# PREFACE

In the curricular structure introduced by this University for students of Post-Graduate degree programme, the opportunity to pursue Post-Graduate course in a subject is introduced by this University is equally available to all learners. Instead of being guided by any presumption about ability level, it would perhaps stand to reason if receptivity of a learner is judged in the course of the learning process. That would be entirely in keeping with the objectives of open education which does not believe in artificial differentiation. I am happy to note that university has been recently accredited by National Assessment and Accreditation Council of India (NAAC) with grade ‘A’.

Keeping this in view, study materials of the Post-Graduate level in different subjects are being prepared on the basis of a well laid-out syllabus. The course structure combines the best elements in the approved syllabi of Central and State Universities in respective subjects. It has been so designed as to be upgradable with the addition of new information as well as results of fresh thinking and analysis.

The accepted methodology of distance education has been followed in the preparation of these study materials. Co-operation in every form of experienced scholars is indispensable for a work of this kind. We, therefore, owe an enormous debt of gratitude to everyone whose tireless efforts went into the writing, editing, and devising of a proper lay-out of the materials. Practically speaking, their role amounts to an involvement in ‘invisible teaching’. For, whoever makes use of these study materials would virtually derive the benefit of learning under their collective care without each being seen by the other.

The more a learner would seriously pursue these study materials the easier it will be for him or her to reach out to larger horizons of a subject. Care has also been taken to make the language lucid and presentation attractive so that they may be rated as quality self-learning materials. If anything remains still obscure of difficult to follow, arrangements are there to come to terms with them through the counselling sessions regularly available at the network of study centres set up the University.

Needless to add, a great deal of these efforts are still experiment—in fact, pioneering in certain areas. Naturally, there is every possibility of some lapse or deficiency here and there. However, these do admit of rectification and further improvement in due course. On the whole, therefore, these study materials are expected to evoke wider appreciation the more they receive serious attention of all concerned.

**Professor (Dr.) Ranjan Chakrabarti**
Vice-Chancellor

**NETAJI SUBHAS OPEN UNIVERSITY**
**Post Graduate Degree Programme**
**Subject : Social Work**
**Course : Social Work Research & Statistics**
**(Social Work Research/Statistics)**
**Code : PGSW-VII**

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**PG : Social Work (MSW)**

## Course : Social Work Research & Statistics
## Code : PGSW-VII

## Module 1 : Social Research



## Module 2



## Module 3

# Unit 1 ❑ Concept of Social Research

***Structure***



## 1.0 Objective

Dear learners Social Work Research is one of the Secondary methods of Social Work. In this unit you will get an idea of how do we conduct Social Work research in a scientific manner and the ethical issues that one has to keep in mind while carrying Research.

## 1.1 Introduction

Scientists gather information about facts in a way that is organized and intentional, usually following a set of predetermined steps. A key word here is “systematically,” because it is important to understand that conducting science is a deliberate process. More specifically, social work is informed by social science, the science of humanity, social interactions, and social structures. In sum, social work research uses organized and intentional procedures to uncover facts or truths about the social world and it also relies on social scientific research to promote individual and social change. **Science** is a particular way of knowing that attempts to systematically collect and categorize facts or truths.

## 1.2 Science and Scientific Research

What is research? Depending on who you ask, you will likely get very different answers to this seemingly innocuous question. Some people will say that they routinely research different online websites to find the best place to buy goods or services they want. Television news channels supposedly conduct research in the form of viewer polls on topics of public interest such as forthcoming elections or government-funded projects. Undergraduate students research the Internet to find the information they need to complete assigned projects or term papers. Graduate students working on research projects for a professor may see research as collecting or analyzing data related to their project. Businesses and consultants research different potential solutions to remedy organizational problems such as a supply chain bottleneck or to identify customer purchase patterns. However, none of the above can be considered "scientific research" unless: (1) it contributes to a body of science, and (2) it follows the scientific method. This chapter will examine what these terms mean.

## 1.3 Elements of Social Work Research

### History of Scientific Thought

It may be interesting to go back in history and see how science has evolved over time and identify the key scientific minds in this evolution. Although instances of scientific progress have been documented over many centuries, the terms "science," "scientists," and the "scientific method" were coined only in the 19 th century. Prior to this time, science was viewed as a part of philosophy, and coexisted with other branches of philosophy such as logic, metaphysics, ethics, and aesthetics, although the boundaries between some of these branches were blurred.

In the earliest days of human inquiry, knowledge was usually recognized in terms of theological precepts based on faith. This was challenged by Greek philosophers such as Plato, Aristotle, and Socrates during the 3 rd century BC, who suggested that the fundamental nature of being and the world can be understood more accurately through a

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process of systematic logical reasoning called rationalism. In particular, Aristotle's classic work Metaphysics (literally meaning "beyond physical [existence]") separated theology (the study of Gods) from ontology (the study of being and existence) and universal science (the study of first principles, upon which logic is based). Rationalism (not to be confused with "rationality") views reason as the source of knowledge or justification, and suggests that the criterion of truth is not sensory but rather intellectual and deductive, often derived from a set of first principles or axioms (such as Aristotle's "law of non-contradiction").

The next major shift in scientific thought occurred during the 16 th century, when British philosopher Francis Bacon (1561-1626) suggested that knowledge can only be derived from observations in the real world. Based on this premise, Bacon emphasized knowledge acquisition as an empirical activity (rather than as a reasoning activity), and developed empiricism as an influential branch of philosophy. Bacon's works led to the popularization of inductive methods of scientific inquiry, the development of the "scientific method" (originally called the "Baconian method"), consisting of systematic observation, measurement, and experimentation, and may have even sowed the seeds of atheism or the rejection of theological precepts as "unobservable."

Empiricism continued to clash with rationalism throughout the Middle Ages, as philosophers sought the most effective way of gaining valid knowledge. French philosopher Rene Descartes sided with the rationalists, while British philosophers John Locke and David Hume sided with the empiricists. Other scientists, such as Galileo Galilei and Sir Issac Newton, attempted to fuse the two ideas into natural philosophy (the philosophy of nature), to focus specifically on understanding nature and the physical universe, which is considered to be the precursor of the natural sciences. Galileo (1564-1642) was perhaps the first to state that the laws of nature are mathematical, and contributed to the field of astronomy through an innovative combination of experimentation and mathematics.

In the 18 th century, German philosopher Immanuel Kant sought to resolve the dispute between empiricism and rationalism in his book Critique of Pure Reason, by arguing that experience is purely subjective and processing them using pure reason without first delving into the subjective nature of experiences will lead to theoretical illusions. Kant's ideas led to the development of German idealism, which inspired later development of interpretive techniques such as phenomenology, hermeneutics, and critical social theory.

At about the same time, French philosopher Auguste Comte (1798–1857), founder of the discipline of sociology, attempted to blend rationalism and empiricism in a new doctrine

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called positivism. He suggested that theory and observations have circular dependence on each other. While theories may be created via reasoning, they are only authentic if they can be verified through observations. The emphasis on verification started the separation of modern science from philosophy and metaphysics and further development of the "scientific method" as the primary means of validating scientific claims. Comte's ideas were expanded by Emile Durkheim in his development of sociological positivism (positivism as a foundation for social research) and Ludwig Wittgenstein in logical positivism.

In the early 20 th century, strong accounts of positivism were rejected by interpretive sociologists (antipositivists) belonging to the German idealism school of thought. Positivism was typically equated with quantitative research methods such as experiments and surveys and without any explicit philosophical commitments, while antipositivism employed qualitative methods such as unstructured interviews and participant observation. Even practitioners of positivism, such as American sociologist Paul Lazarsfield who pioneered large-scale survey research and statistical techniques for analyzing survey data, acknowledged potential problems of observer bias and structural limitations in positivist inquiry. In response, antipositivists emphasized that social actions must be studied though interpretive means based upon an understanding the meaning and purpose that individuals attach to their personal actions, which inspired Georg Simmel's work on symbolic interactionism, Max Weber's work on ideal types, and Edmund Husserl's work on phenomenology.

In the mid-to-late 20 th century, both positivist and antipositivist schools of thought were subjected to criticisms and modifications. British philosopher Sir Karl Popper suggested that human knowledge is based not on unchallengeable, rock solid foundations, but rather on a set of tentative conjectures that can never be proven conclusively, but only disproven. Empirical evidence is the basis for disproving these conjectures or "theories." This metatheoretical stance, called postpositivism (or postempiricism), amends positivism by suggesting that it is impossible to verify the truth although it is possible to reject false beliefs, though it retains the positivist notion of an objective truth and its emphasis on the scientific method.

