A Primer in Scientific Geographic Research Terminology: Implications for Teaching Geography Majors

Sharafat Khan

The major purpose of this paper is to (1) focus on the meaning of geographic research and (2) identify and elaborate upon the basic terms utilized within geographic research literature.

Geographic research is the critical objective study, investigation and explanation of specific cultural and physical phenomenon. Transportation planners, economic planners, military personnel and others are heavily dependent upon geographic research to provide pertinent data they need to make tactical and strategic decisions. Specifically, geographic research is utilized in many diverse academic and non-academic organizations and agencies. As more data become available about the world, there will be more demand for quality basic and applied research. Basic research personnel attempt to acquire data through experimentation by describing and evaluating usefulness of theory for observation of new principles and laws. In short, basic researchers test, reformulate and extend theory. Applied researchers, on the other hand, seek to use theory to derive implications for practice. In other words, they attempt to solve or bridge a particular deficiency or gap in geographic knowledge. Another type of geographic research is the phenomenological approach, which aims to measure and evaluate geographical problems as "unique entities" in the context of the environment (Moriarty, 1981).

In carrying out the geographic research process, however, there are a number of scientific and other related procedures that must be considered. These procedures may vary depending upon the needs, wants, and aspirations of the researcher that determine the nature of the problem under examination; be it a farm study, population distribution study, or natural hazard study, to cite a few. Historical researchers aim to look at the evolutionary thinking pertaining to geographic concepts, generalizations, principles, facts, and practices. Or they may analyze historical antecedents that led to development of geography as a viable scientific disci-
pline. *Normative* procedures focus on metaphysical types of questions which are rooted in personal values, beliefs and prescriptive dimensions that might lead to the conflict of "objective" purpose. *Experimental* inquiry follows a logical or systematic path of observing the geographical processes and phenomenon so that generalizations observed are value and belief free. Both normative and experimental procedures, moreover, are based on four sequential levels of measurement that form the basis for research design and analysis. Generally, statisticians refer to these as nominal, ordinal, interval, and ratio. When using the *nominal* scale, the researcher is simply placing phenomenon into a specific category. For example, all cities located west of X have a population of 1 million or less. In the *ordinal* category, the investigator provides a rank-order to the phenomenon. City X has a greater population than city Y is an example. The *interval* scale measures equal values for a given phenomenon. If city X, for example, has a mean annual temperature of 50°F and city Y has one of 55°F then one can say that city Y is 5°F warmer compared to city X. The *ratio* measurement is similar to the interval scale with one notable difference, that it has a true "zero" point, with zero indicating an absence of a phenomenon. For example, city X has twice as large a population compared to city Y.

The empirically based geographic reasoning, nevertheless, can be classified into one of two categories. First, the *descriptive* investigation is a narrative of an actual field condition or situation as it is perceived and analyzed in the context of reality. And, second, the *experimental* examination seeks to change the existing conditions by introducing some activity in order that a preferred outcome could be achieved (Kerlinger, 1973). It is evident that the methodology pursued in empirical research is contingent on the investigator's goals and objectives. If the investigator wants, for example, to report the level of geographic place location knowledge of undergraduate students, the appropriate strategy would be to construct a descriptive survey. However, if the researcher wishes to bring about some type of a change in the place location knowledge of individual subjects, the empirical methods require experimental courses of *instruction* or *treatment*.

The major focus and aim of scientifically based empirical research is the construction of testable *hypotheses*. Hypotheses are tentative hunches, statements or propositions developed as a possible explanation of the existence of specific phenomena or processes, and through which the investigator accepts or rejects the proposed relationships (Ary, Jacobs & Razavieh, 1979). It is possible hypotheses may illuminate upon *why*, *how*, and *when* a particular process takes place. The distribution of population in relation to availability of water is an example. Additionally, hypotheses attempt to predict possible single or multiple outcomes with regard to a particular phenomenon. Hypotheses are an integral part of scientific methodology and are primarily derived from logical *assumptions*, which provide a path-goal frame of reference for investigating the central premise. Hence, two types of hypotheses can be identified: *directional* or *nondirectional* (Hinkle, Wiersma & Jurs, 1979). The directional hypothesis predicts relationships between variables by suggesting that the characteristic of the phenomenon is "more" or "less" than the hypothesized value. A nondirectional hypothesis implies that the attribute of the phenomenon is "different" or "not equal" to the predicted value (Hinkle et al., 1979). However, there are two types of theories upon which the hypothesized relationships are predicted: *normative* or *scientific*. Normative theory constitutes relationships that should be; "if all things were equal and if the investigator's premises are sound" (Ginsburg, 1971, p. 23). A scientific theory, on the other hand, defines hypothesized relationships in the most objective manner.

