STATISTICAL PRINCIPLES AND TECHNIQUES IN SCIENTIFIC AND SOCIAL INVESTIGATIONS pdf

1: Scientific method - Wikipedia

Get this from a library! Statistical principles and techniques in scientific and social investigations. [W J Krzanowski] -- This text provides a clear discussion of the basic statistical concepts and methods frequently encountered in statistical research.

Introduction[edit] The goal of this chapter is to introduce the methods employed by sociologists in their study of social life. This is not a chapter on statistics nor does it detail specific methods in sociological investigation. The primary aim is to illustrate how sociologists go beyond common sense understandings in trying to explain or understand social phenomena. They do not see the world as we normally do, they question and analyze why things happen and if there is a way to stop a problem before it happens. At issue in this chapter are the methods used by sociologists to claim to speak authoritatively about social life. There are dozens of different ways that human beings claim to acquire knowledge. A few common examples are: Choosing to trust another source for information is the act of making that source an authority in your life. Parents, friends, the media, religious leaders, your professor, books, or web pages are all examples of secondary sources of information that some people trust for information. People often claim to have learned something through an experience, such as a car accident or using some type of drug. Some physical skills, such as waterskiing or playing basketball, are acquired primarily through experience. On the other hand, some experiences are subjective and are not generalizable to all. Simple deduction is often used to discern truth from falsity and is the primary way of knowing used in philosophy. I might suggest that if I fall in a swimming pool full of water, I will get wet. If that premise is true and I fall in a swimming pool, you could deduce that I got wet. Many people who live in societies that have not experienced industrialization decide what to do in the future by repeating what was done in the past. Even in modern societies, many people get satisfaction out of celebrating holidays the same way year after year. Fast-paced change in modern societies, however, makes traditional knowledge less and less helpful in making good choices. Some people claim to acquire knowledge believed to be valid by consulting religious texts and believing what is written in them, such as the Torah, the Bible, the Koran, the Bhagavad Gita, or the Book of Mormon. Others claim to receive revelations from a higher power in the form of voices or a general intuitive sense of what one should do. The scientific method combines the use of logic with controlled experience, creating a novel way of discovery that marries sensory input with careful thinking. By adopting a model of cause and effect, scientists produce knowledge that can explain certain phenomena and even predict various outcomes before they occur. These methods of claiming to know certain things are referred to as epistemologies. An epistemology is simply a way of knowing. In Sociology, information gathered through science is privileged over all others. That is, information gleaned using other epistemologies will be rejected if it is not supported by evidence gathered using the scientific method. The Scientific Method[edit] A scientific method or process is considered fundamental to the scientific investigation and acquisition of new knowledge based upon verifiable evidence. In addition to employing the scientific method in their research, sociologists explore the social world with several different purposes in mind. Like the physical sciences i. This approach to doing science is often termed positivism though perhaps more accurately should be called empiricism. The positivist approach to social science seeks to explain and predict social phenomena, often employing a quantitative approach where aspects of social life are assigned numerical codes and subjected to in-depth analyses to uncover trends often missed by a casual observer. This approach most often makes use of deductive reasoning , which initially forms a theory and hypothesis, which are then subjected to empirical testing. Unlike the physical sciences, sociology and other social sciences, like anthropology also often seek simply to understand social phenomena. Max Weber labeled this approach Verstehen , which is German for understanding. This approach, called qualitative sociology, aims to understand a culture or phenomenon on its own terms rather than trying to develop a theory that allows for prediction. Qualitative sociologists more frequently use inductive reasoning where an investigator will take time to make repeated observations of the phenomena under study, with the hope of coming to a thorough and grounded understanding of what is really going on. Both approaches employ a scientific method as they make observations and gather data, propose hypotheses, and test or refine their hypotheses in the formulation of theories. These steps are outlined in more detail below. Sociologists use observations, hypotheses, deductions, and inductions to understand and ultimately develop explanations for social phenomena in the form of theories. Predictions from these theories are tested. If a prediction turns out to be correct, the theory survives. If not, the theory is modified or discarded. The method is commonly taken as the underlying logic of scientific practice. Science is essentially an extremely cautious means of building a supportable, evidenced understanding of our natural and social worlds. The essential elements of a scientific method are iterations and recursions of the following four steps: The systematic, careful collection of measurements, counts or categorical distinctions of relevant quantities or qualities is often the critical difference between pseudo-sciences, such as alchemy , and a science, such as chemistry. Scientific measurements are usually tabulated, graphed, or mapped, and statistical manipulations, such as correlation and regression , performed on them. The measurements might be made in a controlled setting, such as a laboratory, or made on more or less inaccessible or unmanipulatable objects such as human populations. The measurements often require specialized scientific instruments such as thermometers, spectroscopes, or voltmeters, and the progress of a scientific field is usually intimately tied to their invention and development. These categorical distinctions generally