowing students to investigate a problem entirely by themselves is not the intent of these processes. Guiding the investigation is the intent. Telling, no! Guiding, yes!

Adequate guidance requires careful, systematic, yet flexible planning. Planning for solving academic problems of a social nature in the classroom is quite analogous to a football team preparing to play a Saturday afternoon game. A football team is faced with solving a problem each Saturday during autumn days. Their major problem is how to win the game next weekend. They analyze movies, draw upon scouting reports, talk to persons who know players on the other team, analyze the background of each of the opposing players' experience including the type of coaching received, consider the record of the opposing team, review the teams already played, and review the background and past performances (successes) of the coaches. The coaches plan **carefully!**

The coaches also plan **systematically.** Their team runs plays likely to be encountered by next Saturday's opponent. They practice various counter-attacks. They plot new strategy. They hope to counteract their teams' weaknesses by attacking the opposing team's weaknesses. In short, they systematically plan an attack dependent upon what has been anticipated.

But wait a minute! Even though the planning has been careful, thorough, and systematic the other team has a few surprises to unfold on the gridiron. However, the really outstanding football team has some coaches who have also incorporated flexibility in their planning. This team is able to alter offense and defense to plug weaknesses while the game is being played. The coaches may have "missed the boat" in anticipation of the other team's mode of operation, but they have also plotted for alternate attacks.

Comparing the football analogy to an elementary school classroom, carefully thought-out plans incorporate a myriad of ideas, techniques, and activities to spur curiosity (motivation), state a problem, attack the problem, proceed to gather information, verify information, and arrive at conclusions.

Systematic plans are required to learn and make application to innumerable skills during the process of solving problems. However, the learning of the skills are garnered from systematic employment of teaching strategies.

Flexible planning allows for alternate plans of attack. Very few problems are solved by an orderly, step-by-step (lock step) procedure. If one line of attack doesn't produce results, an alternate tactic should be held in reserve.

SECTION B: DEVELOPING SKILLS USING GLOBES

1. **Of what value are globes in solving problems?**
2. **What principles apply to globe usage?**

Globes are often the forgotten maps of a classroom. Flat maps are so commonly used that globes, if in existence at all, are likely found in the schoolroom closet or placed on display, but seldom used. However, several concepts and understandings may be garnered more effectively through globe usage than by utilization of flat maps.

> Man's activities always have been related to the distribution of physical features over the earth's surface and to the effects of the earth's motion. In order to better understand his relationship to the earth, man developed methods and devices to study the earth. Of these devices none is more important than the globe.[1]

VALUES OF GLOBES

To indicate the vast importance of the globe in the study of man, his environment, and his activities the values in Figure 1 are of infinite merit:

Distortion-free. A globe is the most distortion-free representation of the planet Earth. In fact, globes are the basis of flat maps. If a globe and a flat map are not in agreement, the flat map is normally in the wrong. There has never been a flat map produced which approaches the accuracy of a globe. As the earth is a spheroid, the globe is a small replica of it and is a vital source of information for elementary students studying the social studies. Early in the life of a school child it should be realized the further away from the equator on most flat maps, the greater the distortion.

Because globes are spherical in shape, geographical features denoting size, shape, and distribution of land areas compared to water areas are quite accurately portrayed. Mercator, Azimuthal, and semi-elliptical projections are examples of attempts to make flat maps accurate; however, none of these methods portray the geographical features of the earth as concisely nor as accurately as a globe.

Hand drawn globes provide maximum accuracy. However, few globes are hand drawn; most are printed. Since a

1"Successful Teaching with Globes," Denoyer-Geppert Company, 1957, p. 14.

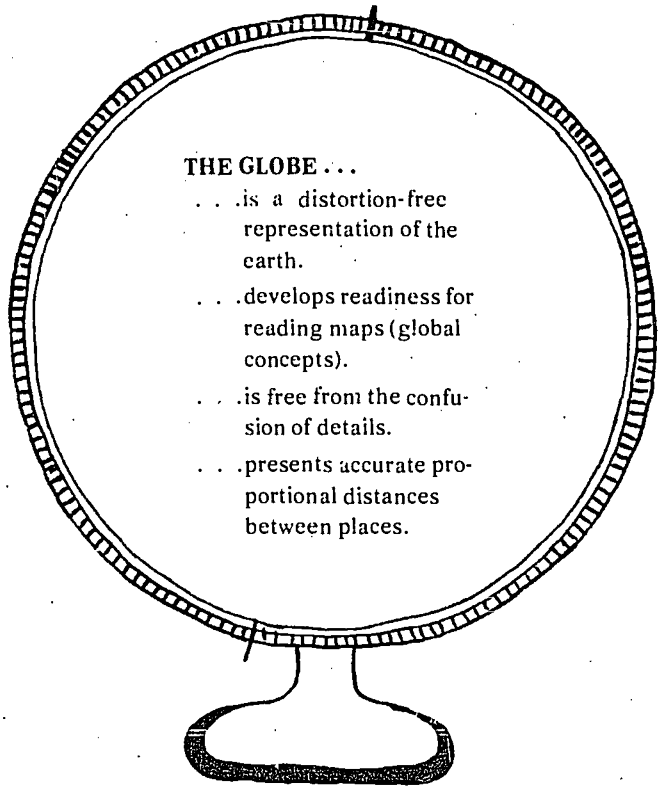


Figure 1. Values of a Globe

satisfactory spherical printing press has not yet been invented, most globes are made of flat gores of paper which are stretched and pasted onto the globe.

Readiness for Flat Maps. During the first years of school the globe should be an essential tool for developing children's geographic understandings. The globe should be the forerunner of flat maps. Early experiences in using a globe develops readiness for map and globe reading in later years. The map readiness value of globes does not terminate with primary students. Although flat maps are used more frequently as students advance through educational levels or grades, globes continue to provide a valuable asset for teaching geographical concepts.

Free from Details. Globes are usually not detailed by representing every conceivable geographic feature of the earth's surface. Flat maps, scaled to depict small surface areas, are considerably more effective is showing detail. The globes strength lies in its unclutteredness. Relationships of size and shape of hemispheres, continents, countries, and water areas, may be readily learned through globe usage because details do not handicap the user.

Accuracy of Proportional Distances and Directions. A flat map of the world cannot proportionately present true distances or directions. Distances between two places on a globe can be projected quite accurately. The tapered effect of the globe allows for near-accurate scaled distances. The globe's roundness likewise creates an accurate representation of direction.

Principles Pertaining to Globe Usage

Seven generalizations are applicable to globe usage in elementary classrooms. The generalizations, or principles, are briefly presented by Figure 2.

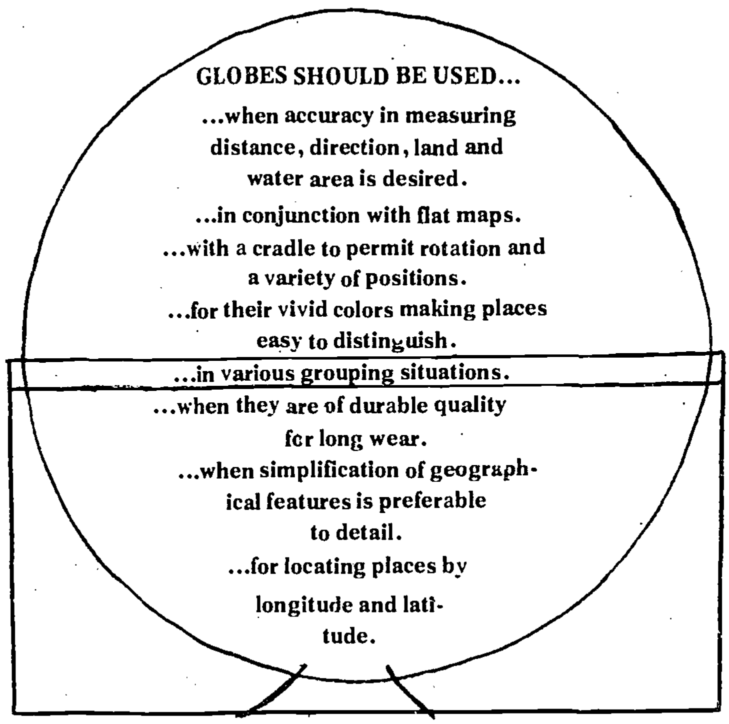


Figure 2. Principles for using globes.

Globes Should be Used for Accuracy in Measurement. When accuracy in measuring distance, direction, or surface areas of land and water is important globes should be used rather than flat maps.

Globes Should be Used in Conjunction with Flat Maps. A question often heard is, "When should globes be used rather than flat maps?" Although globes and flat maps each have advantages they seldom should be used to the exclusion of the other, rather in conjunction with one another. Comparing and contrasting information gleaned from both globes and flat maps leads to better concept formation. Through the processes of comparison students discover advantages of each type of map. But, it is important to hold the concept that globes and flat maps are not in competition with each other. They are in cooperation and should be used in that manner.

A Cradle Should be Provided for the Globe. Whether using large globes in a large group setting or smaller globes in small groups or individually, a cradle permits rotating the globe. Rotation of the globe is of considerable value in learning time, direction, and distance concepts. Additionally, the cradle furnishes a substantial base and provides an easier method for storing globes.

Time Concepts. By rotating the globe students may become aware of such understandings as why time changes each 15 degrees and how night and day occur. Experimentation with lamps to show night and day is made more realistic by facility in turning the globe.

Directional Concepts. By allowing the globe to rotate in the cradle, direction becomes more accurately defined in the student's mind. "Up" is not necessarily related to north. "Up," defined as away from the center of the earth, becomes meaningful. When asked, "Which direction would you fly when traveling from New York to Hong Kong," students may readily find the shortest route is north and then south. The route takes one almost directly over the North Pole. The concept of north being toward the North Pole becomes well imbedded.

Concepts of Distance. Referring to the example of the flight between New York and Hong Kong the shortest distance is nearly over the North Pole. Using a wooden cradle with a horizon mounting the cities may be lined up along the frame with the North Pole facing directly toward the students, "eye-ball to eye-ball." Globes framed in a stand and metal ring (stand mounting) are quite useable in determining distance and direction. In this type of situation, a string may serve as the "yardstick" for measurement.

Colors Should be Vivid and Easy to Distinguish. The smaller the globe the smaller the representation of the various countries and states. Because the representation is small, colors should be vivid to differentiate the political boundaries of countries. Globes of larger dimension, such as the 16 inch ones, need not be as sharply differentiated in color.

Colored and raised relief maps, especially, should be distinctive in the shades of blue, green, yellow, and red.

Size of Globes Should be Related to the Size of the Group. Large globes, 12 to 16 inches, should be used with large groups or an entire class. A large globe should be made available in each classroom for individual reference as well as group reference, experimentation, and discussion.

Smaller globes, six to eight inches, should be available for use with individual students or pairs of students.

No matter what grouping arrangement — individual, pairs, small group (committees), or large group — globes should be readily available for learning various geographical concepts.

Globes Should be Durable. To withstand long wear and frequent use, as well as misuse, globes should be durable. Easily punctured plastic globes are not economically feasible if they do not stand the wear and tear of classroom use. However, our world, geographically, changes rapidly. If globes are of sufficient quality to last eight to ten years they are quite adequate.

Geographical Features Should Display Simplicity. Detailed geographical features is not an important aspect of globes. Since the size of globes is relatively small in proportion to the earth it is not realistically feasible for globes to be detailed. If the globe significantly illustrates the hemispheres, continents, countries, bodies of water, and major cities it is sufficiently detailed.

Longitude and Latitude Should be Clearly Indicated. Flat maps cannot accurately depict longitude and latitude markings. Globes may serve a quite useful function by clearly established markings of longitude and latitude for students to learn how to locate places by degrees and minutes.

SECTION C: MAKING FLAT MAPS

What are some advantages of flat maps?

Why should various projections of flat maps be understood?

- **What is the Mercator projection?**
- **What is an Azimuthal projection?**
- **What are some other types of projections?**

How may geographical concepts be acquired through map making?

What are some techniques for drawing or sketching maps?

ADVANTAGES OF FLAT MAPS

Although globes are, proportionately, more accurate in their portrayal of the planet earth, flat maps are indispensable for many occasions where globes may not be advantageous.

Flexibility. Perhaps the greatest advantage of flat maps is their flexibility. Flat maps have a wide variety of purposes. Globes normally show political divisions of the world or relief of the earth's surface. Flat maps may also represent political divisions and relief. In addition, flat maps portray land use, natural resources, highway routes, railroad and airway routes, and dozens of other geographical features not indicated by globes.

Globes represent the entire world. Globes never portray only a continent, one country, one state or a very small section of land. Flat maps may be constructed on virtually any scale desired. Very small areas such as a city block of a small park may be charted on rather large scales. As an example, Yellowstone National Park in Wyoming may be represented on a flat map by a scale of 4" equal to one mile. A globe constructed to the same scale would be so large it wouldn't fit into a school classroom.

Flexibility of flat maps is likewise exhibited by various types of projections. Depending upon what purpose the map is intended a specific type of projection can be drafted to meet special needs of the map reader.

Inexpensive. Flat maps are considerably lower in cost than globes. Although the price range of wall maps and other flat maps vary markedly the expense is not so great as purchase of globes. Many maps are free or available for a small cost.

Storage. Flat maps may be folded and stored in drawers. Even wall maps can be quite easily stored in closets or out of the way places where globes take up greater space and do not lie flat.

Detail. Because flat maps can be constructed on a larger scale than globes more geographical features, both natural and man-made, are shown in detail. Detailed symbolism would clutter a globe rendering geographic features unrecognizable.