*Statistical* procedures involve collecting, organizing, analyzing and describing information into meaningful cate-
gories and are used in testing hypothesized data. Two types of statistics can be identified: descriptive and inferential. Descriptive statistics aim to summarize and organize data to communicate the research results (Bryant, 1966; Blank, 1968). Inferential statistics are concerned with inferring some measurable characteristic of a sample to other peoples, conditions, settings, and situations (Kerlinger, 1973; Taylor, 1977).

In testing the hypotheses using these statistics, one of two possible outcomes can be reached: type I error and type II error. The researcher makes a type I error when he/she rejects a "true" hypothesis. The probability of that occurring is called alpha. In committing a type II error, the researcher accepts a "false" hypothesis (Haber & Runyon, 1977). Statisticians refer to this type of error as beta.

In order to demonstrate the truth or falsity of the hypothesis, the relationship between and/or among the variable(s) must be tested. To this end, a research design needs to be constructed. The research design is like a map, for it tells the researcher "how" to proceed and in what order. Before actually testing a hypothesis, the investigator must operationalize important terms pertaining to the research topic. That is, the researcher must give the terms a meaning and describe definitions commonly used in basic and applied research, namely; theoretical and operational (Kerlinger, 1973). The theoretical definition uses other terms to define its purpose or limits. The operational definition is a scheme of classifying events, objects, processes and people into a particular concept. It guides the investigator to measure the phenomenon. For example, the statement, "students are deficient in locating geographic places" is not appropriately defined to allow the researcher to collect meaningful and useful data. Specifically, the researcher would not be able to carry out his/her desired goal, until the terms are clearly specified and a level of measurement is selected. For example, the researcher needs to identify: what type of students he/she wishes to study, what age level needs to be observed, what geographic background needs to be taken into consideration, the criterion to measure place location knowledge, etc. A working definition of the observation might be stated thusly: "undergraduate freshmen geography majors are unable to locate places (e.g., countries, cities) accurately on an outline map of the world." This necessitates that the investigator must posit a rationale as to "why" students cannot locate with accuracy place names on a map.

In the foregoing example of "undergraduate geography majors," a population has been identified from which subjects for the experiment can be chosen (Silk, 1979). A population is a set of any well-defined class of individuals, events, people or objects that share common observable and measurable traits (Kerlinger, 1973). Related to this is the concept of a parameter which is the measurable characteristic of a population under experimentation.

However, since there are many undergraduate geography majors throughout the United States, it is impractical because of cost, for example, for all of them to be included in the research. Even if it was feasible to include the entire population, it is unnecessary to do so because available statistical procedures could compensate and predict with some accuracy how the "whole group" would have scored based on the information collected from its members or peers.

As a result, when the researcher identifies his/her target population, he/she need only administer an instrument to a sample subset of the population in gathering the hypothesized data (Hinkle et al., 1979). Since the sample is chosen from a well defined population, the investigator needs to consider factors jeopardizing internal and external validity of the experimental design(s) (Campbell & Stanley, 1966; Bracht & Glass, 1968). Internal validity is crucial for the effects of the experimental treatment to be determined. Without internal validity the researcher cannot use results objectively since they may have been caused by other factors. External validity refers
to the degree to which the attained results of the experiment can be generalized to other conditions, peoples, settings and situations.

An important component of the research design, nonetheless, is the way in which the sample is selected. In order to minimize bias, mathematicians and statisticians have formulated random sampling procedures (Gregory, 1978). When these methods are applied appropriately they permit the investigator to select equally every member of a target population for inclusion in the study. To construct an unbiased map location test comprised of countries and capital cities, for example, the researcher first must list all countries and capital cities individually and randomly draw the desired number. Yet when a sample is selected often times members must be deleted for a variety of reasons. Since this might have influence on the final results, it is proper to calculate the sampling error to compensate for the lack of randomness of the sample (Mendenhall, 1967).

The experiment might consist of administering some type of treatment and then observing the responses of the subjects. In order to keep the research design "pure," treatment control and sound evaluation procedures are essential so that the sample findings could be generalized to other situations (Bracht & Glass, 1968). One way to control research is to build extraneous variables into the design to prevent them from impinging upon the final outcome. For example, to determine what factors other than interest in geography prompt individuals to pursue a major, it is imperative that the researcher study only similar individuals who share interest in geography so that the results could uncover other motivating factors as well. Additionally, other control factors can also be adopted (See Kerlinger, 1973, pp. 309-313).

The major interest of the researcher, however, is to examine geographical phenomena as variables, because they can take on different characteristics. For example, upon testing undergraduate students with regard to geographic place location knowledge, it might be observed that individuals differ in their level of knowledge or achievement. This might be true despite the fact that individuals share similar characteristics such as level of education. In the experimental phase the investigator presents some organized and sequential activity that causes a change in student knowledge or recognition, such as geographic place location cognition. The researcher varies the level of treatment through manipulation of independent variables, e.g., teaching students place name geography through structured map exercises. The instructional materials the researcher uses with students to bring about change in the knowledge level are called the dependent variables. An example of the dependent variable would be the place location knowledge test score for individual subjects. In order to attain this stage, however, the researcher identifies certain procedures to collect pertinent data on the dependent variable. This is done through the use of an instrument which aims to evaluate the level of change the treatment had on the subjects. The level of measure permits the researcher to compare and contrast the performance of students. This can be accomplished by several statistical procedures.