Likewise, antipositivists have also been criticized for trying only to understand society but not critiquing and changing society for the better. The roots of this thought lie in Das Capital, written by German philosophers Karl Marx and Friedrich Engels, which critiqued capitalistic societies as being social inequitable and inefficient, and recommended resolving this inequity through class conflict and proletarian revolutions. Marxism inspired social

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revolutions in countries such as Germany, Italy, Russia, and China, but generally failed to accomplish the social equality that it aspired. Critical research (also called critical theory) propounded by Max Horkheimer and Jurgen Habermas in the 20 th century, retains similar ideas of critiquing and resolving social inequality, and adds that people can and should consciously act to change their social and economic circumstances, although their ability to do so is constrained by various forms of social, cultural and political domination. Critical research attempts to uncover and critique the restrictive and alienating conditions of the status quo by analyzing the oppositions, conflicts and contradictions in contemporary society, and seeks to eliminate the causes of alienation and domination (i.e., emancipate the oppressed class).

## Science

What is science? To some, science refers to difficult high school or college-level courses such as physics, chemistry, and biology meant only for the brightest

students. To others, science is a craft practiced by scientists in white coats using specialized equipment in their laboratories. Etymologically, the word "science" is derived from the Latin word scientia meaning knowledge. Science refers to a systematic and organized body of knowledge in any area of inquiry that is acquired using "the scientific method" (the scientific method is described further below). Science can be grouped into two broad categories: natural science and social science. Natural science is the science of naturally occurring objects or phenomena, such as light, objects, matter, earth, celestial bodies, or the human body. Natural sciences can be further classified into physical sciences, earth sciences, life sciences, and others. Physical sciences consist of disciplines such as physics (the science of physical objects), chemistry (the science of matter), and astronomy (the science of celestial objects). Earth sciences consist of disciplines such as geology (the science of the earth). Life sciences include disciplines such as biology (the science of human bodies) and botany (the science of plants). In contrast, social science is the science of people or collections of people, such as groups, firms, societies, or economies, and their individual or collective behaviors. Social sciences can be classified into disciplines such as psychology (the science of human behaviors), sociology (the science of social groups), and economics (the science of firms, markets, and economies).

The natural sciences are different from the social sciences in several respects. The natural sciences are very precise, accurate, deterministic, and independent of the person m

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aking the scientific observations. For instance, a scientific experiment in physics, such as measuring the speed of sound through a certain media or the refractive index of water, should always yield the exact same results, irrespective of the time or place of the experiment, or the person conducting the experiment. If two students conducting the same physics experiment obtain two different values of these physical properties, then it generally means that one or both of those students must be in error. However, the same cannot be said for the social sciences, which tend to be less accurate, deterministic, or unambiguous. For instance, if you measure a person's happiness using a hypothetical instrument, you may find that the same person is more happy or less happy (or sad) on different days and sometimes, at different times on the same day. One's happiness may vary depending on the news that person received that day or on the events that transpired earlier during that day. Furthermore, there is not a single instrument or metric that can accurately measure a person's happiness. Hence, one instrument may calibrate a person as being "more happy" while a second instrument may find that the same person is "less happy" at the same instant in time. In other words, there is a high degree of measurement error in the social sciences and there is considerable uncertainty and little agreement on social science policy decisions. For instance, you will not find many disagreements among natural scientists on the speed of light or the speed of the earth around the sun, but you will find numerous disagreements among social scientists on how to solve a social problem such as reduce global terrorism or rescue an economy from a recession. Any student studying the social sciences must be cognizant of and comfortable with handling higher levels of ambiguity, uncertainty, and error that come with such sciences, which merely reflects the high variability of social objects.

Sciences can also be classified based on their purpose. Basic sciences, also called pure sciences, are those that explain the most basic objects and forces, relationships between them, and laws governing them. Examples include physics, mathematics, and biology. Applied sciences, also called practical sciences, are sciences that apply scientific knowledge from basic sciences in a physical environment. For instance, engineering is an applied science that applies the laws of physics and chemistry for practical applications such as building stronger bridges or fuel efficient combustion engines, while medicine is an applied science that applies the laws of biology for solving human ailments. Both basic and applied sciences are required for human development. However, applied sciences cannot stand on their own right, but instead relies on basic sciences for its progress. Of course, the industry and private enterprises tend to focus more on applied sciences given their practical value, while universities study both basic and applied sciences.

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## Scientific Knowledge

The purpose of science is to create scientific knowledge. Scientific knowledge refers to a generalized body of laws and theories to explain a phenomenon or behavior of interest that are acquired using the scientific method. Laws are observed patterns of phenomena or behaviors, while theories are systematic explanations of the underlying phenomenon or behavior. For instance, in physics, the Newtonian Laws of Motion describe what happens when an object is in a state of rest or motion (Newton's First Law), what force is needed to move a stationary object or stop a moving object (Newton's Second Law), and what happens when two objects collide (Newton's Third Law). Collectively, the three laws constitute the basis of classical mechanics – a theory of moving objects. Likewise, the theory of optics explains the properties of light and how it behaves in different media, electromagnetic theory explains the properties of electricity and how to generate it, quantum mechanics explains the properties of subatomic \particles, and thermodynamics explains the properties of energy and mechanical work. An introductory college level text book in physics will likely contain separate chapters devoted to each of these theories. Similar theories are also available in social sciences. For instance, cognitive dissonance theory in psychology explains how people react when their observations of an event is different from what they expected of that event, general deterrence theory explains why some people engage in improper or criminal behaviors, such as illegally download music or commit software piracy, and the theory of planned behavior explains how people make conscious reasoned choices in their everyday lives.

The goal of scientific research is to discover laws and postulate theories that can explain natural or social phenomena, or in other words, build scientific knowledge. It is important to understand that this knowledge may be imperfect or even quite far from the truth. Sometimes, there may not be a single universal truth, but rather an equilibrium of "multiple truths." We must understand that the theories, upon which scientific knowledge is based, are only explanations of a particular phenomenon, as suggested by a scientist. As such, there may be good or poor explanations, depending on the extent to which those explanations fit well with reality, and consequently, there may be good or poor theories. The progress of science is marked by our progression over time from poorer theories to better theories, through better observations using more accurate instruments and more informed logical reasoning.

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We arrive at scientific laws or theories through a process of logic and evidence. Logic (theory) and evidence (observations) are the two, and only two, pillars upon which scientific knowledge is based. In science, theories and observations are interrelated and cannot exist without each other. Theories provide meaning and significance to what we observe, and observations help validate or refine existing theory or construct new theory. Any other means of knowledge acquisition, such as faith or authority cannot be considered science.

## Scientific Research

Given that theories and observations are the two pillars of science, scientific research operates at two levels: a theoretical level and an empirical level. The theoretical level is concerned with developing abstract concepts about a natural or social phenomenon and relationships between those concepts (i.e., build "theories"), while the empirical level is concerned with testing the theoretical concepts and relationships to see how well they reflect our observations of reality, with the goal of ultimately building better theories. Over time, a theory becomes more and more refined (i.e., fits the observed reality better), and the science gains maturity. Scientific research involves continually moving back and forth between theory and observations. Both theory and observations are essential components of scientific research. For instance, relying solely on observations for making inferences and ignoring theory is not considered valid scientific research.

Depending on a researcher's training and interest, scientific inquiry may take one of two possible forms: inductive or deductive. In inductive research, the goal of a researcher is to infer theoretical concepts and patterns from observed data. In deductive research, the goal of the researcher is to test concepts and patterns

known from theory using new empirical data. Hence, inductive research is also called theory-building research, and deductive research is theory-testing research. Note here that the goal of theory-testing is not just to test a theory, but possibly to refine, improve, and extend it. Figure 1.1 depicts the complementary nature of inductive and deductive research. Note that inductive and deductive research are two halves of the research cycle that constantly iterates between theory and observations. You cannot do inductive or deductive research if you are not familiar with both the theory and data components of research. Naturally, a complete researcher is one who can traverse the entire research cycle and can handle both inductive and deductive research.