FLAT MAP PROJECTIONS

Flat maps of the world are the offspring of globes. Cartographers have tried a variety of ways to peel the world off "Mother Globe" and project it onto a flat surface. The typical classroom activity is to indicate how this may be accomplished is to skin an orange and position it on a flat surface. A better and less messy example is to cut a ball into pieces to indicate how attempts have been made to present an accurate mapping of the round earth on flat surfaces. But, no matter how long and hard the map makers have tried to make flat world maps as accurate as globes, the many arcs just would not flatten into a single plane. Sections of the world would stretch in one place and kink, sag, or bulge in another. One place would be shifted in its position from another, and no distances would remain as they appeared on the globe.

Inaccurate though flat maps may be, several types of projections show parts of the world or areas of the earth in distances, directions, and shapes quite similar to those depicted on the globe. Two of the most noteworthy projections are the Mercator and Azimuthal Equidistant Projections.

Mercator Projection. This is the most widely observed and well-known projection. At the same time it is, perhaps, the most misunderstood. The Mercator projection has an equator of correct proportions. North and south of the equator the projection appears as though strings were attached, at one end, to each corner of the flat map and, at the other end, to each country, island, and lake on the globe. A sheet of paper (flat map) curved partially around the globe is then opened, stretching and pulling the shapes of the countries, islands and lakes.

In Mercator's projection the lines of meridian are parallel, never coming closer together toward the North and South Poles. To compensate for the parallel meridians, Mercator moved the parallels farther apart from each other according to the proportional distance between his "straight-line" meridians and the "curved line" meridians on a globe. As an example, the 60th parallel on the globe is just half the size of the equator; but on Mercator projections it is the same size. To make up for this east-west magnification Mercator doubled the north-south exaggeration (parallel) at the 60th parallel.

The effect of this balanced stretching results in shapes that resemble those on the globe. Yet, the only true to shape land and water forms are those near the equator. The stretching

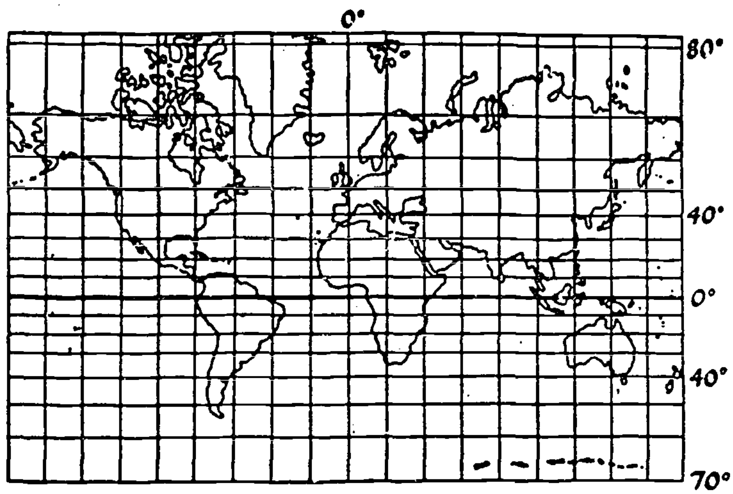


Figure 3. A Mercator Projection

makes areas appear larger in the northern and southern latitudes.

By applying a scale of miles to a Mercator projection different scales would indicate the miles at various latitudes. The following diagram illustrates the differences in scale at several latitudes:

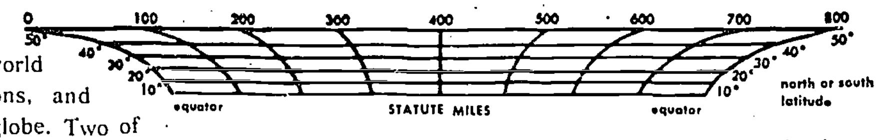


Chart 2. Differences in mileage scales on a Mercator Projection at latitudes 0°, 20°, 40° and 50°.

Azimuthal Projection. An Azimuthal Equidistant projection ordinarily gives an accurate view of the polar caps; in fact, is often used in making polar caps for globes. The Azimuthal projection is often nicknamed the "Polar Projection" although there are other polar projections which may be equally as good.

The strongest feature of an Azimuthal projection is that all distances going out from one spot, often the North or South Pole, are true to scale. As the Mercator projection stretches the land and water areas nearer the poles, the Azimuthal projection, with the pole as the center point, stretches the earth's surface near the equator.

Azimuthal projections may be made from any point on the earth's surface. By centering on a cite, such as Memphis, Tennessee, an Azimuthal Equidistant projection would enable the flat map user to gauge, accurately, the distance to any other point in the world — a true, constant scale of distance from the central point to all other locations.

The Azimuthal projections are normally seen as hemisphere maps or polar-centered maps. They are focal and radial maps. The focus is upon a certain point and the rays or radiating lines from the focal center have correct bearing. These radiating lines are also called great-circle lines and are always straight.

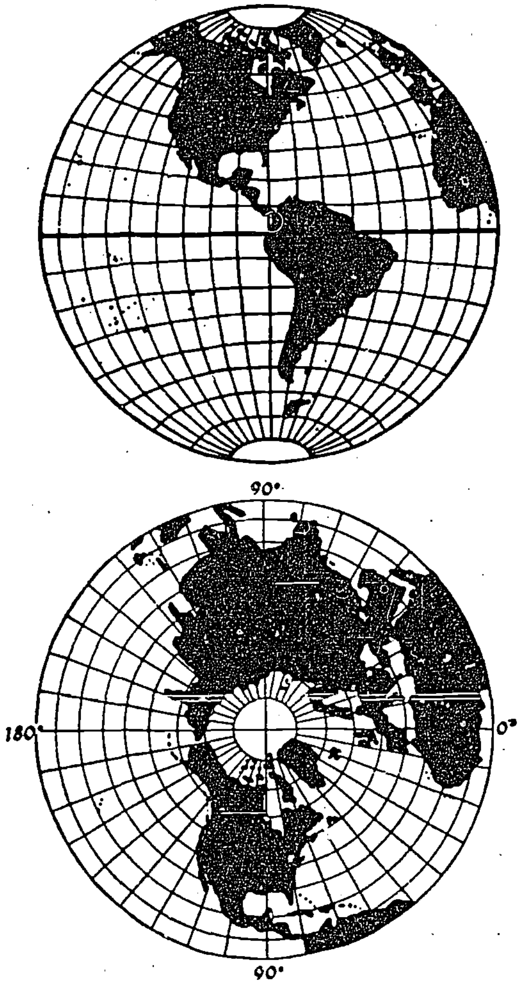


Figure 4. An example of Azimuthal Projections

Other Projections. One of the earliest attempts to "flatten" the globe was made by Cahill in the early 1900's. He reasoned that eight curvilinear triangles, each representing one-eighth of the world was about as much as could be represented without unreasonable distortion. His end product was Cahill's Butterfly World Map.

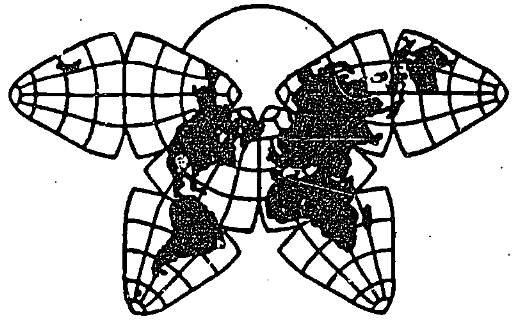


Figure 5. Cahill's Butterfly World Map

Goode, in the 1920's fashioned an interrupted projection of the globe. He contended maps could be interrupted in any section of the world for which the map user was not interested. For oceanographers, and persons interested in sailing and charting the seas he interrupted the continents, thus allowing a near accurate representation of the oceans. For those interested in charting the land surfaces the oceans were interrupted allowing near accuracy of land shapes and sizes.

Conical and polyconical, though difficult, are other projections sometimes noted. Identifying characteristics of the conical projections are parallels forming concentric arcs which are equally spaced and straight-lined meridians which narrow toward the poles. The conical maps compromise shape, area and scale. Although not perfect, there is little that is excessively imperfect in the conical projections. Lambert's Conic Projection and Alber's Conic Equal-Area Projection are deviations of the basic conic projection.

Polyconic projection compromises shape, area, and scale to a point where they are useable only in small area, east-west plottings. However, in small area maps the direction, distance, proportion, and shape are true.

Stereographic, gnomonic, polar equal-area, polyhedron, eumorphic, and semi-elliptical projections are other efforts to accurately portray the round, round earth on a flat, flat plane.

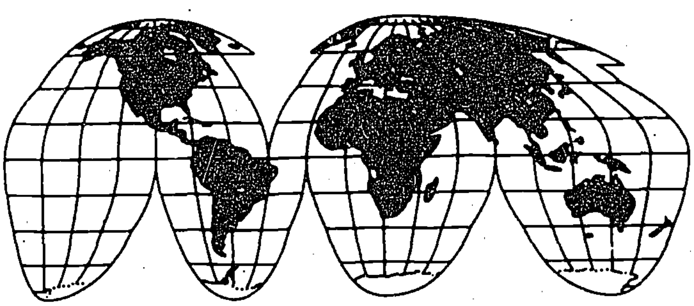
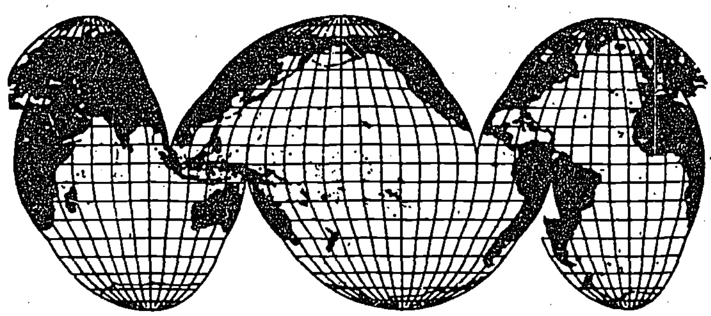


Figure 6. Goode's Interrupted Projection



Goode's Homolosine Equal-Area Projection

ACQUIRING GEOGRAPHICAL CONCEPTS THROUGH MAP-MAKING

Map-making projects provide optimal opportunities for students to learn through discovery and inquiry processes. Motivation for making maps is derived most efficiently by providing a challenging problem. If students feel the problem is theirs, a real need for map-making is developed. How is this "feeling" for ownership of a problem and need developed? Samples of how several teachers have supplied motivation and involved their classes in map-making activities follow:

1. Planning: One teacher of eight and nine year old students (third grade) asked the class to help plan activities for learning more about the city in which they lived. Their study problem was, "What are the most important things we could learn about our city, Topeka, Kansas?" Before the class was ready to formulate plans, the teacher's responsibility demanded that her students realize a need for a greater data base from which to draw clearly defined ideas. This realization, by itself, brought about a purpose for reviewing existing maps of the city, learning to locate various places by using the legend. After spending several weeks learning about their city the class began to formulate plans. The teacher, one day, distributed individual mimeographed maps showing only the major roads of the city. The students were asked, individually, to indicate on the map places they would like to know more about, either through field trips, resource persons visiting the classroom, or obtaining information from printed reference materials. Upon completion of this activity the students formed small committees to agree upon which areas they considered most important to study. The day following, the class members found a large teacher-made map (4' x 8') of the city, showing only major streets, pinned to the bulletin board. The small group committees proceeded to report their plans to the entire class. While the committees reported, other students marked, in pencil, symbols representing the areas in which they desired knowledge. In this particular situation there were three vital activities in map-making procedures— (1) interpreting already existing maps; (2) completing individual maps; and (3) completing the large group map.

2. An upper grade (junior high) teacher obtained aerial photographs of a locality from a city newspaper. To study the history and size of the home town and surrounding countryside the students made maps from these aerial photos which showed their locality, periodically, from about 1920 through 1973. By making map comparisons of the community at various dates throughout the past 53 years, students not only knew the history of their locality better, but also the present city. The map-making activity branched out into side study excursions. Students studied the historical development and growth of several industries. By comparing maps of different vintages the students investigated various locations and growth of such institutions and government buildings as city hall, libraries, schools, hospital, and churches. Growth of the city in terms of population was traced and reported to the class by a special committee. Several persons were obtained as resources to aid in the historical study. The entire problem was motivated by the map-making activity which developed from the teacher's opportunism in obtaining aerial photographs of the locale.

3. An intermediate grade classroom constructed a map of South America and traced the route of travel as a top political figure from the United States visited various Latin American cities. The daily newspapers reported the reactions of the South American people to the visits by the United States representative. From locating each city on the map and a globe the students, daily, located information concerning the various cities and countries. Discussions developed because the arrival of the politician in Caracas, Venezuela was greeted by jeers and cat-calls. The reception at Quito, Ecuador and Lima, Peru was met with very positive action. What caused the difference in feeling? How do people in Venezuela, Ecuador and Peru feel about people in the United States? Why? These questions were analyzed as a result of a well-known political figure making a journey to South America and a teacher's inventiveness by capitalizing upon map study which supplied motivation to deeper study.

SUGGESTIONS FOR NOVICE CARTOGRAPHERS

Maximal map information is not attainable unless the symbolism is interpreted correctly by persons reading the map. Junior cartographers can be taught some basic skills in symbolizing various geographical features which can be adequately interpreted by others.

First grade teachers may draw symbols on the chalkboard. In later grades students refer to published maps to gain an awareness of what symbols are used to represent various features.

Although some symbols are widely used, there are no specific symbols which must be used by cartographers. As an example, towns are normally represented on a map by a dot. However, the cartographer has the prerogative to use some other symbol to represent a town if he so desires. He may choose to use an X or a small square. The important aspect of map-making is to record the symbolic representations in the map key or **legend.**

What are some helpful hints for constructing maps? Suppose the novice cartographer wishes to symbolize a river. Merely draw a line.