require specialized coding or sorting protocols that allow differential qualities to be sorted into distinct categories, which may be compared and contrasted over time, and the progress of scientific fields in this vein are generally tied to the accumulation of systematic categories and observations across multiple natural sites. In both cases, scientific progress relies upon ongoing intermingling between measurement and categorical approaches to data analysis. Measurements demand the use of operational definitions of relevant quantities a. That is, a scientific quantity is described or defined by how it is measured, as opposed to some more vague, inexact or idealized definition. The operational definition of a thing often relies on comparisons with standards: In short, to operationalize a variable means creating an operational definition for a concept someone intends to measure. Similarly, categorical distinctions rely upon the use of previously observed categorizations. A scientific category is thus described or defined based upon existing information gained from prior observations and patterns in the natural world as opposed to socially constructed "measurements" and "standards" in order to capture potential missing pieces in the logic and definitions of previous studies. In both cases, however, how this is done is very important as it should be done with enough precision that independent researchers should be able to use your description of your measurement or construction of categories, and repeat either or both. The scientific definition of a term sometimes differs substantially from its natural language usage. For example, sex and gender are often used interchangeably in common discourse, but have distinct meanings in sociology. Scientific quantities are often characterized by their units of measure which can later be described in terms of conventional physical units when communicating the work while scientific categorizations are generally characterized by their shared qualities which can later be described in terms of conventional linguistic patterns of communication. Measurements and categorizations in scientific work are also usually accompanied by estimates of their uncertainty or disclaimers concerning the scope of initial observations. The uncertainty is often estimated by making repeated measurements of the desired quantity. Uncertainties may also be calculated by consideration of the uncertainties of the individual underlying quantities that are used. Counts of things, such as the number of people in a nation at a particular time, may also have an uncertainty due to limitations of the method used. Counts may only represent a sample of desired quantities, with an uncertainty that depends upon the sampling method used and the number of samples taken see the central limit theorem. Hypothesis Development[edit] A hypothesis includes a suggested explanation of the subject. In quantitative work, it will generally provide a causal explanation or propose some association between two variables. If the hypothesis is a causal explanation, it will involve at least one dependent variable and one independent variable. In qualitative work, hypotheses generally involve potential assumptions built into existing causal statements, which may be examined in a natural setting. Variables are measurable phenomena whose values or qualities can change e. A dependent variable is a variable whose values or qualities are presumed to change as a result of the independent variable. In other words, the value or quality of a dependent variable depends on the value of the independent variable. Of course, this assumes that there is an actual relationship between the two variables. If there is no relationship, then the value or quality of the dependent variable does not depend on the value of the independent variable. An independent variable is a variable whose value or quality is manipulated by the experimenter or, in the case of non-experimental analysis, changes in the society and is measured or observed systematically. Perhaps an example will help clarify. Promotion would be the dependent variable. Change in promotion is hypothesized to be dependent on gender. Scientists use whatever they can â€" their own creativity, ideas from other fields, induction, deduction, systematic guessing, etc. There are no definitive guidelines for the production of new hypotheses. The history of science is filled with stories of scientists claiming a flash of inspiration, or a hunch, which then motivated them to look for evidence to support, refute, or refine their idea or develop an entirely new framework. Prediction[edit] A useful quantitative hypothesis will enable predictions, by deductive reasoning, that can be experimentally assessed. If results contradict the predictions, then the hypothesis under examination is incorrect or incomplete and requires either revision or abandonment. If results confirm the predictions, then the hypothesis might be correct but is still subject to further testing. Predictions refer to experimental designs with a currently unknown outcome. A prediction of an unknown differs from a consequence which can already be known. Testing[edit] Once a prediction is made, a method is designed to test or critique it. The investigator may seek either confirmation or falsification of the hypothesis, and refinement or understanding of the data. Though a variety of methods are used by both natural and social scientists, laboratory experiments remain one of the most respected methods by which to test hypotheses. Scientists assume an attitude of openness and accountability on the part of those conducting an experiment. Detailed record keeping is essential, to aid in recording and reporting on the experimental results, and providing evidence of the effectiveness and integrity of the procedure. They will also assist in reproducing the experimental results. This is a diagram of the famous Milgram Experiment which explored obedience and authority in light of the crimes committed by the Nazis in World War II. In experiments where controls are observed rather than introduced, researchers take into account potential variables e. On the other hand, in experiments where a control is introduced, two virtually identical experiments are run, in only one of which the factor being tested is varied. This serves to further isolate any causal phenomena. For example in testing a drug it is important to carefully test that the supposed effect of the drug is produced only by the drug. Doctors may do this with a double-blind study:

STATISTICAL PRINCIPLES AND TECHNIQUES IN SCIENTIFIC AND SOCIAL INVESTIGATIONS pdf

2: Introduction to Sociology/Sociological Methods - Wikibooks, open books for an open world

Statistical principles and techniques in scientific and social investigations. [W J Krzanowski] -- "Statistical Principles and Techniques in Scientific and Social Research is aimed at graduates and researchers in the Sciences and Social Sciences wanting to increase their understanding of the.

However, the Glass and Smith study was criticized e. Some subsequent reviews reached conclusions similar to Glass and Smith e. In the midst of controversy, the Tennessee state legislature asked just this question and funded a randomized experiment to find out, an experiment that Harvard statistician Frederick Mosteller , p. As Webb, Campbell, Schwartz, and Sechrest , pp. Scientific Research in Education. The National Academies Press. The experiment began with a cohort of students who entered kindergarten in , and lasted 4 years. After third grade, all students returned to regular size classes. Although students were supposed to stay in their original treatment conditions for four years, not all did. Three findings from this experiment stand out. First, students in small classes outperformed students in regular size classes with or without aides. Second, the benefits of class-size reduction were much greater for minorities primarily African American and inner-city children than others see, e. And third, even though students returned to regular classes in fourth grade, the reduced class-size effect persisted in affecting whether they took college entrance examinations and on their examination performance Krueger and Whitmore, New theories about the periodicity of the ice ages, similarly, were informed by multiple methods e. The integration and interaction of multiple disciplinary perspectivesâ€"with their varying methodsâ€"often accounts for scientific progress Wilson, ; this is evident, for example, in the advances in understanding early reading skills described in Chapter 2. This line of work features methods that range from neuroimaging to qualitative classroom observation. Page 66 Share Cite Suggested Citation: This is true for many research endeavors in the social sciences and education research, although not for all of them. If the concepts or variables are poorly specified or inadequately measured, even the best methods will not be able to support strong scientific inferences. The history of the natural sciences is one of remarkable development of concepts and variables, as well as the tools instrumentation to measure them. Measurement reliability and validity is particularly challenging in the social sciences and education Messick, Sometimes theory is not strong enough to permit clear specification and justification of the concept or variable. Sometimes the tool e. Sometimes the use of the measurement has an unintended social consequence e. And sometimes error is an inevitable part of the measurement process. In the physical sciences, many phenomena can be directly observed or have highly predictable properties; measurement error is often minimal. However, see National Research Council [] for a discussion of when and how measurement in the physical sciences can be imprecise. In sciences that involve the study of humans, it is essential to identify those aspects of measurement error that attenuate the estimation of the relationships of interest e. By investigating those aspects of a social measurement that give rise to measurement error, the measurement process itself will often be improved. Regardless of field of study, scientific measurements should be accompanied by estimates of uncertainty whenever possible see Principle 4 below. SCIENTIFIC PRINCIPLE 4 Provide Coherent, Explicit Chain of Reasoning The extent to which the inferences that are made in the course of scientific work are warranted depends on rigorous reasoning that systematically and logically links empirical observations with the underlying theory and the degree to which both the theory and the observations are linked to the question or problem that lies at the root of the investigation. This chain of reasoning must be coherent, explicit one that another researcher could replicate , and persuasive to a skeptical reader so that, for example, counterhypotheses are addressed. All rigorous researchâ€"quantitative and qualitativeâ€"embodies the same underlying logic of inference King, Keohane, and Verba, This inferential reasoning is supported by clear statements about how the research conclusions were reached: What assumptions were made? How was evidence judged to be relevant? How were alternative explanations considered or discarded? How were the links between data and the conceptual or theoretical framework made?