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It is important to understand that theory-building (inductive research) and theory-testing (deductive research) are both critical for the advancement of science. Elegant theories are not valuable if they do not match with reality. Likewise, mountains of data are also useless until they can contribute to the construction to meaningful theories. Rather than viewing these two processes in a circular relationship, as shown in Figure 1.1, perhaps they

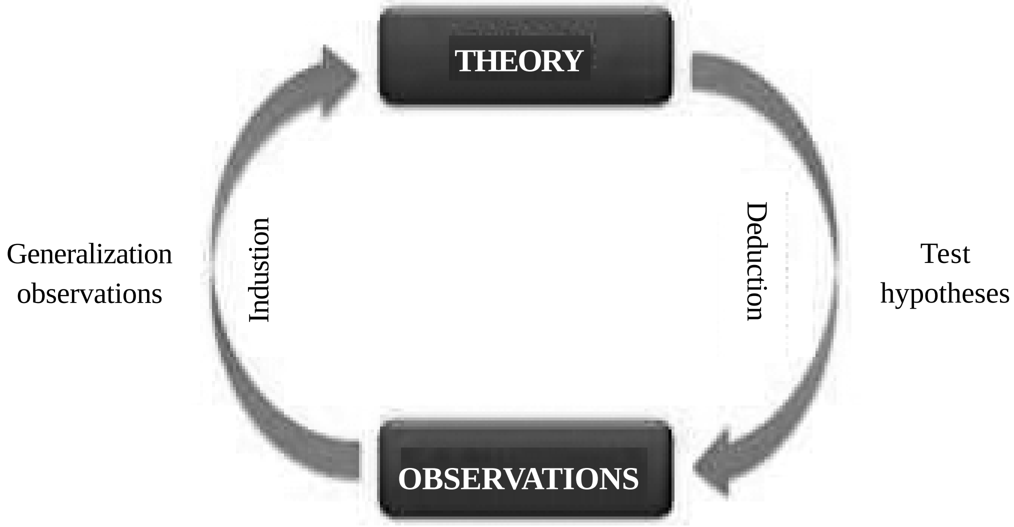


Figure 1.1 : The Cycle of Research

can be better viewed as a helix, with each iteration between theory and data contributing to better explanations of the phenomenon of interest and better theories. Though both inductive and deductive research are important for the advancement of science, it appears that inductive (theory-building) research is more valuable when there are few prior theories or explanations, while deductive (theory-testing) research is more productive when there are many competing theories of the same phenomenon and researchers are interested in knowing which theory works best and under what circumstances.

Theory building and theory testing are particularly difficult in the social sciences, given the imprecise nature of the theoretical concepts, inadequate tools to measure them, and the presence of many unaccounted factors that can also influence the phenomenon of interest. It is also very difficult to refute theories that do not work. For instance, Karl Marx's theory of communism as an effective means of economic production withstood for decades, before it was finally discredited as being inferior to capitalism in promoting economic growth and social welfare. Erstwhile communist economies like the Soviet Union and China

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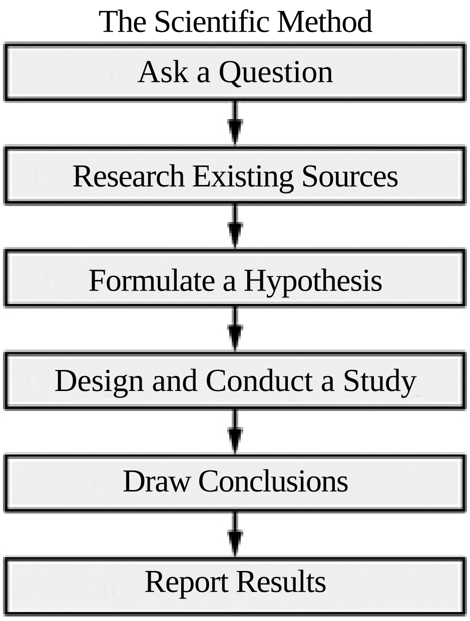
eventually moved toward more capitalistic economies characterized by profit-maximizing private enterprises. However, the recent collapse of the mortgage and financial industries in the United States demonstrates that capitalism also has its flaws and is not as effective in fostering economic growth and social welfare as previously presumed. Unlike theories in the natural sciences, social science theories are rarely perfect, which provides numerous opportunities for researchers to improve those theories or build their own alternative theories.

Conducting scientific research, therefore, requires two sets of skills – theoretical and methodological – needed to operate in the theoretical and empirical levels respectively. Methodological skills ("know-how") are relatively standard, invariant across disciplines, and easily acquired through doctoral programs. However, theoretical skills ("know-what") is considerably harder to master, requires years of observation and reflection, and are tacit skills that cannot be "taught" but rather learned though experience. All of the greatest scientists in the history of mankind, such as Galileo, Newton, Einstein, Neils Bohr, Adam Smith, Charles Darwin, and Herbert Simon, were master theoreticians, and they are remembered for the theories they postulated that transformed the course of science. Methodological skills are needed to be an ordinary researcher, but theoretical skills are needed to be an extraordinary researcher!

## Scientific Method

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In the preceding sections, we described science as knowledge acquired through a scientific method. So what exactly is the "scientific method"? Scientific method refers to a standardized set of techniques for building scientific knowledge, such as how to make valid observations, how to interpret results, and how to generalize those results. The scientific method allows researchers to independently and impartially test preexisting theories and prior findings, and subject them to open debate, modifications, or enhancements. The scientific method must satisfy four characteristics:

- Replicability: Others should be able to independently replicate or repeat a scientific study and obtain similar, if not identical, results.
- Precision: Theoretical concepts, which are often hard to measure, must be defined with such precision that others can use those definitions to measure those concepts and test that theory.
- Falsifiability: A theory must be stated in a way that it can be disproven. Theories that cannot be tested or falsified are not scientific theories and any such knowledge is not scientific knowledge. A theory that is specified in imprecise terms or whose concepts are not accurately measurable cannot be tested, and is therefore not scientific. Sigmund Freud's ideas on psychoanalysis fall into this category and is therefore not considered a "theory", even though psychoanalysis may have practical utility in treating certain types of ailments.
- Parsimony: When there are multiple explanations of a phenomenon, scientists must always accept the simplest or logically most economical explanation. This concept is called parsimony or "Occam's razor." Parsimony prevents scientists from pursuing overly complex or outlandish theories with endless number of concepts and relationships that may explain a little bit of everything but nothing in particular.

Any branch of inquiry that does not allow the scientific method to test its basic laws or theories cannot be called "science." For instance, theology (the study of religion) is not science because theological ideas (such as the presence of God) cannot be tested by independent observers using a replicable, precise, falsifiable, and parsimonious method. Similarly, arts, music, literature, humanities, and law are also not considered science, even though they are creative and worthwhile endeavors in their own right.

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The scientific method, as applied to social sciences, includes a variety of research approaches, tools, and techniques, such as qualitative and quantitative data, statistical analysis, experiments, field surveys, case research, and so forth. Most of this book is devoted to learning about these different methods. However, recognize that the scientific method operates primarily at the empirical level of research, i.e., how to make observations and analyze and interpret these observations. Very little of this method is directly pertinent to the theoretical level, which is really the more challenging part of scientific research.

## Types of Scientific Research

Depending on the purpose of research, scientific research projects can be grouped into three types: exploratory, descriptive, and explanatory. Exploratory research is often conducted in new areas of inquiry, where the goals of the research are: (1) to scope out the magnitude or extent of a particular phenomenon, problem, or behavior, (2) to generate some initial ideas (or "hunches") about that phenomenon, or (3) to test the feasibility of undertaking a more extensive study regarding that phenomenon. For instance, if the citizens of a country are generally dissatisfied with governmental policies regarding during an economic recession, exploratory research may be directed at measuring the extent of citizens' dissatisfaction, understanding how such dissatisfaction is manifested, such as the frequency of public protests, and the presumed causes of such dissatisfaction, such as ineffective government policies in dealing with inflation, interest rates, unemployment, or higher taxes. Such research may include examination of publicly reported figures, such as estimates of economic indicators, such as gross domestic product (GDP), unemployment, and consumer price index, as archived by third-party sources, obtained through interviews of experts, eminent economists, or key government officials, and/or derived from studying historical examples of dealing with similar problems. This research may not lead to a very accurate understanding of the target problem, but may be worthwhile in scoping out the nature and extent of the problem and serve as a useful precursor to more in-depth research.