Illustration 1: Symbol for a river.

A river is nearly always crooked. Smaller streams flow into rivers. Large streams of water are made with heavy lines and smaller streams (tributaries) are made with a light line. As the river becomes wider, the line is drawn more heavily.

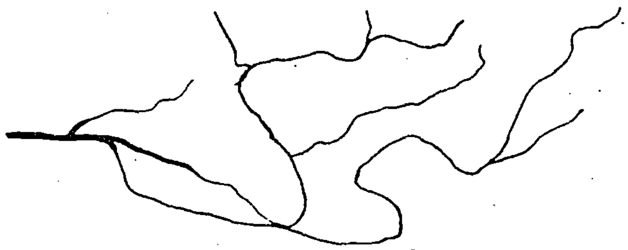


Illustration 2: Symbol for a river and its tributaries.

A lake with rivers flowing into or out of it is easily represented.

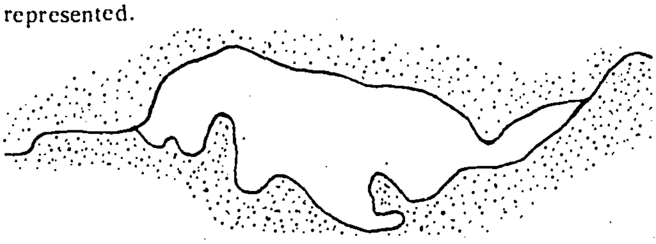


Illustration 3: A lake connecting two rivers

How may a beach be symbolized on a map? Have the students seen a beach? On a map we call the beach a coast line. This is a coast line:

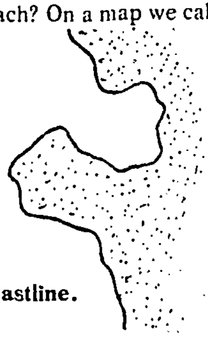


Illustration 4: A coastline.

A coast line with a river flowing into an ocean may be represented in this manner:

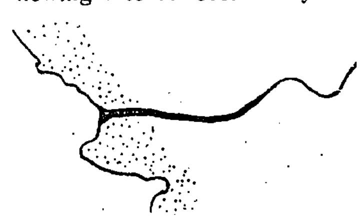


Illustration 5: A coast line with a river flowing into an ocean.

When the shoreline curves and makes an indentation into the land a bay or gulf is formed. A bay or gulf may be represented in the following manner:

Illustration 6: An island and a bay or gulf.

An island is also depicted in the above illustration.

More advanced, yet elementary, cartographic techniques include the use of shading, lines, hachures and color layers to portray relief.

Shading. Forming representations of mountains and valleys by utilizing shading is an easily developed technique. Mountains appear bright and shining on one side by making a mountain slope with the point of a pencil. The shadow side of a mountain may be sketched with the side of the pencil lead. This gives the impression of slope, elevation and a suggestion of ruggedness. The appearance is a three-dimensional effect of valleys and mountains.

Illustration 7: The use of shading for sketching mountains and valleys.

Hachures: The hachure is a name for small, short strokes or lines, usually parallel, indicating breadth and depth of surface features. The length and angle of the hachures indicate slope. From the nature of the hachures direction and steepness are likewise indicated. Proper perspective is difficult to achieve but hachures are most appropriate for the novice map-maker.

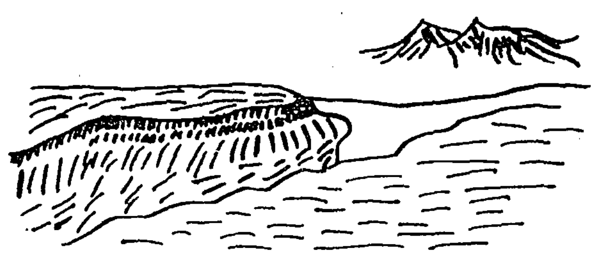


Illustration 8: Using hachures for showing relief on maps.

Contour Lines and Color Layers. Contour lines are extremely difficult for most students to comprehend. Drawing contour maps is a recognized way of enabling a student to gain a concept of what contour really indicates. Relief (elevation) showing contour of the land may be drawn in two ways, (a) by lines and (b) by color layers. Color layers are used on most relief, physical-political atlas maps.

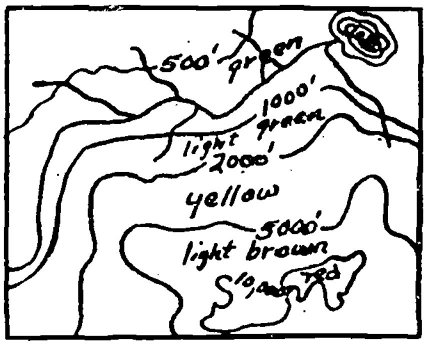


Illustration 9: Using color layers to show relief.

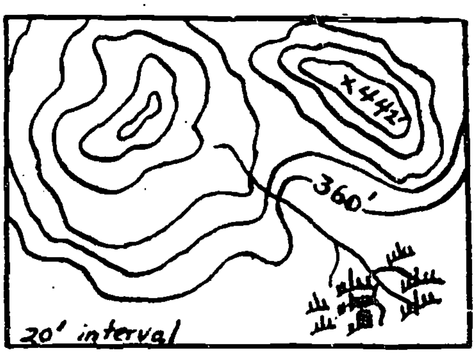


Illustration 10: Using contour lines to show relief.

SECTION D: GUIDING CONCEPT DEVELOPMENT OF MAP SYMBOLISM

What are the skills and understandings related to symbolic representations?

What activities may be helpful for teaching symbolic concepts?

What are the generic map terms represented by symbols?

Although applying to pictures, the adage, "a picture is worth a thousand words," is also appropriate for maps. There is a great body of geographic terminology that cannot be defined in words nearly as efficiently as they can be described on a map. However, the terminology must be linked with the knowledge and experiential background of the student to convey meaning. Because a map is a pictorial representation of geographical and scientific terms, proper concept development is necessary for optimum map reading and interpretation abilities. Learning to interpret maps should take place through seeking solutions and ideas for problems, rather than an activity as an end in itself. Map reading and skill development should take place through projects and activities of the classroom. However, maps and globes may be utilized for many learning situations which may or may not evolve from the social studies class directly. Maps should be reference tools whenever they lend extra visual perception to the learning task. Map symbols carry a tremendous amount of knowledge to the map reader. It is, therefore, important for teachers to plan for teaching map symbolism.

CONCEPTS, UNDERSTANDINGS AND SKILLS RELATED TO SYMBOLIC REPRESENTATION

Maps and globes use a myriad of symbolic representations for places, events, and other items of useful information. Learning to recognize map symbols requires the same depth of perception required for associating the letter names with the letter symbol in reading the printed word. Many of the symbols bear little or no resemblance to the object represented. Concrete symbols (pictorials) are often found in product maps or natural resource maps. Concrete symbols include such pictures as vegetables, fruits, minerals, houses, churches, and schools. Semi-concrete symbols depict replicas of the actual object, but are not full pictorials. An example of a semi-concrete symbol is a tree marking a spot for camping or a fish-like symbol marking the location of fish hatcheries. Most symbols are completely abstract. Various colors represent elevation. Lines represent rivers, boundaries, highways, ferry and boatlines, trails, railroads, and airways.

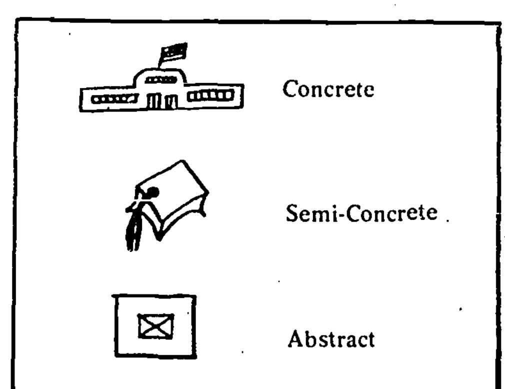


Figure 7. Degrees of abstractness in symbolic representations. Each of the three symbols represents a school.

As in mathematics, the concept of many educators has been to proceed from the concrete to the abstract degree. It is not necessarily accurate to assume this is the most efficient progression for learning map symbolism. If a child has an adequate concept of a lake, the map symbolism of a lake will be meaningful. If a child has no concept of a fish hatchery the symbol will carry nc meaning and likely will be an unlearned symbol. However, verbalized learning may take place. It is not uncommon to find intermediate grade children who can verbalize the definition of a peninsula as, "A strip of land surrounded on three sides by water," yet who are unable to point out a peninsula on a map. First-hand or vicarious experiences are necessary. Meaning is conveyed to the map user only when some meaningful experience is brought to the symbol..

A research investigation conducted in Oregon elementary schools vividly illustrates the necessity of students associating experience with printed map symbols and geographical terms, including lines and colors. One-hundred eighty-eight sixth grade students were asked to identify, by pointing to an atlas map, ten geographical terms. The ten terms were bay, cape, island, lake, river, peninsula, mountains, valley, state boundary and county boundary. One-hundred sixty-one students (85.6%) were unable to identify a cape. In Oregon many children have, physically, seen capes; yet a great percentage couldn't identify a cape on an atlas map of the state of Washington. However, a cape may be a trifle difficult to comprehend, but should a valley? Ninety-seven of the sixth graders tested (51.1%) were unable to identify a valley. Sixty-seven (35.6%) could not identify a peninsula. Astonishingly, sixty-three students (33.5%) were unable to select the proper representation of a river (in this situation, blue colored lines). Many of the sixty-three examinees selected the heavy red line which represented state boundaries or a thin red line which represented county boundaries. A few selected lines of latitude or longitude which were light green in coloration. Additionally, forty-eight (25.5%) and thirty-seven students (19.7%) were unable to identify, correctly, county or state boundaries. Of the other three geographical terms, bay was selected incorrectly by thirty-eight pupils (20.2%); mountains by sixteen pupils (8.5%); island by ten pupils (5.3%); and lake by eight pupils (4.3%) [1]

Teachers cannot take it for granted that students are able to interpret map symbols. There must be a foundation laid upon which students may build concepts. Two major concepts are presented in the following pages; (1) symbols on maps represent natural geographic features and man-made structures, and (2) colors usually signify elevation on physical-political and relief maps: political sub-divisions on political maps.

It must be noted the grade level distinctions should be very loosely regarded. The grade level designations — primary, intermediate, and upper — are provided as a guide, not a law. Need, interest, and maturity of the students are much better prognosticators of readiness to learn map symbols than classification in a social studies textbook.

[1]op.cit., Gengler, pp. 129-132.

Primary level refers to skills and understandings to be developed during the first three years of school. Intermediate refers to the years four, five and six. Upper refers to the seventh and eighth years of a student's school life.

MAJOR CONCEPT: Symbols on maps represent natural geographic features and man-made structures.

SKILLS AND UNDERSTANDINGS RELATED TO CONCEPT

Primary: Understand symbols for land, water, mountains, cities, cliffs, coastlines, directional indicators, falls and rivers.
(See glossary beginning on page 17.)

Recognize concrete and semi-concrete map symbols representing man-made structures such as schools, churches, and airports.

Intermediate: Understand the relationship of photographs to map symbols. Aerial photographs are used extensively for map reading.

Recognize and understand symbols for county, state, and international boundaries, canals, bluffs, dunes, glaciers, capital cities, towns, villages, deserts, grasslands, mountain peaks, tributaries, swamplands, marshes, and volcanoes, lava beds, lava flows, mountain passes, summits, plateaus, and rapids.
(See glossary beginning on page 17)

Recognize and understand most symbols for reading highway maps.

A legend is provided for helping to locate places.

Recognize and understand symbolism on special purpose maps indicating climate (including weather maps), distribution of population, transportation, and products.

Size and darkness of print (bold-faced type) indicate size of cities.

Upper: Understand and recognize symbols for escarpments, reefs, and shoals.
(See glossary beginning on page 17.)

Understand and recognize all symbols on highway maps.

Symbols may vary for identification of the same feature or structure, but the legend will determine the representation.

Contour lines indicate elevation on topographical maps.

Recognize and understand symbols on a weather map representing cold fronts, warm fronts, isotherms, isobars, isolines, wind velocity, wind direction, and ocean currents.
(See glossary, page 35.)

ACTIVITIES RELATED TO CONCEPT

1. Primary: Construct a map of the school playground. Create symbols which represent various play equipment — slides, ladders, merry-go-round, teeter-totters, swings. (See figure 8).

2. Primary: Pupils construct maps of the route from home to school and surrounding areas.

3. Primary: Supply individual mimeographed maps of the town, city or community in which the students live. On this map include only streets and roads, identifying the roads by name labels. Ask the students to draw symbols which would represent various landmarks which are important to people in the community. Landmarks might include schools, churches, airports, historical sites, historical markers, rivers, mountains, or even homes, trees, fences, etc., which may be important to the locale. Remember: Symbols for the landmarks may be the creation of the students, but the symbol must appear in the legend if others reading the map are to benefit from its contents.

a. The class may wish to draw boundary lines on the map for the town, city, school district or other divisions of political units.

b. At the third or fourth grade level this activity could be extended by including a wider area and adding coloration for denoting elevation.

c. Consider the above activity for the entire class with the map drawn on a large piece of white butcher paper.

4. Primary: Use a flannel board to construct maps. Symbols, made of flannel, are placed on the flannel board to represent various geographical features. Note the sequence of flannel board symbols added to the flannel board by two first grade girls in Figure 9.

5. Primary: Have students take turns feeling the kinesthetic sensations of an uncolored relief globe. How do you determine the difference between land and water areas by feel? How do you determine the differences between mountains, coastlines, and lower areas?