The nature of this chain of reasoning will vary depending on the design of the study, which in turn will vary depending on the question that is being investigated. Will the research develop, extend, modify, or test a hypothesis? Does it aim to determine: How does it work? Under what circumstances does it work? If the goal is to produce a description of a complex system, such as a subcellular organelle or a hierarchical social organization, successful inference may rather depend on issues of fidelity and internal consistency of the observational techniques applied to diverse components and the credibility of the evidence gathered. The research design and the inferential reasoning it enables must demonstrate a thorough understanding of the subtleties of the questions to be asked and the procedures used to answer them. Putnam used multiple methods to subject to rigorous testing his hypotheses about what affects the success or failure of democratic institutions as they develop in diverse social environments to rigorous testing, and found the weight of the evidence favored Page 68 Share Cite Suggested Citation: This principle has several features worthy of elaboration. Assumptions underlying the inferences made should be clearly stated and justified. Moreover, choice of design should both acknowledge potential biases and plan for implementation challenges. Estimates of error must also be made. Claims to knowledge vary substantially according to the strength of the research design, theory, and control of extraneous variables and by systematically ruling out possible alternative explanations. Although scientists always reason in the presence of uncertainty, it is critical to gauge the magnitude of this uncertainty. In the physical and life sciences, quantitative estimates of the error associated with conclusions are often computed and reported. In the social sciences and education, such quantitative measures are sometimes difficult to generate; in any case, a statement about the nature and estimated magnitude of error must be made in order to signal the level of certainty with which conclusions have been drawn. To make valid inferences, plausible counterexplanations must be dealt with in a rational, systematic, and compelling way. Well-known research designs e.

STATISTICAL PRINCIPLES AND TECHNIQUES IN SCIENTIFIC AND SOCIAL INVESTIGATIONS pdf

3: Contact Support

Statistical Principles and Techniques in Scientific and Social Investigations, by W.J. Krzanowski. Oxford, Oxford University Press, pp.