Descriptive research is directed at making careful observations and detailed documentation of a phenomenon of interest. These observations must be based on the scientific method (i.e., must be replicable, precise, etc.), and therefore, are more reliable than casual observations by untrained people. Examples of descriptive research are tabulation of demographic statistics by the United States Census Bureau or employment statistics by the

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Bureau of Labor, who use the same or similar instruments for estimating employment by sector or population growth by ethnicity over multiple employment surveys or censuses. If any changes are made to the measuring instruments, estimates are provided with and without the changed instrumentation to allow the readers to make a fair before-and-after comparison regarding population or employment trends. Other descriptive research may include chronicling ethnographic reports of gang activities among adolescent youth in urban populations, the persistence or evolution of religious, cultural, or ethnic practices in select communities, and the role of technologies such as Twitter and instant messaging in the spread of democracy movements in Middle Eastern countries.

Explanatory research seeks explanations of observed phenomena, problems, or behaviors. While descriptive research examines the what, where, and when of a phenomenon, explanatory research seeks answers to why and how types of questions. It attempts to "connect the dots" in research, by identifying causal factors and outcomes of the target phenomenon. Examples include understanding the reasons behind adolescent crime or gang violence, with the goal of prescribing strategies to overcome such societal ailments. Most academic or doctoral research belongs to the explanation category, though some amount of exploratory and/or descriptive research may also be needed during initial phases of academic research. Seeking explanations for observed events requires strong theoretical and interpretation skills, along with intuition, insights, and personal experience. Those who can do it well are also the most prized scientists in their disciplines.

The theories of Truth rely on an **ontology**, or a set of assumptions about what is real. We assume that gravity is real and that the mitochondria of a cell are real. With a powerful microscope, mitochondria are easy to spot and observe, and we can theorize about their function in a cell. The gravitational force is invisible, but clearly apparent from observable facts, like watching an apple fall. The theories about gravity have changed over the years, and those improvements in theory were made when existing theories fell short in explaining observations.

If we weren't able to perceive mitochondria or gravity, they would still be there, doing their thing because they exist independent of our observation of them. This is a philosophical idea called *realism,* and it simply means that the concepts we talk about in science really and truly exist. Ontology in physics and biology is focused on **objective truth**. You may have heard the term "being objective" before: it involves observing and thinking with an open mind and pushing aside anything that might bias your perspective. Objectivity also

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involves finding what is true for everyone, not just what is true for one person. Gravity is certainly true for everyone, everywhere, but let's consider a social work example. It is objectively true that children who are subjected to severely traumatic experiences will experience negative mental health effects afterwards. A diagnosis of post-traumatic stress disorder (PTSD) is considered objective because it refers to a real mental health issue that exists independent of the social worker's observations, and it presents similarly in all clients who experience the disorder.

Objective, ontological perspective implies that observations are true for everyone, regardless of whether we are there to observe them or not observe them. **Epistemology**, or our assumptions about how we come to know what is real and true, helps us to realize these objective truths. The most relevant epistemological question in the social sciences is whether truth is better accessed using numbers or words. Generally, scientists approaching research with an objective ontology and epistemology will use **quantitative methods** to arrive at scientific truth. Quantitative methods examine numerical data to precisely describe and predict elements of the social world. This is due to the epistemological assumption that mathematics can represent the phenomena and relationships we observe in the social world.

Mathematical relationships are uniquely useful because allow us to make comparisons across individuals as well as time and space. For example, let's look at measures of poverty. While people can have different definitions of poverty, an objective measurement such as an annual income less than Rs25,000 for a family of four is insightful because (1) it provides a precise measurement, (2) it can be compared to incomes from all other people in any society from any time period, and (3) it refers to real quantities of money that exist in the world. In this book, we will review survey and experimental methods, which are the most common designs that use quantitative methods to answer research questions.

It may surprise you to learn that objective facts, like income or mental health diagnoses, are not the only facts that are present in the social sciences. Indeed, social science is not only concerned with objective truths, but it is also concerned with subjective truth. Subjective truths are unique to individuals, groups, and contexts. Unlike objective truths, subjective truths will vary based on who you are observing and the context you are observing them in. The beliefs, opinions, and preferences of people are actually truths that social scientists measure and describe. Additionally, subjective truths do not exist indepen-

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dent of human observation because they are the product of the human mind. We negotiate what is true in the social world through language, arriving at a consensus and engaging in debate.

Epistemologically, a scientist seeking subjective truth assumes that truth lies in what people say, in their words. A scientist uses **qualitative methods** to analyze words or other media to understand their meaning. Humans are social creatures, and we give meaning to our thoughts and feelings through language. Linguistic communication is unique. We share ideas with each other at a remarkable rate. In so doing, ideas come into and out of existence in a spontaneous and emergent fashion. Words are given a meaning by their creator, but anyone who receives that communication can absorb, amplify, and even change its original intent. Because social science studies human interaction, subjectivists argue that language is the best way to understand the world.

This epistemology is based on some interesting ontological assumptions. What happens when someone incorrectly interprets a situation? While their interpretation may be wrong, it is certainly true *to them* that they are right. Furthermore, they act on the assumption that they are right. In this sense, even incorrect interpretations are truths, even though they are only true to one person. This leads us to question whether the social concepts we think about really exist. They might only exist in our heads, unlike concepts from the natural sciences which exist independent of our thoughts. For example, if everyone ceased to believe in gravity, we wouldn't all float away. It has an existence independent of human thought.

One area that social workers commonly investigate is the impact of a person's social class background on their experiences and lot in life. You probably wouldn't be surprised to learn that a person's social class background has an impact on their educational attainment and achievement. In fact, one group of researchers in the early 1990s found that the percentage of children who did not receive any postsecondary schooling was four times greater among those in the lowest quartile (25%) income bracket than those in the upper quartile of income earners (i.e., children from high- income families were far more likely than low-income children to go on to college). Another recent study found that having more liquid wealth that can be easily converted into cash actually seems to predict children's math and reading achievement (Elliott, Jung, Kim, & Chowa, 2010).

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These findings—that wealth and income shape a child's educational experiences—are probably not that shocking to any of us. Yet, some of us may know someone who may be an exception to the rule. Sometimes the patterns that social scientists observe fit our commonly held beliefs about the way the world works. When this happens, we don't tend to take issue with the fact that patterns don't necessarily represent all people's experiences. But what happens when the patterns disrupt our assumptions?

For example, did you know that teachers are far more likely to encourage boys to think critically in school by asking them to expand on answers they give in class and by commenting on boys' remarks and observations? When girls speak up in class, teachers are more likely to simply nod and move on. The pattern of teachers engaging in more complex interactions with boys means that boys and girls do not receive the same educational experience in school (Sadker & Sadker, 1994). People who object to these findings tend to cite evidence from their own personal experience, refuting that the pattern actually exists. However, the problem with this response is that objecting to a social pattern on the grounds that it doesn't match one's individual experience misses the point about patterns. Patterns don't perfectly predict what will happen to an individual person, yet they are a reasonable guide. When patterns are systematically observed, they can help guide social work thought and action.

## 1.4 Concepts of Construct and Variables

Concepts may also have progressive levels of abstraction. Some concepts such as a person's *weight* are precise and objective, while other concepts such as a person's *personality* may be more abstract and difficult to visualize. A **construct** is an abstract concept that is specifically chosen (or "created") to explain a given phenomenon. A construct may be a simple concept, such as a person's *weight*, or a combination of a set of related concepts such as a person's *communication skill*, which may consist of several underlying concepts such as the person's *vocabulary*, *syntax*, and *spelling*. The former instance (weight) is a **unidimensional construct**, while the latter (communication skill) is a **multi-dimensional construct** (i.e., it consists of multiple underlying concepts). The distinction between constructs and concepts are clearer in multi-dimensional constructs, where the higher order abstraction is called a construct and the lower order abstractions are called concepts. However, this distinction tends to blur in the case of unidimensional constructs.

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Constructs used for scientific research must have precise and clear definitions that others can use to understand exactly what it means and what it does not mean. For instance, a seemingly simple construct such as *income* may refer to monthly or annual income, before-tax or after-tax income, and personal or family income, and is therefore neither precise nor clear. There are two types of definitions: dictionary definitions and operational definitions. In the more familiar dictionary definition, a construct is often defined in terms of a synonym. For instance, attitude may be defined as a disposition, a feeling, or an affect, and affect in turn is defined as an attitude. Such definitions of a circular nature are not particularly useful in scientific research for elaborating the meaning and content of that construct. Scientific research requires **operational definitions** that define constructs in terms of how they will be empirically measured. For instance, the operational definition of a construct such as *temperature* must specify whether we plan to measure temperature in Celsius, Fahrenheit, or Kelvin scale. A construct such as *income* should be defined in terms of whether we are interested in monthly or annual income, before-tax or after-tax income, and personal or family income. One can imagine that constructs such as *learning*, *personality*, and *intelligence* can be quite hard to define operationally.