6. Intermediate: Compare aerial photographs with actual maps of the same area. Aerial photographs may be obtained from persons employed in county and city government offices. Newspapers sometimes have aerial photos which may be obtained.

a. Construct maps from simple aerial photographs. Encourage students to devise their own symbols for various geographic features. Emphasize the need for devising a legend for other people interpreting the map symbols. In this activity it is important for students to delineate aerial photographs taken from a vertical viewpoint and those snapped from a slanted position.

7. Intermediate: Engaging the use of outline globes and maps draw in the physical features of countries, states, provinces, and regions studies. How are the various physical features symbolized on maps? Accuracy of placement is vital to concept formation of place geography. This activity should correlate meaningfully with problems developed in reference to countries of the Western Hemisphere.

8. Intermediate: Plan a vacation trip by referring to highway maps. What roads shall we travel? Why? Shall we camp out? If so, where? What national and state parks could be visited? At what points of interest shall we stop? Will we need to know where airports are located? From plotting places where the class or individuals would visit to the distance traversed, — students are actively engaged in using the map legend and learning symbolism. During this activity note two ways in which the size of cities is symbolized, on highway maps, on other flat maps, and on atlas maps — (1) by the size of the dot or other symbol, and (2) by the size and heaviness of print of the city's name.

9. Intermediate: Cut out, or ask students to cut out, flannel symbols representing various geographical features. Place the symbols on a flannel board. String is a useful item to outline the shape of a country, province or state on the flannel board.

a. The same flannel board may be used to compare special features of a country, province or state. Compare rainfall, products, population, vegetation and natural resources.

10. Intermediate: Special features of countries, provinces, states or local regions may be sketched on outline maps and globes.

11. Intermediate: Utilize a geographic features map to point out how various features are symbolized on a map.

12. Intermediate: Observe the weather. Not how the weather is symbolically recorded on weather maps by (a) viewing weather reports on television, (b) asking local weather station for a copy of their map on a particular day, (c) taking a field trip to the weather station, or (d) asking a weather station employee to visit the class as a resource person.

a. Construct weather recording instruments. Through observation of the weather and measurement by various instruments record temperatures, wind directions, and cloud forms.

13. Upper: A study of the water problems in an Asiatic or African country could develop into a map-making project for

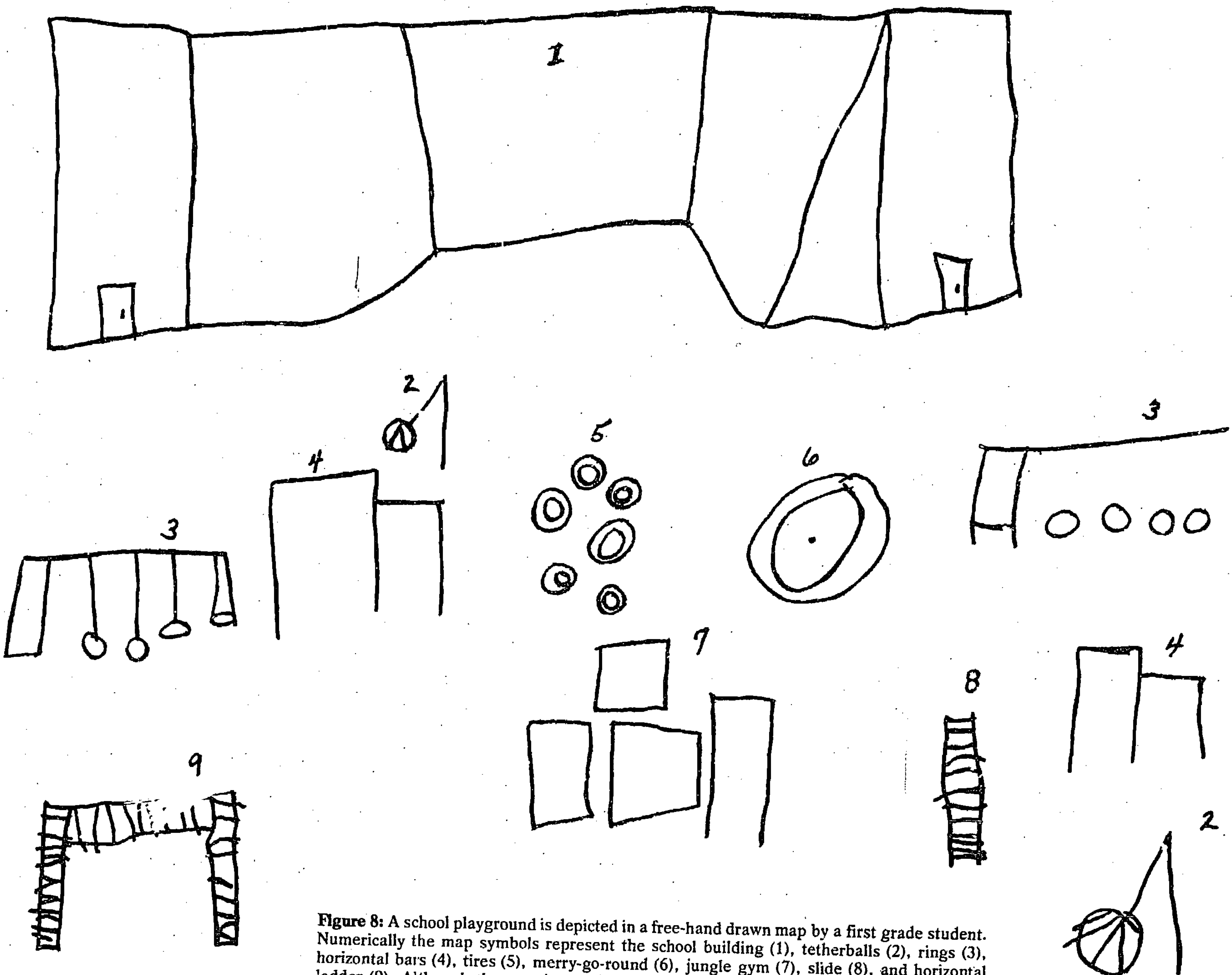
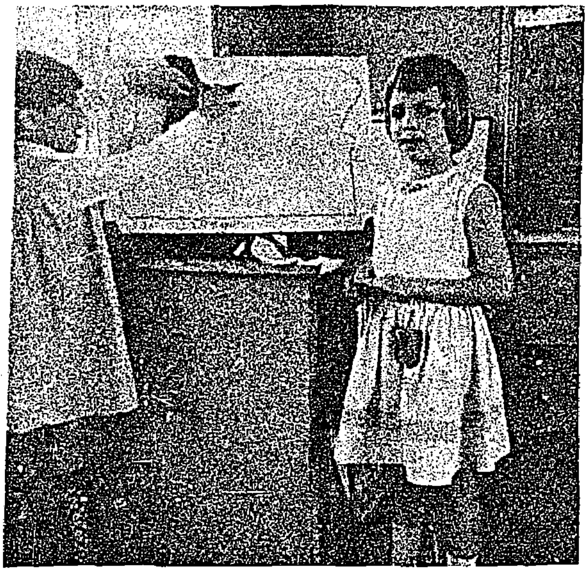
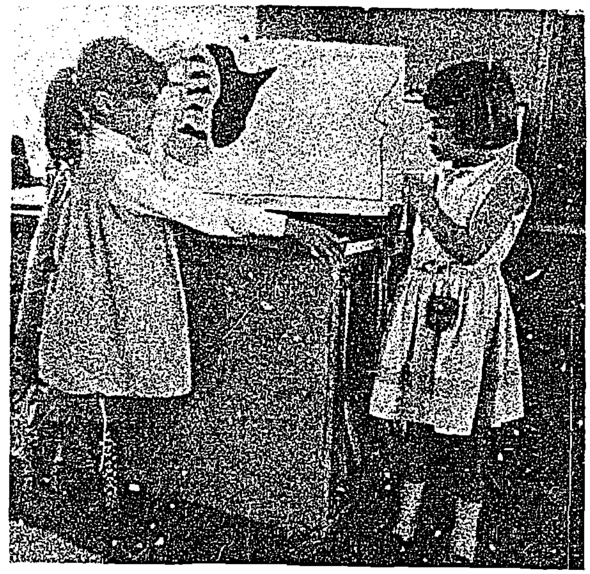


Figure 8: A school playground is depicted in a free-hand drawn map by a first grade student. Numerically the map symbols represent the school building (1), tetherballs (2), rings (3), horizontal bars (4), tires (5), merry-go-round (6), jungle gym (7), slide (8), and horizontal ladder (9). Although the map is not drawn to scale this first grade youngster is gaining rudimentary concepts of symbolic map representations and place position.

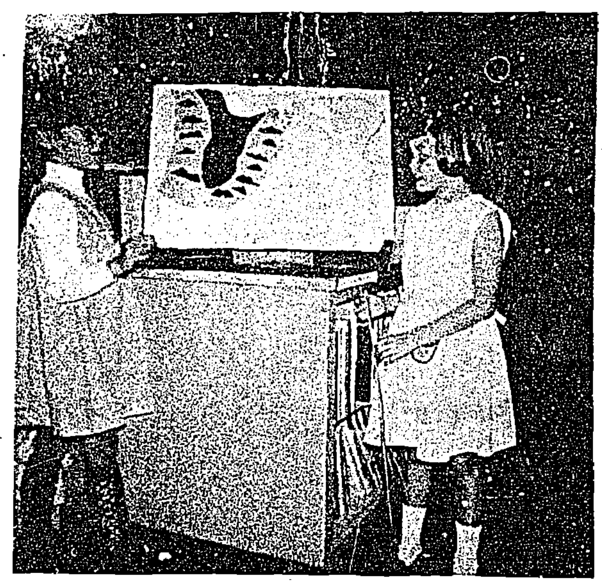


1. The Willamette Valley is positioned in the appropriate place. Green flannel corresponds to the symbolism for altitude of this valley.



2. Symbols indicating mountains are added to the west of the valley. These symbols represent the Coast Range.

3. Symbols indicating mountains are added to the east of the valley. These symbols represent the Cascade Range.



4. Symbolism of two cities most important to the students are added to the flannel board map. These symbols represent the cities of Salem and Eugene.

Figure 9. A sequence of four pictures illustrating the construction of a flannel board map of Oregon's Willamette Valley.

learning symbolic representations. Compare water diversion and pollution problems of Asiatic and African countries with those of the United States.

14. Upper: As in the intermediate grades, planning a trip through Europe, Africa or Asia may be beneficial in providing map-making motivation.

15. Upper: Construct maps from complex aerial photographs.

16. Upper. Map comparisons is a worthy activity for upper grade students. Comparing topographical maps with physical-political and relief maps; comparing special feature maps with one another and with physical-political maps; and comparing outline maps with other commercially available maps are all useful activities. How do symbols differ on each of these maps?

17. Upper: Discuss the value of weather maps to the individual as well as to the industry. Apply the value of weather maps to the weather of areas studied. Regarding the relation of weather to man's activities, Thralls[1] comments:

> Many people think that the farmer is the only one interested in weather, but actually almost every modern industry has to take weather into account. Many industries pay a large sum annually to private weather forecasting companies for special forecasts for their specific industry.

a. Construct weather maps symbolically charting the wind directions, wind velocity and air pressure.

SKILLS AND UNDERSTANDINGS RELATED TO CONCEPT

Major Symbolic Concept: Colors usually signify elevation on physical-political and relief maps; political sub-divisions on political maps.

Primary:

- Recognize difference between land and water areas.
- There is considerably more water than land area on the earth's surface.
- Land and water masses vary in shape and size.
- Continents or countries can be recognized by a change in color.

Intermediate:

- General understanding and ability to interpret the colors which represent various elevations:
  Shades of blue indicating areas below sea level. Green indicating low altitudes (0-1000 feet.) Yellow indicating intermediate altitudes (1,000-5,000 feet). Brown and red indicating altitudes above 5,000 feet.
- About 30% of the earth's surface is land; about 70%, water.

Upper:

- Complete understanding of the International Color Scheme. The International Color Scheme has shadings from dark blue, medium blue, light blue, dark green, light green, yellow, golden yellow, orange, brown, and red indicating increase in altitude from the lowest elevations below sea level to the highest elevations above sea level.

[1]Thralls, Zoe A. **The Teaching of Geography.** New York: Appleton-Century-Crofts, Inc., 1958, p. 58.

Activities Related to Concept

1. Primary: Draw a map of the school. Color each division of rooms a different color to distinguish between them. Stress the likeness of the division of classrooms to the division of political units.

2. Primary: Draw a map of a familiar region in which there is a body of water, preferably a lake or ocean. Students should recognize the difference in coloration between land and water areas.

3. Intermediate: Compare Southern Hemisphere with the Northern Hemisphere. Note the differences in land and water areas. Note the differences and similarities in elevations. How do North and South American continents compare in location of mountains and lowlands? Which of the continents has the most highlands? Lowlands?

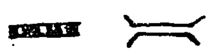
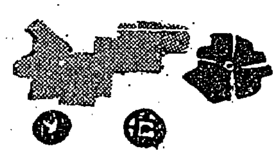
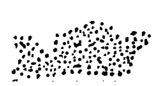
4. Upper: The teacher draws a cross-section of a country on the blackboard or duplicated paper. Cross-sectional drawings may be found in most encyclopedia. Ask students to color the cross-sectional drawing according to the International Color Scheme. Compare the cross-sectional drawings with the flat maps of the same regions.