Timeline of the history of scientific method Aristotle , â€” BCE. A polymath, considered by some to be the father of modern scientific methodology , due to his emphasis on experimental data and reproducibility of its results. This is the greatest piece of Retroductive reasoning ever performed. According to Albert Einstein , "All knowledge of reality starts from experience and ends in it. Propositions arrived at by purely logical means are completely empty as regards reality. Because Galileo saw this, and particularly because he drummed it into the scientific world, he is the father of modern physics â€" indeed, of modern science altogether. The term "scientific method" did not come into wide use until the 19th century, when other modern scientific terminologies began to emerge such as "scientist" and "pseudoscience" and significant transformation of science was taking place. The scientific method is the process by which science is carried out. This is in opposition to stringent forms of rationalism: A strong formulation of the scientific method is not always aligned with a form of empiricism in which the empirical data is put forward in the form of experience or other abstracted forms of knowledge; in current scientific practice, however, the use of scientific modelling and reliance on abstract typologies and theories is normally accepted. The scientific method is of necessity also an expression of an opposition to claims that e. Different early expressions of empiricism and the scientific method can be found throughout history, for instance with the ancient Stoics , Epicurus , [29] Alhazen , [30] Roger Bacon , and William of Ockham. From the 16th century onwards, experiments were advocated by Francis Bacon , and performed by Giambattista della Porta , [31] Johannes Kepler , [32] and Galileo Galilei. The hypothetico-deductive model [35] formulated in the 20th century, is the ideal although it has undergone significant revision since first proposed for a more formal discussion, see below. Staddon argues it is a mistake to try following rules [36] which are best learned through careful study of examples of scientific investigation. Process The overall process involves making conjectures hypotheses , deriving predictions from them as logical consequences, and then carrying out experiments based on those predictions to determine whether the original conjecture was correct. Though the scientific method is often presented as a fixed sequence of steps, these actions are better considered as general principles. As noted by scientist and philosopher William Whewell â€" , "invention, sagacity, [and] genius" [11] are required at every step. Formulation of a question The question can refer to the explanation of a specific observation , as in "Why is the sky blue? If the answer is already known, a different question that builds on the evidence can be posed. When applying the scientific method to research, determining a good question can be very difficult and it will affect the outcome of the investigation. A statistical hypothesis is a conjecture about a given statistical population. For example, the population might be people with a particular disease. The conjecture might be that a new drug will cure the disease in some of those people. Terms commonly associated with statistical hypotheses are null hypothesis and alternative hypothesis. A null hypothesis is the conjecture that the statistical hypothesis is false; for example, that the new drug does nothing and that any cure is caused by chance. Researchers normally want to show that the null hypothesis is false. The alternative hypothesis is the desired outcome, that the drug does better than chance. Prediction This step involves determining the logical consequences of the hypothesis. One or more predictions are then selected for further testing. The more unlikely that a prediction would be correct simply by coincidence, then the more convincing it would be if the prediction were fulfilled; evidence is also stronger if the answer to the prediction is not already known, due to the effects of hindsight bias see also postdiction. Ideally, the prediction must also distinguish the hypothesis from likely alternatives; if two hypotheses make the same prediction, observing the prediction to be correct is not evidence for either one over the other. Scientists and other people test hypotheses by conducting experiments. The purpose of an experiment is to determine whether observations of the real world agree with or conflict with the predictions derived from a hypothesis. If they agree, confidence in the hypothesis increases; otherwise, it decreases. Agreement does not assure that the hypothesis is true; future experiments may reveal problems. Karl Popper advised scientists to try to falsify hypotheses, i. Large numbers of successful confirmations are not convincing if they arise from experiments that avoid risk. For example, tests of medical treatments are commonly run as double-blind tests. Test personnel, who might unwittingly reveal to test subjects which samples are the desired test drugs and which are placebos , are kept ignorant of which are which. Such hints can bias the responses of the test subjects. Furthermore, failure of an experiment does not necessarily mean the hypothesis is false. Experiments always depend on several hypotheses, e. See the Duhemâ€"Quine thesis. Astronomers do experiments, searching for planets around distant stars. Finally, most individual experiments address highly specific topics for reasons of practicality. As a result, evidence about broader topics is usually accumulated gradually. Analysis This involves determining what the results of the experiment show and deciding on the next actions to take. The predictions of the hypothesis are compared to those of the null hypothesis, to determine which is better able to explain the data. In cases where an experiment is repeated many times, a statistical analysis such as a chi-squared test may be required. If the evidence has falsified the hypothesis, a new hypothesis is required; if the experiment supports the hypothesis but the evidence is not strong enough for high confidence, other predictions from the hypothesis must be tested. Once a hypothesis is strongly supported by evidence, a new question can be asked to provide further insight on the same topic. Evidence from other scientists and experience are frequently incorporated at any stage in the process. Depending on the complexity of the experiment, many iterations may be required to gather sufficient evidence to answer a question with confidence, or to build up many answers to highly specific questions in order to answer a single broader question. DNA example The basic elements of the scientific method are illustrated by the following example from the discovery of the structure of DNA: Previous investigation of DNA had determined its chemical composition the four nucleotides , the structure of each individual nucleotide, and other properties. It had been identified as the carrier of genetic information by the Averyâ€"MacLeodâ€"McCarty experiment in , [40] but the mechanism of how genetic information was stored in DNA was unclear. Watson hypothesized that DNA had a helical structure. This prediction was a mathematical construct, completely independent from the biological problem at hand. The results showed an X-shape. When Watson saw the detailed diffraction pattern, he immediately recognized it as a helix. Each step of the example is examined in more detail later in the article. Other components The scientific method also includes other components required even when all the iterations of the steps above have been completed: As a result, it is common for a single experiment to be performed multiple times, especially when there are uncontrolled variables or other indications of experimental error. For significant or surprising results, other scientists may also attempt to replicate the results for themselves, especially if those results would be important to their own work. Some journals request that the experimenter provide lists of possible peer reviewers, especially if the field is highly specialized. Peer review does not certify correctness of the results, only that, in the opinion of the reviewer, the experiments themselves were sound based on the description supplied by the experimenter. If the work passes peer review, which occasionally may require new experiments requested by the reviewers, it will be published in a peer-reviewed scientific journal. The specific journal that publishes the results indicates the perceived quality of the work. This allows scientists to gain a better understanding of the topic under study, and later to use that understanding to intervene in its causal mechanisms such as to cure disease. The better an explanation is at making predictions, the more useful it frequently can be, and the more likely it will continue to explain a body of evidence better than its alternatives. The most successful explanations â€" those which explain and make accurate predictions in a wide range of circumstances â€" are often called scientific theories. Most experimental results do not produce large changes in human understanding; improvements in theoretical scientific understanding typically result from a gradual process of development over time, sometimes across different domains of science. In general, explanations become accepted over time as evidence accumulates on a given topic, and the explanation in question proves more powerful than its alternatives at explaining the evidence. Often subsequent researchers re-formulate the explanations over time, or combined explanations to produce new explanations. Tow sees the scientific method in terms of an evolutionary algorithm applied to science and technology. That is, no theory can ever be considered final, since new problematic evidence might be discovered. If such evidence is found, a new theory may be proposed, or more commonly it is found that modifications to the previous theory are sufficient to explain the new evidence. The strength of a theory can be argued[by whom? Theories can also become subsumed by other theories. Thus, in certain cases independent, unconnected, scientific observations can be connected to each other, unified by principles of increasing explanatory power. In subsequent modifications, it has also subsumed aspects of many other fields such as biochemistry and molecular biology. This demonstrates a use of photography as an experimental tool in science. Scientific methodology often directs that hypotheses be tested in controlled conditions wherever possible. This is frequently possible in certain areas, such as in the biological sciences, and more difficult in other areas, such as in astronomy. The practice of experimental control and reproducibility can have the effect of diminishing the potentially harmful effects of circumstance, and to a degree, personal bias. For example, pre-existing beliefs can alter the interpretation of results, as in confirmation bias ; this is a heuristic that leads a person with a particular belief to see things as reinforcing their belief, even if another observer might disagree in other words, people tend to observe what they expect to observe. Such proto-ideas are at first always too broad and insufficiently specialized. Once a structurally complete and closed system of opinions consisting of many details and relations has been formed, it offers enduring resistance to anything that contradicts it. MacKay has analyzed these elements in terms of limits to the accuracy of measurement and has related them to instrumental elements in a category of measurement. The scientific community and philosophers of science generally agree on the following classification of method components. These methodological elements and organization of procedures tend to be more characteristic of natural sciences than social sciences. Nonetheless, the cycle of formulating hypotheses, testing and analyzing the results, and formulating new hypotheses, will resemble the cycle described below. The scientific method is an iterative, cyclical process through which information is continually revised. These activities do not describe all that scientists do see below but apply mostly to experimental sciences e. The elements above are often taught in the educational system as "the scientific method". A linearized, pragmatic scheme of the four points above is sometimes offered as a guideline for proceeding: Characterizations The scientific method depends upon increasingly sophisticated characterizations of the subjects of investigation. The subjects can also be called unsolved problems or the unknowns.