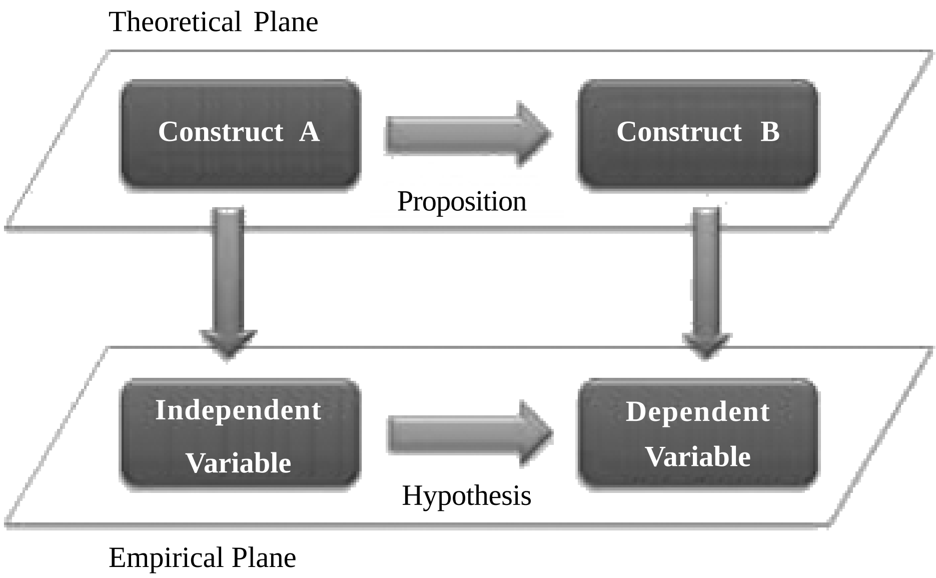


Figure 1.2 : The theoretical and empirical planes of research

A term frequently associated with, and sometimes used interchangeably with, a construct is a variable. Etymologically speaking, a variable is a quantity that can vary (e.g., from low to high, negative to positive, etc.), in contrast to constants that do not vary (i.e.,

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remain constant). However, in scientific research, a **variable** is a measurable representation of an abstract construct. As abstract entities, constructs are not directly measurable, and hence, we look for proxy measures called variables. For instance, a person's *intelligence* is often measured as his or her *IQ* (*intelligence quotient*) *score*, which is an index generated from an analytical and pattern-matching test administered to people. In this case, *intelligence* is a construct, and *IQ score* is a variable that measures the intelligence construct. Whether IQ scores truly measures one's intelligence is anyone's guess (though many believe that they do), and depending on whether how well it measures intelligence, the IQ score may be a good or a poor measure of the intelligence construct. As shown in Figure 2.1, scientific research proceeds along two planes: a theoretical plane and an empirical plane. Constructs are conceptualized at the theoretical (abstract) plane, while variables are operationalized and measured at the empirical (observational) plane. Thinking like a researcher implies the ability to move back and forth between these two planes.

Depending on their intended use, variables may be classified as independent, dependent, moderating, mediating, or control variables. Variables that explain other variables are called **independent variables**, those that are explained by other variables are **dependent variables**, those that are explained by independent variables while also explaining dependent variables are **mediating variables** (or intermediate variables), and those that influence the relationship between independent and dependent variables are called **moderating variables**. As an example, if we state that higher intelligence causes improved learning among students, then intelligence is an independent variable and learning is a dependent variable. There may be other extraneous variables that are not pertinent to explaining a given dependent variable, but may have some impact on the dependent variable. These variables must be controlled for in a scientific study, and are therefore called **control variables**.

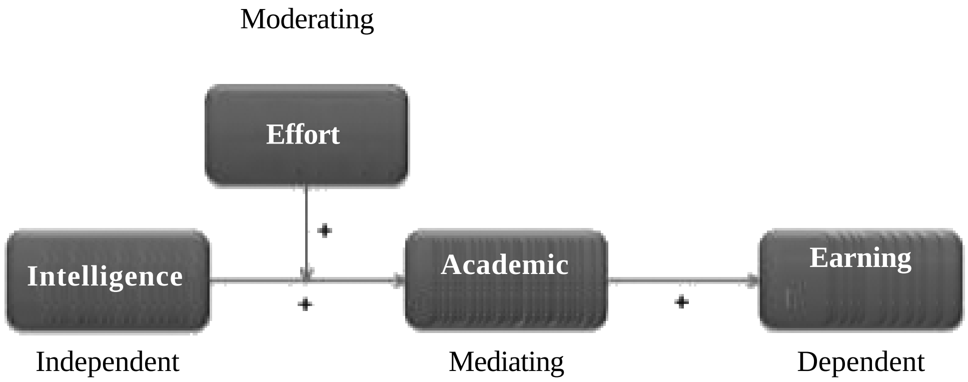


Figure 1.3. A nomological network of constructs

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To understand the differences between these different variable types, consider the example shown in Figure 1.2. If we believe that intelligence influences (or explains) students' academic achievement, then a measure of intelligence such as an *IQ score* is an independent variable, while a measure of academic success such as *grade point average* is a dependent variable. If we believe that the effect of intelligence on academic achievement also depends on the effort invested by the student in the learning process (i.e., between two equally intelligent students, the student who puts is more effort achieves higher academic achievement than one who puts in less effort), then *effort* becomes a moderating variable. Incidentally, one may also view effort as an independent variable and intelligence as a moderating variable. If academic achievement is viewed as an intermediate step to higher earning potential, then *earning potential* becomes the dependent variable for the independent variable *academic achievement,* and academic achievement becomes the mediating variable in the relationship between intelligence and earning potential. Hence, variable are defined as an independent, dependent, moderating, or mediating variable based on their nature of association with each other. The overall network of relationships between a set of related constructs is called a **nomological network** (see Figure 2.2). Thinking like a researcher requires not only being able to abstract constructs from observations, but also being able to mentally visualize a nomological network linking these abstract constructs.

## 1.5 Social Survey

**a. Definition :** It is very difficult to give a universally accepted definition of social survey. This is because the scope of social survey is very wide. So, generally any definition cannot suffice to express its aims. Actually, it is practically impossible to define the different applications of social survey in just few lines. This is because starting from a more or less eighty years from now, the classical poverty survey till modern-day survey of urban planning or market surveyor public opinion surveyor surveys conducted by government offices have been so varied that it is really difficult to encompass all these types under one single definition.

Again, with respect to its aims, the scope of social survey has been very wide. This because it can range from implementation of administrative decision, from finding, cause-effect relation to shed light on some social theory. Moreover if we look at it as subject, then it may be inclusive of characteristic of population distribution social environment, different activities, opinion of social groups and the like.

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Wells had delivered a definition of social survey in 1935 as primarily the expression of real cause of the poverty of labour class, their problems and social nature of it. But this is not a complete definition. In modern days, social surveys are used in wider meanings and contexts because on the one hand, .it is attached to governmental surveys, market research, public opinion research and on the other, it is attached to different sides of social science research. Therefore social survey can be defined as scientific method by which the cause-effect relationship is understood, with an aim to realize the real cause of an event or to understand the source of a social problem.

**(b) Purpose of social survey:** Some social surveys aim at exploring some data delivering those to concerned people. In other words, such surveys have a clear descriptive aim. In the same way, as social surveys have descriptive aims for social scientist does it is a means of forming ideas about social relationships and social behaviour of members of society. In reality, different data' based subjects are included in its objective For example, how does different families of various status-positions expend their income, what is the relationship between education and social status, what is the opinion of general public towards social security policies, and many more such issues.

But it should not be believed that descriptions are the only aim of social surveys. Many social surveys also aim at explanation. Such surveys are completely theoretical. It means that, some surveys aim at formulating hypothesis on any theory of social science and then testing it or measuring the effect of theories on different issues. Whatever may be the aim of such surveys, it mainly aims at establishing relationship between different variables. This is why, such surveys require complex analysis and explanation.