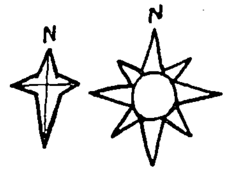
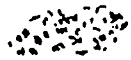
Glossary of Symbolic Representations

A working vocabulary of generic terms is a necessity for translating maps and globes into words. The following glossary of terms and symbols provides a guide to social studies teachers in aiding children to learn concepts about map symbols. (Note: Asterisks indicate the levels when understanding of the terms and symbols should be complete. Students may possess clear concepts of some geographical terms, yet not have lucid images of the symbols representing those terms. Such is often the case when terms as glacier, sand dune and cliff are mentioned.)

To the knowledge of the author, a glossary listing of this type is not available in other professional literature, nor in school district teacher's guides. The definitions are presented for purposes of clarification of terms. The intent of the description of geographical terms is not in the vernacular of elementary school students. Students shouldn't be expected to know definitions of terms as they are presented in this glossary listing. The same is true with glossary definitions in Sections E, F, G and H. However, teachers and students may be able to use these glossaries as students make maps. The glossary is useable for determining three facets of map and globe reading and interpretation; (1) distinguishing between similar geographical features, such as cliffs, bluffs and escarpments; (2) identifying well known symbols for geographical features; and (3) levels at which the concepts for geographical terms should be rather well imbedded.

SYMBOLIC MAP REPRESENTATIONS

Term	Definition	Examples of Symbolic Representation	Level
SYMBOLS FOUND ON MOST ATLAS MAPS:			
boundaries	lines which divide political units of government		
county	the lines marking the perimeter of a political division sub-dividing a state		**
state	the lines marking the perimeter of a political division sub-dividing a nation		**
international	the lines marking the perimeter of a political division between countries or nations		**
canal	an artificial waterway for navigation or irrigation		**
city	a large, incorporated municipality		*
capital city	the city or town which is the official seat of government in a county, country or state		*
town	a thickly populated area, usually smaller than a city and larger than a village, having fixed boundaries and certain local powers of government		**
village	a small community of group of houses in a rural area, larger than a hamlet and usually smaller than a town		**
cliff	the high, steep face of a rocky mass		*
bluff	a hill with a broad, steep face		**
escarpment	a long, precipitous, clifflike ridge of land or rock formed by faulting or fracturing of the earth's crust		***
coastline	the contour or outline of a coast; shoreline		*
desert	a region so arid it supports only sparse or widely spaced vegetation or no vegetation at all		**

direction	the line along which anything lies, faces, or moves; north, south, east and west are the basic directions		*
dunes	a sand hill formed by the wind, usually in desert regions or near lakes and oceans		**
falls	a body of water dropping suddenly to a lower position		*
glacier	an extended mass of ice formed from snow falling and accumulating over a period of years; glaciers move very slowly, descending from high mountains through valley glaciers or centers of accumulation (continental glaciers)		**
grassland	an area in which the natural vegetation consists largely of perennial grasses		**
lava bed	a substance formed when molten rock has solidified		**
lava flow	molten rock from a volcano		**
mountain	a natural elevation the earth's surface rising more or less abruptly to a summit and attaining an altitude greater than that of a hill		*
pass	a road, trail or natural land opening through mountains		**
peak	the pointed top of a mountain		**
summit	the apex or highest point of elevation of a mountain or a mountain pass		**
plateau	a land area having a level surface considerably raised above adjoining land on at least one side; often cut by canyons		**
rapids	a section of a river or stream where the current runs very swiftly		**
reef	a ridge of rocks or coral debris at or near the surface of water		***
shoal	a sand bank or sand bar in the bed of a body of water, especially one which is exposed at low tide		***
river	a natural stream of water of fairly large size flowing in a definite course or channel		*
tributary	a stream contributing its flow of water to a larger stream		**
swampland	a tract of wet spongy ground		**
marsh	a tract of low wet land, usually treeless and inundated; characterized by grasses, sedges, cat-tails and rushes		**
volcano	an opening in the earth's crust through which lava, steam, and ashes are expelled, usually at irregular intervals	+	**

* Primary grades 1-3 ** Intermediate grades 4-6 *** Upper grades 7-8

HIGHWAY MAPS

Road maps are vital instructional tools in a classroom. These maps express the same features as physical-political maps with an added feature — travel routes through the land shown on the map. Primary children should realize the value of highway maps as their parents and other adults use them.

For the motorist, a good road map is standard equipment. It tells him where to go and what he will find when he gets there; for travelers there is nothing more fascinating than a road map.

Anderzohn[1] surveyed 750 children below grade nine and found 43% acquired initial interest in maps through using and handling highway maps. This experience usually occurred outside the classroom. Anderzohn further found that approximately 65% of nine and ten year old children use maps and globes as a "pointer device" for locating places and tracing trips or routes of trips, either real or imaginary. At the junior high school level about 20% of the students used maps for planning trips of their own of following routes of trips taken with their parents.

Besides being fascinating, road maps will serve a highly functional role to the teacher who is alert and aware of its many instructional facets.

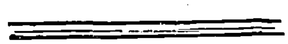
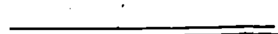
[1] Anderzohn, Mamie L., "The Child Looks Upon a Map," **Journal of Geography** 53: 238 (September 1954).

Values of Highway Maps. There are several advantages of road maps when comparing them to other types of maps. Perhaps the greatest advantage is their availability. Several sources of road maps are (a) major oil companies, (b) state tourist bureaus, and (c) **World Almanac** listings under the categories cities and parks. Free or inexpensive highway maps are also obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., 20402. Two such maps are the Standard Metropolitan Statistical Areas map (30" x 42") for 50¢ and a United States Map of National Parks, two sheets (23" x 29"), for 20¢ each.

For individual use by students large quantities of highway maps are readily available from oil companies and service stations. Storage of highway maps is considerably less troublesome than wall maps and are easily replaced when damaged or worn out.

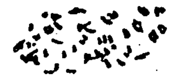
Another advantage of highway maps is the natural interest children have in them. Children find road maps fun to work with because most of them have taken trips with their parents and come into contact with them through daily life. Anderzohn[1] found that over 50% of junior high school youngsters studied maps just for fun, with highway maps of basic interest.

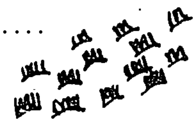
Symbols Found Principally on Highway Maps. Most highway maps symbolize THE SAME FEATURES AS AN ATLAS MAP OR A PHYSICAL-POLITICAL WALL MAP. However, some symbols are represented almost exclusively on highway maps. A glossary of symbols found principally on highway maps follows:

Term Represented Symbolically	Examples of Symbolic Representation	Level Symbols Should Be Recognized
ROADS		
divided highway (multilane controlled access)		***
highway interchanges		***
improved roads		**
paved roads		***
roads under construction		***
unimproved roads		***

county seats  **

desert  **

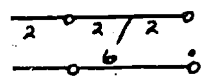
lava bed  ***

marsh  ***

swamplands **

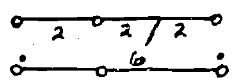
state monuments, memorials and historical sites  **

cemeteries  **

mileage distance markers 

**

between towns & junctions **

accumulated mileage between dots 

**

number designations of highways 

**

national interstate highways 

**

United States highways 

**

state highways 

**

points of intersest  **

roadside rest area **

state parks and recreational areas (no camping facilities)  **

camping facilities  **

state waysides  **

self-explanatory symbols  **

schools  **

airports  **

fish hatcheries  **

winter sports area  **

state memorials  **

state parks **

camping facilities  **

no camping facilities  **

time zone boundary **

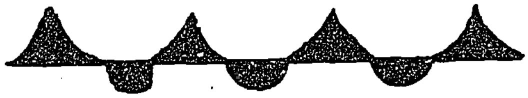
---

* Primary grades 1-3 ** Intermediate grades 4-6 *** Upper grades 7-8

SYMBOLS FOUND ON WEATHER MAPS:

Frontal Systems

Type	Color	Symbol
cold	solid blue	
warm	solid red	
secluded	solid purple	

upper cold	dashed blue	
upper warm	dashed red	
stationary	alternate blue & red	

Weather Symbols

fog

rain

funnel cloud

thunderstorm

drizzle

squalls

haze

sleet

ice needles

light rain shower

dust

lightning

snow

Wind Symbols

Wind Direction

west wind

east wind

north wind

south wind

northeast wind

northwest wind

southeast wind

southwest wind

Wind Velocity

calm

1-4 mph

5-8 mph

9-14 mph

15-20 mph

21-25 mph

26-31 mph

32-37 mph

38-43 mph

Sky Symbols

 no clouds

 less than one-tenth or one-tenth

 one quarter coverage (2-3 tenths)

 four tenths

 one half (five tenths)

 six tenths

 three quarters (7-8 tenths)

 overcast with openings or completely overcast

 sky obscured

Area Symbols

 shower area

 thunderstorm area

Precipitation area
(represented by color)

solid green .... continuous
green hatching ... intermittent
solid yellow .... fog
solid brown .... dust

SECTION E: GUIDING DEVELOPMENT OF DISTANCE CONCEPTS RELATED TO MAP READING

What is the importance of scale?
What are the skills and understandings related to distance concepts?
What activities are helpful for teaching distance concepts?
What map terminology is related to measuring distance?

A group of adults at a PTA meeting were asked to fill out a questionnaire. One item called for the distance of the school from their home. After gathering the questionnaires and computing the data, it was found that some of the people knew exactly how far they lived from the school, perhaps having clocked the distance on the automobile mileage gauge. But, others miscalculated the distance by a considerable margin. One lady who lived .3 miles from the school answered 1.5 miles. Another person who lived 3.8 miles from the school thought the distance was about one mile. What perceptions of distance did these people have? What perceptions do children have of distance?

Even when a person holds a satisfactory concept, distances on a map or globe may still be meaningless. Several learnings must take place before distance is meaningful. First, one must possess considerable knowledge about place geography, where cities or other geographical features are located. Secondly, the map reader must know how to use the scale of miles and understand what that scale represents. Thirdly, the map reader must have an adequate conception of how far the measured distance is. How far is 2,451 statute miles, representing the air distance between New York City and Los Angeles? That question may have as little meaning to many people as the question, "How much is a million dollars." It may be difficult to conjure up a visual image for either of these questions. However, a comparison of distances presently known to those unknown will aid in forming more clearly identified concepts of distance.

Scale

What is scale? What is large scale? Small scale? A vivid image of proportional distances represented by the map scale is virtually the only manner in which correct distances may be visualized. A perfunctory knowledge of scale will not suffice. Large scale or small scale maps depend upon the size of the area represented by the map and the size of the map itself. Scale is whatever the map-maker sees fit to use as a measure. A yardstick may be a large scale for measuring a classroom, but becomes a wholly impossible task for measuring the length of the Mississippi River. A large scale map might be based on three inches equalling one mile. A small scale map depicting the same region might be one inch equalling 100 miles or a scale of 1/00 inch to the mile.

Concepts, Understandings and Skills Related to Distance

MAJOR DISTANCE CONCEPT: Distance is a way of measuring how far from one place or point to another place or point.

Skills and Understandings Related to Distance

Primary:	Recognize familiar distances.
	Long distances appear to be short on maps and globes.
	Be able to chart distances on simple maps.
	Be able to express and compare distances in terms of near and far, too far to walk and near enough to walk.
Intermediate:	Know the definition of scale.
	A scale of miles provides a means of measuring distances on maps and globes.
	Be able to compare maps of varying scales.
	Ability to express and compare distances in miles and time.
	Determining distance on highway maps by road and by linear measurement.
Upper:	Know the meaning of scale, ratio and proportional distance.
	Be able to use graduated scales.
	Know the relation of scale to the selection of the geographic area to be mapped.
	Ability to measure distances in nautical miles, statute miles and light years.

Activities Related to Distance Concept

1. Primary: Trace routes to various places in the community — from school to home; from school or home to parks, swimming pool or other recreational areas, fire station, grocery store, and other schools. Estimate the distance. If able to check distance, provide answers for the estimates. Are these places near or far? Too far to walk?

2. Primary: Discuss the importance of landmarks in determining distance. Schools, churches, hospitals, industries, signs, streets, barns, uniquely-designed homes, and even trees are landmarks that may aid in developing a better "sense" of distance. Measure distances to various landmarks on a map—made by children or use a commerical map. Express distances to landmarks in terms of near or far.

IS IT NEAR OR FAR?

Circle the most likely answer.

The store is one-half mile away. The store is . . . . near, far, close enough to walk, too far to walk.

The beach is 420 miles away. The beach is . . . . near, far, close enough to walk, too far to walk.

Church is a five minute drive from home. The church is . . . near, far, close enough to walk, too far to walk.

The planet Mercury is our closest neighbor in space. Mercury is . . . . near, far, close enough to walk, too far to walk.

Philadelphia is a 20 minute flight from home. Philadelphia is . . . . near, far, close enough to walk, too far to walk.

It takes five days to sail to Honolulu. Honolulu is . . . . . . near, far, close enough to walk, too far to walk.

Chart 3. A test for primary children to ascertain concept of distance.

3. Primary: On a map of the community draw a one mile diameter circle around the school attended by your class. Determine how far each pupil lives from the school. How much time does it take to walk from home to school? How much time does it take to run?

4. Intermediate: Relate the distance of one mile to miles per hour when traveling in a car. (Ratio of one mile to one minute).

5. Intermediate: Locate geographical areas in relation to mountains, river, railroad, bay, etc. Measure distance by road or highway maps. Measure distance by scale of miles on several maps of different scale.

6. Intermediate: Make use of a magnifying glass to build the concept of scale as a proportional distance. Hold a magnifying glass over a small scale map, perhaps an atlas map or one in a social studies textbook. Note that as the map details are magnified the map scale is enlarged to the same mathematical extent.