4: Statistics - Wikipedia

This graduate-level text provides a survey of the logic and reasoning underpinning statistical analysis, as well as giving a broad-brush overview of the various statistical techniques that play a major roll in scientific and social investigations.

Among the very basic principles that guide scientists, as well as many other scholars, are those expressed as respect for the integrity of knowledge, collegiality, honesty, objectivity, and openness. These principles are at work in the fundamental elements of the scientific method, such as formulating a hypothesis, designing an experiment to test the hypothesis, and collecting and interpreting data. In addition, more particular principles characteristic of specific scientific disciplines influence the methods of observation; the acquisition, storage, management, and sharing of data; the communication of scientific knowledge and information; and the training of younger scientists. The basic and particular principles that guide scientific research practices exist primarily in an unwritten code of ethics. Although some have proposed that these principles should be written down and formalized, 2 the principles and traditions of science are, for the most part, conveyed to successive generations of scientists through example, discussion, and informal education. As was pointed out in an early Academy report on responsible conduct of research in the Page 37 Share Cite Suggested Citation: Responsible Science, Volume I: Ensuring the Integrity of the Research Process. The National Academies Press. Physicist Richard Feynman invoked the informal approach to communicating the basic principles of science in his commencement address at the California Institute of Technology Feynman, Details that could throw doubt on your interpretation must be given, if you know them. You must do the best you canâ€"if you know anything at all wrong, or possibly wrongâ€"to explain it. If you make a theory, for example, and advertise it, or put it out, then you must also put down all the facts that disagree with it, as well as those that agree with it. In summary, the idea is to try to give all the information to help others to judge the value of your contribution, not just the information that leads to judgment in one particular direction or another. Even in a revolutionary scientific field like molecular biology, students and trainees have learned the basic principles governing judgments made in such standardized procedures as cloning a new gene and determining its sequence. In evaluating practices that guide research endeavors, it is important to consider the individual character of scientific fields. Research fields that yield highly replicable results, such as ordinary organic chemical structures, are quite different from fields such as cellular immunology, which are in a much earlier stage of development and accumulate much erroneous or uninterpretable material before the pieces fit together coherently. When a research field is too new or too fragmented to support consensual paradigms or established methods, different scientific practices can emerge. Page 38 Share Cite Suggested Citation: This knowledge is based on explanatory principles whose verifiable consequences can be tested by independent observers. Science encompasses a large body of evidence collected by repeated observations and experiments. Although its goal is to approach true explanations as closely as possible, its investigators claim no final or permanent explanatory truths. Verifiable facts always take precedence. Scientists operate within a system designed for continuous testing, where corrections and new findings are announced in refereed scientific publications. The task of systematizing and extending the understanding of the universe is advanced by eliminating disproved ideas and by formulating new tests of others until one emerges as the most probable explanation for any given observed phenomenon. This is called the scientific method. An idea that has not yet been sufficiently tested is called a hypothesis. Different hypotheses are sometimes advanced to explain the same factual evidence. Rigor in the testing of hypotheses is the heart of science, if no verifiable tests can be formulated, the idea is called an ad hoc hypothesisâ€"one that is not fruitful; such hypotheses fail to stimulate research and are unlikely to advance scientific knowledge. A fruitful hypothesis may develop into a theory after substantial observational or experimental support has accumulated. When a hypothesis has survived repeated opportunities for disproof and when competing hypotheses have been eliminated as a result of failure to produce the predicted consequences, that hypothesis may become the accepted theory explaining the original facts. Scientific theories are also predictive. They allow us to anticipate yet unknown phenomena and thus to focus research on more narrowly defined areas. If the results of testing agree with predictions from a theory, the theory is provisionally corroborated. If not, it is proved false and must be either abandoned or modified to account for the inconsistency. Scientific theories, therefore, are accepted only provisionally. It is always possible that a theory that has withstood previous testing may eventually be disproved. But as theories survive more tests, they are regarded with higher levels of confidence. In science, then, facts are determined by observation or measurement of natural or experimental phenomena. A hypothesis is a proposed explanation of those facts. A theory is a hypothesis that has gained wide acceptance because it has survived rigorous investigation of its predictions. Page 39 Share Cite Suggested Citation: Examples of events changing scientific thought are legion. Truly scientific understanding cannot be attained or even pursued effectively when explanations not derived from or tested by the scientific method are accepted. A well-established discipline can also experience profound changes during periods of new conceptual insights. In these moments, when scientists must cope with shifting concepts, the matter of what counts as scientific evidence can be subject to dispute. Historian Jan Sapp has described the complex interplay between theory and observation that characterizes the operation of scientific judgment in the selection of research data during revolutionary periods of paradigmatic shift Sapp, , p. It is a matter of negotiation. It is learned, acquired socially; scientists make judgments about what fellow scientists might expect in order to be convincing. What counts as good evidence may be more or less well-defined after a new discipline or specialty is formed; however, at revolutionary stages in science, when new theories and techniques are being put forward, when standards have yet to be negotiated, scientists are less certain as to what others may require of them to be deemed competent and convincing. Explicit statements of the values and traditions that guide research practice have evolved through the disciplines and have been given in textbooks on scientific methodologies. But the responsibilities of the research community and research institutions in assuring individual compliance with scientific principles, traditions, and codes of ethics are not well defined. Research practices are influenced by a variety of factors, including: The general norms of science; The nature of particular scientific disciplines and the traditions of organizing a specific body of scientific knowledge; The example of individual scientists, particularly those who hold positions of authority or respect based on scientific achievements; The policies and procedures of research institutions and funding agencies; and Socially determined expectations. The