From the above discussion, following can be summarized :-

(1) to uphold the relation between society and the elements of social organization.

(2) to search for reasons or causes of social problems.

(3) to analyse the cause-effect relationship of any social event.

(4) to analyse the different opinions of various social groups.

(5) to measure the effect of any sociological theory of society.

(6) to explore different data, analyse them and over and above create theories with the help of collected facts.

**(c) Subject-matter of Surveys:**

Though it is difficult to produce a complete list of subject-matters of social surveys but still four such subject-matters can be identified-

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(1) To construct ideas about the distribution of a population for example, their family-structure, marital status, age, fertility-rate, ratio of children to aged population etc.

(2) To understand the social environment and economic condition of that population. It includes, occupation, profession, income, condition of living, social securities enjoyed etc.

(3) To construct ideas on the activities of that population. It includes their activities, behaviour, leisure activities, expenditure pattern, etc.

(4) To know about different perspectives and opinion of that population. For example, pre-poll survey, public opinion survey, market research etc.

**(d) Historical Background of Social Survey:**

The history of social survey is not very old. The names that are associated from the beginning are Eden, may how, and Booth. But, Booth is considered to be the father of scientific social survey. In 1886, Booth started a survey on The lives of Labour and Citizens of London and this survey ended in 1902. In the earlier parts of the twentieth century, Booth and Rowntree initiated many long-term social surveys. This is why they are called the torch- bearers of modem social surveys. In the later twenty years, many scholars also initiated surveys. Among them most noteworthy is Bowley. In the later decades of 1920s and earlier parts of 1930s, a number of survey were conducted in British Isles following the methods of earlier studies. Later on, urban planning and governmental activities were associated with survey. Slowly, the significance of survey increased and survey as a method also entered non- governmental sectors. In the mid twentieth century, academic courses of surveys started to come up and was included in the syllabi of various universities. In the U. S. too, alongwith British initiatives, various surveys were conducted. Among then, glock's work in 1967-Survey Research in the Social Sciences was published. In this book, the role of surveys in Sociology, Political Science, Psychology, Economics, Anthropology, Education, Social Work, Public Health and Medical Sciences, was vividly explained.

## The Classical Poverty Survey :

The torchbearer of modern social survey Charles Booth started his survey in 1886 and concluded it in 1902. The results of his work was published in 17 volumes. He was a rich merchant and he felt deeply for the poverty stricken labour class and their social living, condition. The most difficult task which he faced during his survey was how to collect data on the huge population of the labour class living in London. He was the first to introduce "group interview" method. The data collected through this method was divided into eight classes of families. Out of these four were situated above the poverty line and the other

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four below it. But this differentiation was not too logical since, his definition of ‘poor’ and ‘very poor’ was not perfect. But still this survey attracted attention because it highlighted on the terrible sides of poverty and its variation. Beatric webb later on had shown how much and to what extent, this survey had a political effect. In reality, Booths survey paved the way for scientific social survey.

After a decade later, Rowntree started his survey in 1902. The subject of his survey was “Poverty: A Study of Town Life”. His survey was different from Booth’s methods in three respects :

Firstly, he collected data on occupation, income and housing conditions of each labour class family.

Secondly, he directly- gathered data from each family, and

Thirdly, the important issue of his survey was that he was able to present a nearly perfect conception of property. He was also able to differentiate between different strata of poverty stricken families. In his views if the total family income faulters to provide essentials to maintain the basic physical strength of the members then it can be called primary poverty. And, if the family income can provide the least essentials to maintain physical strength of its members, but cannot always satisfy important or unimportant expenditure of the family, it is called secondary poverty. He also, initiated a price index for food and clothing of (≠) such families.

In 1912, Bowley started a very important survey. He conducted the survey on the living conditions of labourers in five cities. The name of this survey was “Livelihood and poverty”. The most important contribution of Bowley was the use of sampling. Later in this method was used in every survey.

In the 1930s, surveys were conducted in random and its use became tampant : In 1932, Ford conducted a survey in Southampton. This was published in 1934 as work and wealth in Modern Port Ford had followed Bowles’ method in this survey but conceptualized poverty in different times. This new term was potential poverty.

The order surveys on labour class which were equally significant were Rowntrees survey Poverty and Progress in 1941 and Lavers’ Survey in 1950 and Abel-Smith’s work in 1965. Rowntree gave up the earlier index if poverty and substituted it with a new one-human necessity value. Lavers’ and Rowntree both conducted a survey named Poverty and the welfare state. Abel-Smith and Townsend conducted a survey named “The Poor and the Poorest”.

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Still today, surveys are conducted on urban planning, market research, public-opinion as done earlier. But in modern times, census is the most elaborate survey conducted so far. In every country, under government patronage census conducted every ten years.

**Exercises**

01. What is social survey? What are its objectives.
02. What are the subject-matter of surveys.
03. Explain the historical background of surveys.

## 1.6 Social Research

**(a) Social Research:** In general terms, social research is a deep concern for search to establish a new knowledge. Social research is research on Society-related any subject. Research is always conducted through scientific methods. The tools for this are experimentation, observation, data-analysis and decision. In natural sciences, experimentation is given more significance than is social science research. In social research on the other hand, observation, data-collection, data analysis is given more importance. In teal sense, research is a process whereby existing knowledge is tested, modified by deep observation analysis and decisions.

In 1947, Western Reserve University in the us conducted a work shop, In its report, it was said that social research is conducted to ensure the progress of pure natural sciences. But the characteristics that are found in social research are as follows :

1. Social research is conducted in social and behavioural sciences.
2. Such researches are also conducted in sociology and anthropology.
3. To clearly understand human behaviour and to make progress in knowledge acquired, or to reject an old theory, or modify it, or to establish, a new theory, such researches are conducted.
4. Social research is also conducted with an aim to help in formulating policies and to see it an idea on social issues is practically useable.
5. A social researcher starts his research with an educational aim and also to fill up the gaps in social science knowledge. The ultimate aim of such researches is to acquire unknowledge about social facts and social environment.

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**(b) Importance of Research in Social Work:**

Social work is a practical profession. The scope of social work is mainly : Proposal, Promotion, Medical treatment of mental illness and over and above it is associated with, the positive aspects of social state. For this reason, it is important for the social workers to have a clear idea of different social problems and the reality. Because, the lack of it, the social researcher may find it difficult to construct an appropriate proposal and technique that would be a help for an individual or a group. Social research is for this reason helpful for social work. It becomes easier to find solutions to a problem and also find out the possible sources of a problem through research. In this way it helps the researcher to dwell deep into a problem and assist him/her in making a decision as to how and where to start their work. For example, let us think that cholerea has shaped up like an epidemic in a village. The first step a social worker should undertake is to find out what are the potential causes of cholerea; which castes or groups are most affected by it. Moreover, the history of the disease, the source of drinking water, opportunities for medical treatment etc. are also to be understood by the researcher. Only after having a complete understanding of the nature of scope of the problem, he/ she will be in a position to draw a policy to solve it. But if an immediate solution to the problem is looked for, then it is advisable to take care of the medical treatment only. But in this way there will be ample scope for the disease to take the tony of an epidemic in the future. If a permanent solution is looked for, then along with medical treatment, efforts should be made to eradicate the causes' of the problem, It means that through research, if a knowledge about the disease is formed, only then it would be possible to create a permanent solution to the problem. The importance of research his here. It is through research, that a social worker can develop a clear concept of the disease, causes of it and the socio-economic background of the patients. And this would had a permanent solution of the problem.

With the development of civilization, social life has become more and more complex. There has been important changes in the Social norms and regulation of earlier times. In order to understand this complex social environment it is important to survey the components of the social setting. It is also for this reason that research has become indispensible for the understanding of social complexities. This is because, unless the social workers can fully understand the social environment and the social facts, it would be impossible to carry on work for them. Whenever there is a disruption in the normal working of the society, social work research becomes essential. It is through research that the

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probable cause of such disruption are looked for. In reality, the aim of social work is to find out the potential causes and solutions of the problems of mankind. It also aims at finding out alternative solutions that evolve out of the understanding of complex social problems. In summary, it can be said that the aim of social work is to build up an opposition to social problems and in this way to enhance the scope of social work and find solutions to problems. Social research helps social workers to practically use theoretical knowledge and help them to find out possible solutions to the problems they face. But, in reality social research and social work research are completely different subjects altogether.