7. Intermediate—Upper: Cut a dispensable map into squares of equal size. Cut an identical number of larger, but mathematically proportional, squares from butcher paper. (Example: If map squares are 3 inches make the butcher paper squares 6, 9, or 12 inches). Give each student a small "map" square and a larger "butcher paper" square. Assign each student the task of enlarging their square from the small scale to the larger scale. After each student completes his square. put the butcher paper and map squares together again for comparison. By cutting the map squares on parallels and meridians a dual concept may be learned; (a) scale is a proportional distance. and (b) the grid pattern of a map may be utilized for expressing distances.

8. Intermediate-Upper: Whether measuring distance in terms of miles or degrees the globe will indicate why flat map scales are not entirely accurate. Measuring east-west degrees along the equator, one degree is equal to 69.172 miles. Measuring east-west degrees along the 80th parallel one degree is equal to only about 12 miles. As students observe the globe the reason for the change will be readily observable. The circles of latitude become smaller as they appear closer to the poles; larger as they approach the equator. Note: the north-south degrees have a slight variation because the earth is not perfectly round. For most classroom computation the variation of the north-south degrees is of relatively little consequence.

Glossary of Terms for Map and Globe Concept of Distance

Term	Definition	Level
distance	the extent or amount of space between two places or points	*
light year	the distance light travels in one year; about 5,880,000,000,000 miles	**
mile	a unit of measurement	*
statute mile	a unit of measurement on land equal to 5,280 feet or 1,760 yards	**
nautical mile	a unit of measurement in sea and air navigation equal to 6076.1033 feet	***
proportional distance	one distance compared with another; if unequal length the short distance is a multiple of the longer distance	***
ratio	the relation of one magnitude to another in respect to the number of times the first contains the second	***
scale	a graduated line representing proportional size	**

* Primary grades 1-3
** Intermediate grades 4-6
*** Upper grades 7-8

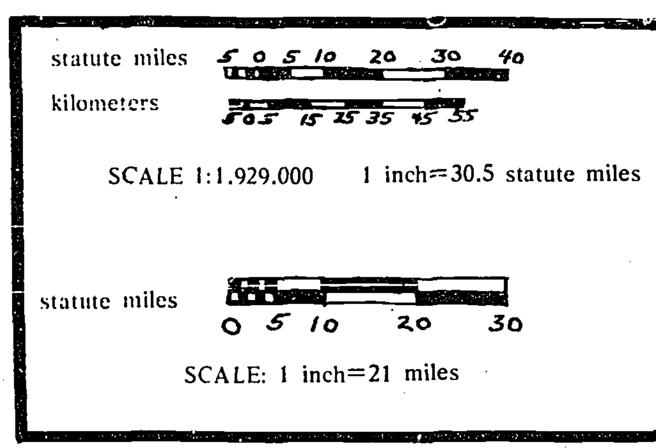


Figure 10: Samples of graduated scales

SECTION F: GUIDING DEVELOPMENT OF DIRECTIONAL CONCEPTS RELATED TO MAP READING

What is the importance of the grid?
What are the skills and understandings related to direction?
What activities are helpful for teaching directional concepts?
What map terminology is related to direction?

It is impossible to accurately identify a place on a map or globe without referring, in some manner, to direction. Interpretation of map and globe information therefore is reliant upon a student's skill to recognize direction for location of places. But knowledge of direction is important to individuals in many ways. The person who says, after parking a car along a city street and spending several hours shopping, "Oh! Oh! Where did I park my car?" may have difficulty with this concept.

Several aspects of direction may be important to every individual. Knowledge of the sun's position will guide many persons in determining direction. Likewise, surface landmarks are important factors in determining direction. The person who lost his car may recall that it was parked in front of a bank. The bank was one block from a motion picture theater. By recalling these landmarks, the car may be found. Maps and globes also have landmarks which aid the map reader. These landmarks are the North and South Poles, the equator, Tropic of Cancer, Tropic of Capricorn, International Date Line, and Prime Meridian.

Exact location of places is dependent upon the landmarks labeled parallels and meridians or lines of latitude and longitude. The intersection of the lines of latitude with the lines of longitude form the basic landmarks for locating points on maps and globes.

The Grid. A system of coordinates to establish direction and provide accuracy in locating places is termed a grid. Parallels, or lines of latitude, encircling the earth in an east-west direction intersect with meridians, lines of longitude, encircling the earth in a north-south direction, thus forming the grid framework. Children will better understand how places are located on a map or globe if they understand how the grid is constructed. The landmarks are then translated into numbers, called degrees and minutes.

CONCEPTS, SKILLS AND UNDERSTANDINGS RELATED TO DIRECTION

Major Directional Concept: Basic directions for interpreting map and globe information are north, south, east and west.

Skills and Understandings Related to Direction

Primary:
The North Pole is the tip of the earth's axis which points toward the North Star, Polaris.
The South Pole is at the opposite tip of the earth's axis
North is the direction toward the North Pole.
South is the direction toward the South Pole and opposite North.
East is to the right of north.
West is to the left of north.
Up is the direction away from the center of the earth.
Down is the direction toward the center of the earth.
The sun may be a valuable aid in determining direction.
People need to know direction in order to travel.
Ability to follow highways from one place to another on highway maps. Ability to follow air and train routes on transportation maps.

Intermediate:
Directions may be more clearly stated in terms of northeast, southeast, northwest and southwest.
Understand the relation of the North Poles, South Pole and equator to the basic directions.
Understand the use of the compass, North Star and noon day sun to determine direction.
Direction and distance are plotted by degrees and minutes south or north of the equator and east or west of the International Date Line.
Learn to measure by degrees and minutes.

Upper:
Understand directions on maps of any projection.
North is not always toward the top of the page or map.
Great-circle routes make a change in direction.

ACTIVITIVES RELATED TO DIRECTION

1. Primary: Make use of familiar landmarks to determine direction. What direction do we travel in walking from the city hall to the school? What direction do we walk when going from the city hall to the fire station? Include other landmarks such as hospitals, libraries, recreational areas, super-markets, schools, churches, industries, police departments, etc.

2. Primary: Form a grid chart. Locate familiar landmarks on the grid. Number the grid lines in the same fashion as highway maps; north-south lines numbered by Arabic numberals (1,2,3) and east-west lines numbered by capital letters (A, B, C). Constantly talk about directions when involved in locating landmarks. (Please, do not refer to north as "up", south as "down".)

3. Primary: Observe, first-hand, the direction of sunrise and sunset. Chart the course of the sun, hourly, during one day. Determine directions each hour. How does the sun help us determine direction?

4. Primary: Place a shadow stick outside the classroom where it may be easily observed. Chart (graph) the length and direction of the shadows cast during each season.

5. Primary: Place appropriate labels on the walls of the classroom, marked north, south, east and west. The teacher may emphasize these directions by asking children to stand along the east wall or to water the plants along the south wall.

6. Primary: Refer to places in the school environs as the west wing of the school or the north end of the building.

7. Primary:Construct weather charts showing wind direction.

8. Primary: Locate the community in which the children live in relation to water bodies of the community. (Mountains or railroad tracks may also be used for purposes of relating community location and direction from basic geographic features.)

9. Primary: "Directional May I" game. Leader instructs players, "Gloria may take three hops east. Bill may take four leaps north. Jill may take one step west." All players start from a beginning circle. A player failing to say, "May I," or heading in the wrong direction must return to the center circle again. The player who first reaches a larger outer circle becomes the leader for the next game.

10. Primary-Intermediate: Capitalize upon events which are important in the lives of children. Interest in Santa Claus may lead into a discussion about the North Pole and life in the north. When rockets and satellites are launched from Cape Kennedy many students watch the proceeding on television. What direction is this from the children's place of habitation? Globes are handy references for this activity.

11. Intermediate: Locate "home" on a world map by the mathematical terms of geographer's degrees and minutes, north-south latitude and east-west longitude.

12. Intermediate: When giving directions the teacher may use "directional language." Please form a circle in the northeast corner of the gym. Please report to the southeast softball diamond.

13. Intermediate: Individually, ask students to show north, south, east, and west directions on the globe from several specific locations such as Melbourne, Australia; Toronto, Canada; Sao Paulo, Brazil; and Cairo, Egypt. Choose places in various hemispheres. Additionally, ask students to show directions along the parallels and meridians.

14. Intermediate-Upper: A compass is a valuable asset to surveyors and reconnaissance men. It is valuable instrument for hunters and fishermen. There are several constructive uses of compasses in a classroom. Curiosity may be aroused about the magnetic poles. Direction becomes a clear concept through experimentation with a compass. Students should be instructed to face the object whose bearing is being taken. Holding the compass in the palm of the hand, the compass box should be slowly rotated with the opposite hand until the north end of the needle is at the point indicating north on the compass. The needle will not stand completely still, but near accuracy in direction will be obtained.

Laying a pencil across the compass face for obtaining a sight line on the object is helpful to the beginning compass reader.

Reading a compass near metal objects such as automobiles, fences, high tension power lines, bicycles, or steel poles will indicate the magnetic force exerted by materials which are efficient conductors.

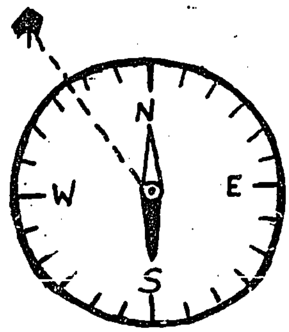


Figure 11. Reading a compass. With the compass needle directly on north; the object is sighted west of the needle. Degree of the object (tree) is measurable.

15. Upper: Orient the globe so north points northward (to the top). Rotate the globe from west to east (counterclockwise) so the point marking the location of the student's home town is on the highest meridian. Next, place the center of the compass at the location of your home so the following three points are in a straight line on the oriented globe: (a) center of the compass at "home," (b) zero degrees on the compass (north), (c) North Pole on the globe. The angle made by the line of the great circle and the line described in the three points (preceding sentence) is the angle of direction to be used when following the great circle from one point to another. To discover the direction of the student's home from any other point on the globe, orient the map in the same manner as described above. Always use the compass to identify north.

Glossary of Terms Related to Direction

Term	Definition	Level
compass	an instrument for determining directions by means of a freely rotating magnetized needle that indicates magnetic north	**
compass tick	the markings indicating degrees on a compass	***

direction	see definition, p. 17,	*
north	the direction toward the North Pole	*
south	the direction toward the South Pole; opposite the north	*
east	the direction to the right of north	*
west	the direction to the left of north	*
up	the direction away from the earth's center	*
down	the direction toward the earth's center	*
upstream	toward or in the higher part of a stream; against the current	**
downstream	toward or in the lower part of a stream; with the current	**
northeast	a point midway between north and east	**
northwest	a point midway between north and west	**
southeast	a point midway between south and east	**
southwest	a point midway between south and west	**
great circle	an imaginary line encircling the earth so that the plane of the circle passes directly through the center of the earth. All meridians are great circles. The Equator is a great circle.	**
small circle	the line (arc) of shortest distance between two points on the surface of the earth. Except for the Equator, all lines of parallel are small circles.	***

*** Primary grades 1-3 ** Intermediate 4-6 *** Upper 7-8**

Section G: Guiding Development of Time and Motion Concepts Related to Map Reading

What are the skills and understandings related to time and motion concepts?

What activities are helpful for teaching time and motion concepts?

What map terminology is related to understanding time and motion?

To completely interpret maps and globes, students need a thorough understanding of how our earth moves and how time and season changes affect man and his evironment. Time and motion are related to man's behavior and geographic elements of the earth in many ways. The changes of season bring about many climatic differences in various parts of the world. Arid and hot lands have little vegetation, little water, and sparse population except along rivers. Wet, hot lands have myriad types of vegetation. Population also may be sparse. Elevation, too, causes a difference in the climatic conditions. At any rate, the climatic factors have much to do with the number of people living in a given area and the manner in which they live.

The concept of night and day as the earth spins on its axis will aid students in better concepts for translating lives of people into the reading of maps. Children in Point Barrow, Alaska have different bed times and eating times than children in New Orleans, Louisiana. Why? A study of night-day causes and relationships will provide some understanding.

Concepts, Understanding and Skills Related to Time and Motion

MAJOR TIME AND MOTION CONCEPT: The rotation and revolution of the earth cause time

Skills and Understandings Related to Time and Motion

Primary:
- The sun is apparently, but not really, in motion.
- There is change in the length of day and night.
- There is a change in seasons.
- The total length of a day is twenty-four hours.
- The sun is most nearly overhead at midday; most nearly opposite at midnight.
- Understand time relationships of yesterday, tomorrow, today, history, future.

Intermediate:
- The earth rotates on its axis in one day.
- The earth revolves around the sun in one year.
- Rotation of the earth causes night and day.
- Revolution of the earth causes seasons.
- Understand meaning of the terms Equator, Tropic of Capricorn, Tropic of Cancer, Antarctic Zone, Arctic Circle, Arctic Zone, North and South Temperature Zones, Torrid Zone morning, evening, noon, night, midnight, twilight, dawn, dusk, horizon.
- Express time in relation to history. How long was long ago?

The earth spins in a counter-clockwise direction on its axis.

While one half of the earth is daylight, theother half is in darkness.

The North and South Poles (Frigid Zones) have periods of time when there is virtually total darkness and total daylight.

Latitude is expressed in degrees and is approxmiately 70 miles per degree.

Upper:

As the earth rotates counter-clockwise on its axis time changes by one hour each 15 degrees of movement.

Apparent paths of the sun at different latitudes is due to the ecliptic path of the earth's movement around the sun.

Using the analemma, to determine seasons in various parts of the world and exact times when the sun's rays shine directly upon the earth's surface in different parts of the world.

Understand terms of analemma, aphelion, civil time, equinox, solar time, local mean time, declination of the sun, ecliptic, horizon ring, meridian ring, nadir, perihelion, small circle, great circle, solstice, zenith, Celestial Pole, Celestial Sphere, apogee, perogee, perigee, circle of illumination.