first three factors have been important in the evolution of modern science. The latter two have acquired more importance in recent times. Norms of Science As members of a professional group, scientists share a set of common values, aspirations, training, and work experiences. A set of general norms are imbedded in the methods and the disciplines of science that guide individual, scientists in the organization and performance of their research efforts and that also provide a basis for nonscientists to understand and evaluate the performance of scientists. But there is uncertainty about the extent to which individual scientists adhere to such norms. Most social scientists conclude that all behavior is influenced to some degree by norms that reflect socially or morally supported patterns of preference when alternative courses of action are possible. The strength of these influences, and the circumstances that may affect them, are not well understood. In a classic statement of the importance of scientific norms, Robert Merton specified four norms as essential for the effective functioning of science: Neither Merton nor other sociologists of science have provided solid empirical evidence for the degree of influence of these norms in a representative sample of scientists. It is clear that the specific influence of norms on the development of scientific research practices is simply not known and that further study of key determinants is required, both theoretically and empirically. Commonsense views, ideologies, and anecdotes will not support a conclusive appraisal. Individual Scientific Disciplines Science comprises individual disciplines that reflect historical developments and the organization of natural and social phenomena for study. Social scientists may have methods for recording research data that differ from the methods of biologists, and scientists who depend on complex instrumentation may have authorship practices different from those of scientists who work in small groups or carry out field studies. Even within a discipline, experimentalists engage in research practices that differ from the procedures followed by theorists. The disciplines have traditionally provided the vital connections between scientific knowledge and its social organization. Scientific societies and scientific journals, some of which have tens of thousands of members and readers, and the peer review processes used by journals and research sponsors are visible forms of the social organization of the disciplines. The power of the disciplines to shape research practices and standards is derived from their ability to provide a common frame of reference in evaluating the significance of new discoveries and theories in science. Disciplinary departments rely primarily on informal social and professional controls to promote responsible behavior and to penalize deviant behavior. These controls, such as social ostracism, the denial of letters of support for future employment, and the withholding of research resources, can deter and penalize unprofessional behavior within research institutions. The Role of Individual Scientists and Research Teams The methods by which individual scientists and students are socialized in the principles and traditions of science are poorly understood. The principles of science and the practices of the disciplines are transmitted by scientists in classroom settings and, perhaps more importantly, in research groups and teams. The social setting of the research group is a strong and valuable characteristic of American science and education. The dynamics of research groups can foster â€”or inhibitâ€”innovation, creativity, education, and collaboration. Page 43 Share Cite Suggested Citation: Individuals in positions of authority are visible and are also influential in determining funding and other support for the career paths of their associates and students. Research directors and department chairs, by virtue of personal example, thus can reinforce, or weaken, the power of disciplinary standards and scientific norms to affect research practices. To the extent that the behavior of senior scientists conforms with general expectations for appropriate scientific and disciplinary practice, the research system is coherent and mutually reinforcing. When the behavior of research directors or department chairs diverges from expectations for good practice, however, the expected norms of science become ambiguous, and their effects are thus weakened. Thus personal example and the perceived behavior of role models and leaders in the research community can be powerful stimuli in shaping the research practices of colleagues, associates, and students. The role of individuals in influencing research practices can vary by research field, institution, or time. The standards and expectations for behavior exemplified by scientists who are highly regarded for their technical competence or creative insight may have greater influence than the standards of others. Individual and group behaviors may also be more influential in times of uncertainty and change in science, especially when new scientific theories, paradigms, or institutional relationships are being established. Institutional Policies Universities, independent institutes, and government and industrial research organizations create the environment in which research is done. As the recipients of federal funds and the institutional sponsors of research activities, administrative officers must comply with regulatory and legal requirements that accompany public support. Academic institutions traditionally have relied on their faculty to ensure that appropriate scientific and disciplinary standards are maintained. A few universities and other research institutions have also adopted policies or guidelines to clarify the principles that their members are expected to observe in the conduct of scientific research. Institutional policies governing research practices can have a powerful effect on research practices if they are commensurate with the norms that apply to a wide spectrum of research investigators. In particular, the process of adopting and implementing strong institutional policies can sensitize the members of those institutions to the potential for ethical problems in their work. Institutional policies can establish explicit standards that institutional officers then have the power to enforce with sanctions and penalties. Institutional policies are limited, however, in their ability to specify the details of every problematic situation, and they can weaken or displace individual professional judgment in such situations. Currently, academic institutions have very few formal policies and programs in specific areas such as authorship, communication and publication, and training and supervision. Government Regulations and Policies Government agencies have developed specific rules and procedures that directly affect research practices in areas such as laboratory safety, the treatment of human and animal research subjects, and the use of toxic or potentially hazardous substances in research. But policies and procedures adopted by some government research agencies to address misconduct in science see Chapter 5 represent a significant new regulatory development in the relationships between research institutions and government sponsors. The standards and criteria used to monitor institutional compliance with an increasing number of government regulations and policies affecting research practices have been a source of significant disagreement and tension within the research community. In recent years, some government research agencies have also adopted policies and procedures for the treatment of research data and materials in their extramural research programs.