**(C) Features of Social Work Research:**

There may be some similarities between social work research and social research but there are some characteristics of social work research, which are as follows :

1. The aim of social work research is to explore any answer to question related to social work through the application of structured scientific method. Besides, social work research tries to find alternative solutions to those problems which social workers face.
2. Social work research is not always directed towards enhancing knowledge in social science. It specially aims at finding out how this knowledge can be utilized for building up self-sufficiency and independence among people who are in trouble.
3. Social research aims at progressive enhancement of the works of individuals, group and over and above, the society.
4. Social work research is a part of social research.
5. Social work research is always oriented towards the reality. It emphasizes mostly on the practicality of the problems that men face and tries to find 'out possible solutions for it. It also aims at finding out the practicality of the methods used.

**(D) Scope of Social Work Research:**

The scope of social work research underlines the parameter within which social work is practically implemented. Its scope extends from establishing different theories of social work, research on various facts, policy formulation, implementation of different programmes practical utilization of policies and evaluation of policies and its control. In all aspects of social work research is essential. Due to changes in ideas, development of science and technology and differences between nature and culture, social work research alongwith changing social problems is undergoing revision.

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Not denying the fact is the concept that social work has different implications in differing space and time. It is for this reason that implications of a particular research is not applicable universally. For example, changes that take place in a urban area does not have same effect in rural areas. But it is true that the implications of development in urban areas have some effect on rural areas as well. It is for this reason that social work research is continuous and its importance can never be underestimated.

Areas in which social work research is immensely applied is policies-for social welfare activities, formulation of social laws and strengthening of same security policies of some communities. Through this, there develops a deep bond of cooperation between the members of the society. In different areas, through social work research social justice and social security is easily established through such research the different gaps between different strata of people can be diminished.

**(F) Position of Social Work Research in India :**

Social Work as an academic discipline was first started in Tata Institute of Social Science. In the same way, social work research also started in the same institute. But still, it is suffice to say that social work research has not gained momentum in India. The social work researchers in India still accept and depend solely on research methods, theories and techniques developed in the west. Indian social work researchers lack originality in their orientation. It is not true that research methods and techniques developed in the west are in applicable in India. But it needs revision while applying those on Indian conditions. Generally, it is seen that there lies a gap between the results of research and what common people think. Besides that, common people have very little knowledge about career in social work. The NGOs, government offices, international organisations, who do a lot of social work research, do not inspire social work researchers in any pure research. The type or research conducted by such organisations are so error some, that common people find it hard to integrate with them, It is for this reason that, though demand for trained efficient researchers are growing but still, the scope of social work research remains unchanged. The participatory research which are conducted usually entrusts its results on common people. But such researches should aim at hypothesizing after understanding the needs of the mass. Many times, such researches are conducted according to the needs of the organization which sponsors the research. Only in few cases, researches aim at the needs of the masses, evaluation of resources and importance of policy building. The reasons behind such errors in social work research are as follows :

(i) The administrators and policy-makers give less importance or research.

(ii) Insufficient financial resources are available for the research and the aims of the financial organizations or sponsoring agents limit the scope of research.

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(iii) Lack of a central organization that would help in promoting social work research.

(iv) No real training centre for researchers.

(v) Lack of initiative among professional social work researchers. But in a country like India, where a substantial number of people live below the poverty line, it can play a viable role. The importance of social work research in India can be underlined below :

(1) **Social work research method :** Indian Social System is dynamic. Therefore, which social work research method is applicable in which social context of Indian society is very important to discern. The traditional methods of social work research used in Indian conditions are case work, group work and convey organization. There is importance in evaluating the success of each method. Because in the changing socio-cultural circumstances in India, these methods should be evaluated so that they can be more effective.

(2) **Development of Policies, Integration and Evaluation:** India has a number of tribes, castes and a number of people belonging to different classes. It is necessary to integrate the different social welfare works and evaluate these methods used. This is because, it is important to analyse the significance and the importance of collecting evidences for different demands. It is possible to develop varying programmes evaluate and integrate them only through research.

(3) **Social problem oriented research:** Different social problems such as illiteracy, superstition, poverty, unemployment, prostitution etc. are so complex that it is possible to understand them only through research. Besides them, problems of the scheduled castes and scheduled tribes, the unorganized labour force are only to be understood through research. Other than these problems faced by AIDS patients the negative reactions towards them also can be understood through research. Therefore, in order to understand any complex social problem social work research has an important role to play.

(4) **To know the history of social work:** It is impossible to understand the present without throwing the past. It is only by analysing the history of social work, we can understand the nature of its continuity of works already done. So, it is important for social workers to understand how changes in socio-cultural and political spheres has had an effect on social work. So, one of the important aspects of social work research is to enlighten on the history and its development.

(5) **To understand Social Work and Social Policy:** Many social policies are enacted for social work. It is important for social workers to understand the effectiveness of such policies at present and the success and failures of these policies. It can be understood only through social work.

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Besides these, the importance of social work is understood in areas like administration, establishing human rights, training of social workers and in developing those etc.

**(6) Limitations of Social Work Research:**

Research answers questions on many unknown issues. This is why social research is called a pioneer of modern civilization. But the level of reliable data that research can yield for natural sciences, is some what jeopardised in case of social science. This is the reason why there are certain limitations of social work research. These are :

(i) Many social work research is based on systems approach. This approach is based on human body. The parts of the human body perform certain particular functions. Any disruption in this working has a negative effect on the human body. This means there is an internal cohesion and mutual dependence in the working of the parts of human body. Similarly, if this logic is applied on research then it means that the data collected would try to find out ways to solve problems in such a way that it would match the modern social structure. But problem arises when it is inherent in the structure. This is how social work research begets its limitation.

(ii) The problem areas where social work research is generally conducted are not analysed deeply. As a result, in place of analysing the complex social causes, the researcher only explores some causes ignoring the others. Thus often happens because, the amount of labour and time needed for such work is not given. So, it lacks continuity.

(iii) The effect of India's regional differences is high on social work. To do such work," continuous research is essential. The time and labour needed is often not adhered to.

(iv) The relationship between theory and research is significant. Though it cannot be denied that the social work theory and its applicability is universal but still its applicability is truly limited by regional differences. In respect to regional difference, modification of theories is so important but this aspect is not given significance by researchers.

(v) Many a times it is seen that there lies a misconception among researcher, financial institute, government office, and organisations dealing with social work. As a result of this, the policies taken up to consider needs of common man are not always accurate. As a result of misconception and biased ideas of the researcher, the results of research can also be misleading.

(vi) In Indian situation, behind different social work policies, are a particular impact of politics is envisaged. This political impact poses limitations on social work research.

(vii) Men hope that through research, solution to many human problems can be found. But this concept is not true in all senses. So, social work research too, cannot always bring success and help in meeting all kinds of demands, or bring about desired changes.

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(F) Distinction between Social Research and Social Work Research.

In 1937, Helen Jetter in her book "Social Work Year Book" said that the aim of social work research is to find out social work philosophy, method, process, technique etc. for the problems faced by social work researchers, in a scientific and national exploration. Differently, though social work research aim at progress in fundamental social science. The theories of social science and methods are applied on social work and in this way, there establishes a relationship between the two. In reality, the main differences between social work research and social research is that social work research is always conducted from the point of view of the social worker. The differences between the two are as follows :-

| **The Subject of difference** | **Social Research** | **Social work Research** |
|---|---|---|
| 1. Definition | Social research is exploration of social science development through scientific and national methods. | Social work research is to find solutions to the problems social workers face, through scientific and national exploration. |
| 2. Field | Social Research is conducted on behavioral sciences such associology, anthropology etc. | Such research is conducted on areas where social workers face problems. |
| 3. Aim | To establish clear concepts regarding social environment, social problem, human behaviour, to reject any old theory, to reform or modify them. In short, to aim at knowledge regarding social Science research. | To understand the causes of the problems social workers face to find solutions to these problems, to examine the utility of social policies. |
| 4. Scope | The scope of social research is very wide. Any issues of social significance are included in such research. | Social work research is apart of social research. As it is limited by its scope of working within the field of Social Welfare in comparison to social research, its scope is limited. |
| 5. Basis | Social research works on the limitation of social science. Its aim is exploration of new knowledge. | The basis of social work research is to find" solutions to the problems of human kind. |

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**F : Distinction between Survey and Research :-**

Though survey and research have some common areas but still they cannot be synonymous. In reality, survey is to analyse or explore on certain issues so that its true nature can be highlighted on. Generally, survey is conducted to find out if a plan is researchable or not. On the other hand, to explore on a fundamental issue on the basis of scientific and rational criterion is research. Its aim is to find out sources of knowledge and rectify' or modify old theories. If social survey is done explicitly that in-depth social surveys can be called research.