Activities Related to Time and Motion Concept

1. Primary: Construct a shadow chart illustrating various times of the day--morning, noon, early afternoon and late afternoon.

2. Primary: Construct a chart showing differences in autumn, winter, spring, and summer.

3. Primary: Construct calendars for each month.

4. Primary: Demonstrate with a globe representing the larger earth and a ball representing why the sun appears to be in motion when actually the earth is in motion (beginning concept of night and day).

5. Intermediate: One child holds a flashlight or a lamp in a stationary position representing the sun. Another child spins, counter-clockwise, the globe, representing the earth with the lamp beam shining directly on the globes equator. As the light beam begins to light up the globe as it spins, that section of the earth is experiencing sunrise; the opposite side of the earth, sunset.

6. Intermediate: Continue holding up a lamp beam on the equator so the daylight hemisphere falls exactly between the International Date Line and the Prime Meridian. Demonstrate the differential in time of 12 hours in each direction between these lines. Next, place the International Date Line so the light beam shines directly toward it. Demonstrate the midday (noon) position of the date line and the midnight position of the Prime Meridian. Post the question, "Why does time change by one full day at the International Date Line?

7. Intermediate: On another day, continue the lamp and globe demonstration. This time have the pupil spinning (rotating) the globe also begin moving, simultaneously with the spinning, around the sun (lamp). Indicate the slant and ask, "What effect does the slant of the earth and the slant of sun's rays have upon our weather?"

8. Intermediate: Chart the length of daylight for the four seasons.

9. Upper: Show exact times and differences (in slant) of the shadows on specific dates and times. Use the globe and analemma to aid in constructing the chart.

10. Intermediate-Upper: Use a large smooth ball. Ask the children to imagine the ball is a replica of the world. Encourage the children to locate their home or community on this ball. Finding no lines or points of reference the students will realize the importance of imaginary lines, labeled parallels and meridians for locating places. Proceed to label the lines on the ball with appropriate degree markings. Continue by locating the position of North America, the United States, the state and the community where the students live. When the class members are able to locate their own community by the use of parallels and meridians ask them to locate the position of out-of-state friends in the same manner. Do you have friends in other countries? How might you locate where they live? By utilizing the lines of parallel and meridian proceed to have children express place position in the proper mathematical terminology of degrees and minutes coupled with direction such as 52 degrees 44 minutes W longitude by 47 degrees 35 minutes N latitude, the location of Saint Johns, Newfoundland.

After students realize the importance of maps and globes being constructed on the grid pattern it may prove helpful to locate states, countries, and specific places, such as cities, mountains, and parks. This procedure can be used throughout the intermediate and upper grades. Grid lines are the parallels (east-west lines) and meridians (north-south lines) which intersect to form a grid pattern.

Review of grid lines is easily maintained by referring to road maps, city maps, wall maps, atlas map, and maps in an encyclopedia which are constructed along the same patterns.

11. Upper: Make use of the analemma. The analemma is a figure or band imprinted upon a globe which has the general appearance of a figure 8. It extends from the Tropic of Cancer to the Tropic of Capricorn, usually located on the globe in the eastern part of the Pacific Ocean where there are no islands of significance. The band indicates the sun's declination and the equation of time. By reading the date scale, showing the sun's position in accordance with the equator and any meridian, the sun's declination or latitude may be measured during any day

of the year. The equation of time line indicates the difference between sun time and local clock time for any day. This line is known as the equatorial minute scale.

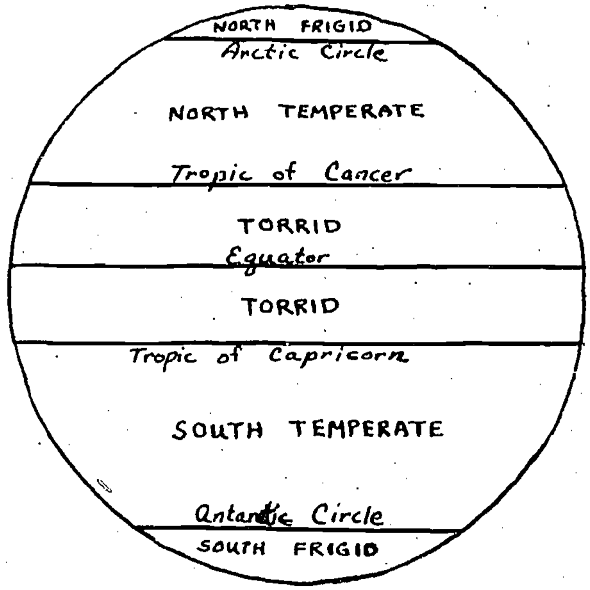
Declination of the sun. Ask students to trace the position of the sun beginning with January 1 and continuing throughout the year. Emphasize that the sun's rays are shining directly upon the earth at approxmiately 23 degrees S latitude on January 1st. Ask the students to find where the sun would be directly overhead on their birthday. Suppose George (one of the students) celebrated his birthday on October 20. Where would the sun be shining directly overhead on George's birthday? George would locate October 20 on the figure 8 band and count the markers south from the equator on the line that passes through the middle of the analemma to find the latitude. The sun is directly overhead at approxmiately 10 degrees south latitude on October 20. Any place in the world located at 10 degrees south latitude receives the direct rays of the sun on George's birthday. Lima, Peru receives the sun's direct rays on this date, and again on February 18. (This experience may even enthuse George to take a greater interest in the study of South America, particuarly Peru, if there is some personal connection with the experience; some feeling of personal possesion.) Proceed by asking each child to locate some city in the world where the sun's rays strike the earth on the anniversary of their birthdays.

Equation of Time. Students may learn to compute the time to the exact minute as well as the day, when the sun is directly overhead at midday. The analemma provides a guide for determining the exact time. The solar day is used to compute the precise time. The solar day is the time interval between two succesive transits by the sun of the meridian exactly opposite that of the observer. It is the interval of time from one midnight to the following midnight. However. the length of time is not always exactly 24 hours. In fact, the sun's rays shine directly upon the earth at 12:00 noon, sharp, only four times per year. These days are April 13, June 15, September 1, and December 25. Our clocks, telling local time, will agree, at noon, with solar time only four times per year. The analemma will help students determine how much faster or slower our clocks may be when compared with the solar day. Showing the effects of the earth's revolution about the sun in an elliptical pattern, rather than a perfect circle will aid in explaining the time differential between the solar day and the clock time. Determining the equation of time may be a challenge to academically bright students in intermediate or to upper grade students. The globe will show the ecliptic; the great, imperfect, circle formed by the intersection of the plane of the earth's orbit with the celestial sphere. The ecliptic is, thus the apparent annual path of the sun in the heavens. The ecliptic intersects with the equator (as pictured on a globe) at the International Date Line and the Prime Meridian. The sun is directly overhead at the equator at 12:07 on March 21 and at 11:53 a.m. on September 23.

Again, ask students to compare "sun time" with "clock time" at 12:00 noon on the students' birthdays. George will find the clock time in Lima, Peru will read 11:44 a.m. This is found by locating the date, October 20, then using a ruler to measure on a 90 degree angle (perpendicular) to the scale of minutes. On October 20 the "sun time", because of the elliptical revolution of the earth about the sun, is sixteen minutes faster than "clock time"

Glossary of Terms Related to Time and Motion

Term	Definition	Level
analemma	a scale shaped like a figure 8, showing the declination of the sun and the equation of time for for the day of the year. Placed on a globe, the analemma will show the latitude where the sun's rays are vertical at noon on each day of the year.	***
circle of illumination	the great circle that is located between the lighted half and the unlighted half of the earth's surface	***
climatic zone	any of five divisions of the earth's surface, bounded by lines parallel to the Equator, and named according to the prevailing temperature. The five great zones are the Arctic (North Frigid) Zone, North Temperate Zone, Antarctic (South Frigid) Zone, South Temperate Zone and the Torrid Zone.	**



Antarctic Zone	also known as the South Frigid Zone. The geographical parallel of 66 degrees 13 minutes South latitude; the section of the earth's surface lying between the Antarctic Circle and the South Pole	**
Arctic Zone	also known as the North Frigid Zone. The geographical parallel of 66 degrees 13 minutes North latitude; the section of the earth's surface lying between the Arctic Circle and the North Pole	**
North Temperate Zone	the part of the earth's surface lying between the Tropic of Cancer and the Arctic Circle in the Northern Hemisphere	**
South Temperate Zone	the part of the earth's surface lying between the Tropic of Capricorn and the Antarctic Circle in the Southern Hemisphere	**
Torrid Zone	the part of the earth's surface between the Tropic of Cancer and the Tropic of Capricorn	**
day	a measure of time based upon one complete rotation of the earth. A solar day is measured from a transit of the sun across a given meridian to its next successive transit across the same meridian	*
afternoon	the time from noon until evening	*
darkness	absence or deficiency of light on the earth's surface	*
dawn	the first appearance of daylight in the morning	**
daylight	the light of the day	*
dusk	the period of partial darkness between day and night in the evening	**
evening	the latter part of the day and the early part of the night	*
forenoon	the period of daylight before noon	**
mid-day	the middle of the day; noon or the time around noon	**
morning	the first period of the day extending from midnight to mid-day	*
noon	the instant when the sun's rays fall vertically on any given meridian	**
solar day	the length of time from noon to noon	**

sunrise	the rise or ascent of the sun above the horizon in the morning	*
sunset	the setting or descent of the sun below the horizon in the evening	*
twilight	the periods of partial daylight after sunset and before sunrise, when light from the sun is reflected from the atmosphere overhead	**
declination of sun	the angular distance of a heavenly body from the celestial equator, measured on the great circle passing through the celestial pole and the body	***
degree	a unit equal to 1/360 of a circle; a degree of latitude on the earth's surface is roughly equivalent to 69 statute miles; a degree of longitude varies in length but is always equivalent to about four minutes of time	**
direction	a position on a line extending from a specific point toward a point of the compass or toward the nadir or the zenith	**
east	a cardinal point of the compass, 90 degrees to the right when facing north; corresponds to the point where the sun is seen to arise	*
north	the direction along any meridian toward the North Pole	*
south	the direction along any meridian toward the South Pole	*
west	a cardinal point of the compass, 90 degrees to the left when facing north; corresponds to the point where the sun is seen to set	*
North Pole	the end of the earth's axis of rotation marking the northernmost point on the earth (Note: A compass needle is attracted to a magnetic pole near the North Pole, but never directly toward the geographic North Pole).	*
South Pole	the end of the earth's axis of rotation marking the southernmost point of the earth	*
Celestial Pole	the North Star; each of the two points in which the extended axis of the earth cuts the celestial sphere and about which the stars seem to revolve	***

Celestial Sphere	the imaginary spherical shell formed by the sky, usually represented as an infinite sphere, the center of which is a given observer's position	***
ecliptic	a great circle sometimes shown on a map or globe and representing the apparent annual path of the sun across the surface of the earth	***
equinox	the time when the sun crosses the plane of the earth's equator, making night and day of equal length all over the earth	***
autumnal equinox	the time when the overhead sun crosses the Equator on its apparent migration from north to south, or about September 23, and the length of day and night is approximately the same in all latitudes	***
vernal equinox	the date when the overhead sun crosses the Equator on its apparent migration from south to north (about March 21) and the length of day and night is approximately the same in all latitudes	***
growing season	the time between the latest killing frost during the spring and the first killing frost of autumn	**
hemisphere	half of the terrestial globe or celestial sphere	*
eastern hemisphere	that half of the earth traversed in passing westward from 180 degrees longitude to the Prime Meridian. The Eastern Hemisphere includes Asia, Africa, Australia, and Europe	**
northern hemisphere	the half of the earth between the North Pole and the Equator	**
southern hemisphere	the half of the earth between the South Pole and the Equator	**
western hemisphere	that half of the earth traversed in passing westward from the Prime Meridian to 180° longitude. The Western Hemisphere includes North and South America, their islands and the surrounding waters	*
horizon	the line at which the earth and sky appear to meet	**
horizon ring	a graduated ring fitted to a globe in such manner that its plane contains the center of the globe, and it can be adjusted into the plane of the horizon for a given point	**
inclination of earth	the tilt of the earth's axis in relation to the plane of the earth's orbit. The angle of inclination is 23½ degrees from a vertical position.	**
latitude	the distance in degrees of a point on the earth north or south of the Equator	**
longitude	the distance in degrees of a point on the earth east or west of the Prime Meridian	**
meridian	a great circle of the earth passing through the poles and any given point on the earth's surface	**
International Date Line	the imaginary line extending from pole to pole along the 180th meridian, with local variations. At this line each new calendar day begins at midnight. Travelers crossing the line going west must advance their calendar one day, while those going east must retard the calendar one day	**
Prime Meridian	the meridian on the earth's surface from which longitude is measured, generally the meridian of Greenwich, England, on modern maps.	**
meridian ring	a graduated ring fitted to a globe in such manner that its plane contains the poles of the globe. The ring can be adjusted into the plane of any given meridian of the globe	**
nadir	the point in the heavens diametrically opposite the zenith, or the point directly under the observer	***
orbit of the earth	the circular pattern in which the earth follows as it revolves around the sun	**