STATISTICAL PRINCIPLES AND TECHNIQUES IN SCIENTIFIC AND SOCIAL INVESTIGATIONS pdf

The running punch Multicultural Theatre 2 Extensions of the standard template Grammar and communication The Usborne Big Book of Things to Spot (1001 Things to Spot) Cyberbullying is a serious, widespread problem Geotechnical engineering solved problems Cultural democracy and ethnic pluralism Immense amount of treasure Its division among the troops Rumors of a rising Trial of the Inca His executi Good Mornin Glory Kumon answer book level d math 1906 San Francisco Earthquake (Disasters) Developmental and Functional Hand Grasps Schoolroom games and exercises. Unravelling words the weaving of water Stable and unstable equilibrium in economics The Cambrian Explosion Some profound questions Mineral physiology and physiography 10. Howd You Like to Do That Subjunctive with certain conjunctions Daily Inspirations of Blessings The baseball life of Sandy Koufax Politics of mental health legislation The Economics of Saving (Recent Economic Thought) Passion for place. The japanese zero a test pilots report A geography of mankind Pre-invasion bombing strategy The complete chronicles of the Jerusalem man Art education in a postmodern world Little handbook to perfecting the art of Christian writing Who needs a school improvement partner? critical friend or Trojan collaborator Bodies, sexes, genders, sexualities Commentary on the Icons 190 Ing financial statements for value investing South Wind Through the Kitchen The diploma peddler The agony of Paul Gauguin The Australian Centenary History of Defence: Volume 1