The mean, for example, is the arithmetic average of a geographical phenomenon under study, and is a point of reference for taking size and location of the region into consideration. The areal distribution is the extent to which the phenomenon is dispersed in a given locality. The range refers to the space (area) between the highest and lowest point of reference. The median is that point where 50% of the cases lie either below or above the distribution. The mode represents that phenomenon that takes place with the greatest frequency in a given place (Haber & Runyon, 1977). The variance, moreover, is the mean squared deviation from the arithmetic mean (Hinkle et al., 1979), and it measures the extent to which there are differences between and/or among, e.g., regional population distribution patterns. The
measures of variability can be calculated through utilization of available statistical procedures which help identify, describe, analyze and articulate regional variations (Silk, 1979). These procedures take into account the shape, size, and location of variation.

When the raw data have been collected, organized, analyzed and summarized, the researcher is then ready to construe the inherent information and to derive a conclusion with respect to the results obtained. When the researcher gets ready to generalize the results to other conditions, settings and situations, the question of confidence remains. In addition, various validity concerns are also taken into consideration.

Predictive validity is the degree to which the investigator predicts correlation between geographical phenomenon for further study and analysis. Concurrent validity postulates the correlation between geographical phenomenon at the same point in time for a given region. A particular instrument, a farm study questionnaire, for example, is said to have both predictive and concurrent validity if it can gather similar types of responses when administered to other populations. Content validity is the extent to which the instrument (e.g., farm study questionnaire) is appropriate to the purposes and interests of the subject matter under consideration. Specifically, if the instrument is about farming techniques used in a given region, the questions must relate to the farming techniques and not what the farmer does in his leisure time! Construct validity refers to the extent to which the questionnaire measures what it is intended to measure, e.g., whether "farming techniques" information is really being gathered (Byrkit, 1972).

It is essential that the researcher is confident that the test or the questionnaire has reliability (Ary, Jacobs, & Razavieh, 1979). That is, the instrument measures the degree of consistency for whatever it was designed to measure. This has two dimensions: internal consistency, which is the relationship of each item appearing in the instrument, and stability, which aims to measure consistency over a designated time period (Kuder & Richardson, 1937; Richardson & Kuder, 1939).

Another statistic often reported in the geographic research is called correlation. This is the degree to which two variables are related to each other. Often times it is called the coefficient of correlation. Inherent in the preceding is the coefficient of determination, this demonstrates the proportion of variance in X variable that could be related to the variance in the Y variable (Hinkle et al., 1979). The most common correlation coefficients are the Pearson Product Moment Correlation Coefficient, simply referred to as Pearson r, and the Spearman Rank Order Correlation Coefficient (Spearman r). The computed coefficient for two variables can range from +1.00 to −1.00. In addition, one of two relationships can be derived. A positive relationship results when a person scores higher on, say a map test, and also scores higher on a multiple-choice test. A negative relationship will be obtained when the subject scores higher on the map test, and lower on the multiple-choice test. The major weakness of the correlational studies is that they do not suggest what causes X variable to be associated with the Y variable. Hence, the researcher is only predicting the strength of the relationship between phenomena. Yet another measure of correlation coefficient, covariance, may be used (Eashoff, 1969). This is the degree to which, for example, human settlements are distributed in relation to natural resources. Like the Pearson r, covariance may be interpreted in terms of the relationship(s) between phenomena.

When the researcher attempts to predict the results, it is highly probable that a chance factor will enter into the computation formula. The probability of prediction is influenced by adapting a chance known as the level of significance, or simply alpha (Cotton, 1967). Most often the symbol "P" is used to denote the level of significance. However, it is defined as the chance of rejecting a true hypothesis. The alpha level most com-
monly used in basic and applied research reports are the 0.05 and 0.01 levels. However, other alpha levels are available and could be used depending upon the nature of the research design.

When the researcher uses a 0.05 alpha level, for example, he/she is suggesting that research results will be observed 5 times out of 100 by pure chance only, but the other 95% of the time similar results will be found because of certain relationships, and processes inherent in the variables under examination. Finally, it should be noted that each statistical mode is based on certain assumptions and these should be carefully examined prior to using a statistic to avoid drawing erroneous conclusions and inferences.

SUMMARY

In this paper, the author identified and elaborated upon some fundamental geographic research terminology that should facilitate the understanding of geographic research reports published in books and other periodical literature. The terms identified and described are common to all research that is conducted within the realm of geographic education, political geography, physical geography, urban geography, and so forth.

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