aphelion	the point in the orbit of a planet or a comet at which it is furthest from the sun	***
perihelion	the point in the orbit of a planet or a comet at which it is nearest the sun	***
apogee	the point in the orbit of a heavenly body or a man-made satellite at which it is furthest from the earth	***
perigee	the point in the orbit of a heavenly body or a man-made satellite at which it is nearest the earth	***
parallels	small circles on the earth's surface, or lines on a map, perpendicular to the axis of the earth and marking latitude north or south of the Equator	**
Antarctic Circle	the geographic parallel of 66 degrees 13' S., enclosing the area within which the sun is continuously above the horizon on December 22 and below the horizon on June 21.	**
Arctic Circle	the geographic parallel of 66 degrees 13' N., enclosing the area within which the sun is continuously above the horizon on June 21, and below the horizon on December 22.	**
Equator	an imaginary line (great circle) encircling the earth equidistant everywhere from the North and South Poles	*
Tropic of Cancer	an imaginary line encircling the earth parallel to the Equator about 23½ degrees N. or the Equator marking the division between the North Temperate Zone and the Torrid Zone. The Tropic of Cancer marks the farthest point north in which the sun's rays shine directly upon the earth	**
Tropic of Capricorn	an imaginary line encircling the earth parallel to the Equator about 23½ degrees S. of the Equator marking the division between the South Temperate Zone and the Torrid Zone. The Tropic of Capricorn marks the farthest point south in which the sun's rays shine directly upon the earth.	**
revolution of the earth	the movement of the earth around the sun. One complete revolution lasts one year or approximately 365¼ days	**
rotation of the earth	the movement of the earth around its axis. One complete rotation lasts one day or approximately 24 hours	**
axis	the straight line passing through the center of the earth, about which the earth rotates	**
solstice	the time at which the overhead sun is at its greatest distance from the Equator. This occurs about June 21 (summer solstice) and December 22 (winter solstice) in the Northern Hemisphere	***
time	the system of those sequential relations that any event has to any other, as past, present, or future	*
civil time	solar time in a day that is considered as beginning at midnight. May be either true solar time or mean solar time. Sometimes considered as two series of twelve hours each--P.M. and A.M.	**
mean solar time	time measured by the daily motion of a nonexistent body called the "mean sun." The sun apparently travels in ecliptic with a variable motion. It, therefore, cannot be used to measure time. The mean sun, supposedly, moves uniformly in the celestial Equator	***
solar time	time measured by the apparent daily motion of the sun	***
standard time	the civil time officially adopted for a country or region	**
time zone	a belt, or zone, extending from north to south across a country, which is given a designated time. In the United States the	**

time zones are Bering, Alaska, Yukon, Pacific, Mountain, Central and Eastern time. The 165th, 150th, 135th, 120th, 90th, and 75th meridians, respectively, mark the boundaries of these seven time zones. The length of time between one time zone and the next is exactly one hour

year	an interval of time based upon the revolution of the earth in its orbit around the sun. It is equal to 365.2422 solar days or 365 days, 5 hours, 48 minutes, 46 seconds	*
zenith	the point in the celestial sphere directly over a given point on the earth	***

* **Primary grades 1-3** ** **Intermediate grades 4-6**
*** **Upper grades 7-8**

SECTION H: DEVELOPMENT OF GENERAL CONCEPTS RELATED TO MAP READING

What are the skills and understandings related to global concepts and uses of maps?

What activities are helpful for teaching global understandings and uses of maps?

What map terminology is useful for teaching global understandings and uses of maps?

CONCEPTS, UNDERSTANDINGS AND SKILLS RELATED TO GENERAL GEOGRAPHIC CONCEPTS

MAJOR CONCEPT: **Global understandings are important to us.**

Skills and Understandings Related to Global Understandings

Primary:
- The shape of the earth is round.
- Although round, the earth's surface is not smooth.
- The globe is a proportional replica of the earth.
- Globes are the basis for flat maps.
- The earth is divided into sections called hemispheres

Intermediate:
- There is more land area in the Northern Hemisphere than in the Southern Hemisphere.
- Each place on earth may be identified by degrees and minutes.
- A grid forms the framework for allowing exact location of places in terms of latitude and longitude.
- The earth is a sphere divided into hemispheres: Western, Eastern, Northern, Southern, daylight, and darkness.
- Climate has a direct relationship with the location of surface features of the earth.
- Realizing the proportional relationship between the size of globes and the size of the earth.

Activities Related to Global Understandings

1. Primary: Compare the earth with photos of the moon, and the moon as seen by the children at night. The reflection of light shows a round moon, yet the photos of the moon show rough spots resembling craters and mountains. Point out the resemblance of this uneveness to the earth, yet both the moon and the earth are, over-all, round.

2. Primary: Use small replicas of ships. 'Sail' them over a globe to show how ships disappear over the ocean. Use blocks of wood or other small objects if toy boats are not readily available.

3. Primary: Compare the above activity (2) with moving the same object across a flat surface such as the floor, a table, a bench, or a counter.

4. Intermediate: Ask a committee to present a report to the class on the relationship of the types of houses, the types of clothes and the types of climates in various places in the world. Select places in all areas of the world. Be certain to include frigid, temperate and torrid zones.

MAJOR CONCEPT: **Maps have different uses.**

Skills an Understandings Related to Concept

Primary:
- Recognize that flat maps are not as accurate as globes for determining direction and distance (location).
- Recognize shape of the United States on all types of maps and globes.
- Recognize shape of students' home state on all types of maps and globes.
- Maps are useful tools to man.
- Weather maps are of value to us as individuals.
- Locate places familiar to the students' environment — home, school, community, neighboring towns or cities, main streets, churches, hospitals, recreational areas, libraries, government buildings.

Intermediate:
- Knowledge of how various maps and globes may be used including outline, relief, political, and physical-political maps.

Understand the use of globes in conjunction with maps

Special maps may provide needed information

Be able to use outline maps for the distribution of places and things.

Learn position and names of continents.

Recognize shape of many states.

Recognize shape of countries in the Western Hemisphere

Upper: Various projections are used according to the purpose for their use. Mercator, Azimuthal, conical, and semi-elliptical are several well-known projections

Recognize shape of countries throughout the world.

Associate countries with continents.

Activities Related to Concept

1. Intermediate: Compare two or more world pattern maps and draw conclusions as to the reasons for certain patterns. Example: Compare (a) world population map, (b) world physical map, and (c) world average yearly rainfall map. Note possible relationships between (a) density of population in various areas, (b) type of topography, and (c) amount of rainfall.

2. Intermediate-Upper: Place two outline maps side-by-side for comparing various aspects of a country or state and the life of its people. Compare population with products; products with climate; population with climate; climate with vegetation; natural resources with manufactured goods, etc. (Remember: the great advantage of outline maps is its unclutteredness.)

3. Intermediate-Upper: Have a student read a news item to the class. Ask students to locate the place where the event occurred. Make it a practice to display and consult more than one map each time it is necessary to use a map.

GLOSSARY OF GENERAL TERMS

Term	Definition	Level
alp	a German term for a high mountain	***
altitude	the height above sea level of any point on the earth's surface or in the atmosphere	**
archipelago	any large body of water with many islands	***
arroyo	a small steep sided watercourse or gulch with a nearly flat floor; usually dry except after heavy rains	***
bahia	a Portuguese or Spanish expression for bay or gulf	***
bar	a long ridge of sand, gravel, or other material near or slightly above the surface of the water at or near the mouth of a river or harbor entrance	**
bay	a body of water forming an indentation of the shoreline, larger than a cove but smaller than a gulf	**
beach	an expanse of sand or pebbles along a seashore	*
boreal	of or pertaining to the north or north wind	***
bourg	a town	***
brook	a small, natural stream of fresh water	**
canal	an artificial waterway for navigation or irrigation	**
canyon	a deep valley with steep sides, often with a stream flowing through it; also, canon	**
cape	a piece of land jutting into a sea or some other large body of water	**
cartography	the production and construction of maps	***
channel	the bed of a stream or waterway; the deepest part of a stream	***
cold front	the zone separating two air masses, of which the cooler, denser air mass is advancing and replacing the warmer	**
community	a social group of any size whose members reside in a specific locality, share government, and have a common cultural and historical heritage	**

coast	the land next to the sea; seashore	*
continent	one of the main land masses of the globe, usually considered seven in number: Europe, Asia, Africa, North America, South America, Australia, and Antarctica	*
continental shelf	the part of a continent that is submerged in relatively shallow sea	***
contour	the outline of a figure or body; the line that defines or bounds anything	***
contour lines	a line joining points of equal elevation	***
cove	a small indentation or recess in the shoreline of a sea, lake, or river	***
crater	the cup-shaped depression or cavity in the face of the earth, moon, or other heavenly body marking the orifice of a volcano	**
creek	a watercourse smaller than a river	*
crevice	a crack in the earth's surface forming an opening; a cleft, rift, or fissure	**
delta	a nearly flat plain of alluvial deposit between branches of a mouth of a river, often, though not necessarily, triangular in shape	**
dew point	the temperature at which dew begins to form	**
drift	the flow or the speed in knots of an ocean current; a shallow ocean current which advances about ten or fifteen miles per day	***
eau	a French term for water	***
elevation	the altitude of a place above sea level or ground level	**
estuary	that part of the mouth or lower course of a river in which the river's current meets the sea's tide	***
forest	a large tract of land covered with trees and underbrush; extensive wooded area	*
geyser	a hot spring that intermittently sends up sprays of water and steam into the air from a small opening in the earth's surface	**
globe	a sphere on which is depicted a map of the earth (terrestrial globe) or of the heavens (celestial globe)	*
gorge	a narrow cleft with steep, rocky walls; a small canyon	**
gradient	the degree of inclination, or the rate of ascent or descent, in a highway, railroad, etc.	***
grid	a network of horizontal and perpendicular lines uniformly spaced, for locating points on a map; lines of longitude and latitude	**
gulf	a portion of an ocean or sea partly enclosed by land	**
hachure	one of several parallel lines drawn on a map to indicate relief features, the width of the spacing between the lines, and the breadth of the lines indicating the slope of hills and mountains	***
harbor	a portion of a body of water along the shore deep enough for anchoring a ship	**
highland	an elevated region of land; a plateau	**
hill	a natural elevation of the earth's surface; smaller than a mountain	*
island	a tract of land completely surrounded by water, and not large enough to be called a continent	*
isobar	a line drawn on a weather map that connects all points having the same barometric pressure, reduced to sea level, at a specified time or over a certain period	**
isobath	a line drawn on a map connecting all points of equal depth below the surface of a body of water	***

isobront	a line on a weather map connecting various points where the same phase of thunderstorm activity occurs simultaneously	***
isodrosotherm	a line on a weather map connecting points having an equal dew point	***
isogram (isoline)	a line representing equality with respect to a given variable, used to relate points on a map	***
isohaline	a line drawn on a map of the ocean connecting all points of equal salinity	***
isohel	a line on a weather map connecting points that receive equal amounts of sunshine	***
isohume	a line on a weather map connecting points of equal relative humidity	***
isohyet	a line drawn on a map connecting points having equal rainfall at a certain time or for a stated period	***
isoneph	a line on a weather map connecting points having the same amount of cloudiness	***
isotach	a line on a weather map connecting points where winds of equal speeds have been recorded	***
isotherm	a line on a weather map connecting points having equal temperture	***
isthmus	a narrow strip of land, bordered on both sides by water, connecting two larger bodies of land	***
lake	a body of water completely surrounded by land	*
ledge	any relatively narrow, shelf-like projection of land or rock; cliff or ridge	**
legend	a table on a map or chart explaining the symbols used	**
llanos	an extensive grassy plain with few trees in Spanish South America	**
lowland	land which is level with respect to the adjacent country	**
map	a drawing or representation of part or all of the surface of the earth or of some other heavenly body	*
land use map	a map showing the relation of man to the landscape; indicates how the land is used	**
landscape map	maps showing the appearance of the earth's surface; a photograph of the Earth's surface	***
physical map	landform maps indicating plains, plateaus, mountains, rivers, lakes, seas, etc.; the geomorphology of a region	**
political map	maps depicting the political description of boundaries between countries, provinces, states or countries	**
relief map	a map showing the relief of an area, usually by generalized contour lines	**
mesa	a land formation having a relatively flat top and steep rock walls	**
metropolitan area	the areas adjoining a large city	**
natural resource	the natural wealth of a country, consisting of land, water, mineral deposits, etc.	**
oasis	a small fertile area in a desert region	**
ocean	the vast body of salt water which covers almost three-fourths of the earth's surface	*
pampas	the vast grassy plains of South America	**
peninsula	a body of land surrounded on three sides by water	**
pictograph	a sign of symbol used in graphs and maps	**
plain	an area of land not significantly higher than adjacent areas and with little difference in altitudes	**
population	the total number of persons living in an area	**
pueblo	an Indian village; a communal village of certain agricultural Indians of the Southwest United States	**

ridge	a long, narrow elevation of land; a chain of hills or mountains	***
river basin	the area of land drained by a river and its tributaries	***
sea	the salt waters that cover the greater part of the earth's surface	*
sea level	that point in altitude in which the sea comes in contact with the land	**
sextant	an instrument used in measuring angular distanees, especially the altitudes of the sun, moon and stars at sea in determing latitude and longitude	***
slope	the sides of foothills or bluffs	***
spit	a narrow point of land projecting into the water	***
strait	a narrow passage of water connecting two large bodies of water	**
stream	a body of water flowing in a channel, such as a river, rivulet, brook or creek	*
terrain	a tract of land considered with reference to its natural features	***
trail	a path or track made across a wild region or over rough country; made by the passage of men or animals	*
tundra	a vast nearly level, treeless plains of the Arctic regions	**
upland	the higher ground of a region or or district	**
vegetation	all the plants or plant life of a place	**
villa	a small town, country residence or estate	***
warm front	a transition zone between a mass of warm air and the colder air it is replacing	**

* Primary grades 1-3 ** Intermediate grades 4-6 *** Upper grades 7-8

FIGURES

ILLUSTRATIONS

CHARTS

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