Survey is mainly based on problems. To find art causes of any problem is the aim of surveys. It is on the basis of surveys that a plan is made and implemented. On the other side, it is possible to know causes of a problem through research and find out permanent solutions to them. In social surveys importance is given to a fact and its description. So, the result of surveys are temporary but the results of researches are permanent. The results of surveys and different recording to time space and persons on whom they and applicable. Therefore they are flexible and universal in the same time.

In case of research, specially pure research experiments are conducted. But the scope of experiments in surveys are limited. Surveys the primarily description and sometimes analytical. On the other hand, research is primarily normative. But in practice research is used as a term instead of surveys-as market research, public opinion research etc. These actually mean market survey, opinion survey.

**Exercise:**

1. What is the meaning of social research? Analyse its objectives and scope.
2. What is the difference between survey and research.
3. Illustrate the difference between social research and social work research.

## 1.7 Process of Social Work Research

Idea : Research is a continuous process. The process depends upon execution of specific work. These are like steps of a stare case who are interrelated, Scientific methods are followed to execute these work. On the other hand the steps which are followed in a scientific research are not scattered rather they are interrelated and interdependent. As these steps are followed and executed in a definite way in a research work thus they are considered as research methods. The main steps of a research works are as follows :

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1. To identify the problems of research.
2. (a) Discussion of various theories and concepts.

   (b) Gathering knowledge on similar kind of research.
3. Project preparation.
4. Draft sketch plan of the research.
5. Collection of data.
6. Analysis of collected data.
7. Detail explanation of information based on the data and preparation of project report. But depending upon the requirement these steps can be changed. In case of social research similar steps are followed. Since the social research are done to solve the problems faced but the social workers and emphasises on the problem itself that is why these kind of researches are very much problem specific. Thus identifying the problem is the initial phase of this kind of research, similarly report with recommended solutions to these problems are the last phase of these research. The intermediate phase of the research work is considered to correlate between the two phase. This is the most critical and major part of a research work. In this phase so many works needs to be done such as sketch plan of the research, tools for the research, to determine the source of data and information which are to be collected, collection of data & Information data analysis, project preparation, examining the project, Analysing of the information etc.

**(B) Identification of Research Problem :**

Problem of a research means to determine the solution to those problems through research. Therefore identification of research problem means the research worker will research on what to find a solution-that means to identify or ascertain the topic of research. The researchers has to discuss thoroughly the theoretical and practical side of the problem so as to understand them properly. For this they have to read specific problem related books as well as to talk who such persons who have experience and have worked on similar kind of problem. This way after identifying the problem then the research methodology is to be settled. Therefore it need various works to be done identify a problem. The good thing that are obtained by identifying a problem are;

1. To ascertain the sphere of the topic of research.

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2. This specifies the topic of the research and makes the research work smoother.

3. The problem can be properly defined.

4. To differentiate between the relevant (Research related) and irrelevant data.

Identification of Research Problem is basically to determine the topic or subject on which the research work will be carried out. This mainly depends upon the discretion of the researcher as well as the knowledge and proficiency of the researcher, on a particular subject. Thus it is the primary job of a researcher to select the subject area of his research. Otherwise it is not possible to reach to the goal of the research. For this he has to perform the following;

1. The researchers have to decide the subject on which he has sufficient knowledge or among the various problems of the society which one attracts him the most. For example a researcher may choose. 'The malice of addiction' as his subject of his research. In this case the sphere of research is quite large, because cigarette, alcohol, Opium, Ganja, various drug they fall in the range of adict substance. Therefore he have to decide among these which will be his choice of research, whether he wants to carry out the research on smokers or alcoholic or drug adict.

2. Once the topic and the subject is selected then it is advised to make it precise: In that case it becomes easier for the researcher to put light on a particular side of the problem such as if a researcher decide to carry out the research on alcoholic person then he can make it more precise as whether he wants to study the health related problem with an alcoholic person or the society related problem with an alcoholic or the role of alcoholism as a cause behind the diplorable condition of a family.

3. After this the researcher has to determine the goal and mission of his research. Because the mission of a research helps the researcher to reach his goal in a disciplined way. Due to this the researcher none other but only concentrates on his research.

Apart from the above steps the researcher has to follow other rules which are as follows.

1) The researcher must exchange his views and ideas with other research fellows and interact with those persons who have experience on similar kind of work. This will make the research more specific and effective.

ii) He have to read books and journals relected to the said research this will make him more knowledgable.

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iii) The researcher must have attraction on which he is carrying out the research work and he should have fairly good conception about the research, which are already done in the same field.

iv) It is always recommended to avoid such fields of research which has a wide area and easily attracts the researcher.

v) Above all the problem of research, or the subject has to be viable in respect of time and money.

**(c) Review of Literature**

After selecting the topic of research the second phase of the research requires that the researcher should gather in depth knowledge about the subject unless the researcher have a clear idea about the nature, cause and depth of the problem, he cannot carry out the research in the right direction. Reading of books helps him to build ideas, learn theories etc. It gives proper direction to the research work and prevents duplication of the same. It also indicates about the problems that may be encountered while doing the research. Study of books does not only mean studying of published books, but it includes study of unpublished books, journals, magazines, articles, Govt. reports etc. The research should make a list of these materials, because at the end of the research the reseacher has to declare about the rferences from which he got help in preparing the thesis.

## 1.8 Ethical issues in Research

Ethics is the moral distinction between right and wrong, and what is unethical may not necessarily be illegal. If a scientist's conduct falls within the gray zone between ethics and law, she may not be culpable in the eyes of the law, but may still be ostracized in her professional community, face severe damage to professional reputation, and may even lose her job on grounds of professional misconduct. Social Work is a field of knowledge that maintains an ethical and political commitment to protecting the rights of the participants in research. Prior to the creation of the resolution, the Social Workers' Professional Code of Ethics already indicated the need for professionals to respect the rights of participants to have prior information about the study procedure, freedom of choice and access to the results of the studies. In research projects conducted by social workers, it is common for the object of the study to be users of Social Work who belong to socially stigmatized social

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classes or groups due to factors such as income, level of education, profession or even physical and mental deficiencies. Some of the people who participate in Social Work studies can be described, according to Barroco,as “a population considered vulnerable to certain requirements presented by scientific research.” In this sense, the adoption of ethical care in the realization of scientific studies is an attribute of considerable importance in the education and professional exercise of social workers.

While we talk about the Ethical issues involved in Research, it would be naive to simply and only trust in the self-guidance and morality of individual researchers. We must keep a few things in our mind-

First, knowledge and acceptance of ethical standards and principles may vary widely between countries and disciplines and a unitary approach is therefore desirable for all stakeholders involved.

Second, the transformation of international research into something akin to a capitalistic competition of scientific reputation with rankings and impact factors deciding on the standing and status of researchers (Münch 2014), the pressure on the individual researcher in this system is too high to expect everyone to adhere simply to their conscience everywhere and all the time during every phase of research.

Third, Ethical concerns envisages issues of data sharing, privacy, and security.We know these days, the misuse of online data by various actors is likely to continue, as the potential gains are huge. However, researchers should not be left alone in addressing these issues. Rather, they should receive support from institutionalized agencies trained and tasked in the handling of ethical issues. These do not need to take the form of established IRBs and should provide guidance as much as restrictions

Following are the Ethical Principles in Scientific Research—

- Scientific validity-

  A study should be designed in a way that will get an understandable answer to the important research question

- **Fair subject selection**

  The primary basis for recruiting participants should be the scientific goals of the study — not vulnerability, privilege, or other unrelated factors.

- **Favourable risk-benefit ratio**

  Everything should be done to minimize the risks and inconvenience to research participants to maximize the potential benefits, and to determine that the potential benefits are proportionate to, or outweigh, the risks.

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- **Independent review**

  To minimize potential conflicts of interest and make sure a study is ethically acceptable before it starts, an independent review panel should review the proposal and ask important questions, including: Are those conducting the trial sufficiently free of bias? Is the study doing all it can to protect research participants? etc

- **Informed consent**

  Potential participants should make their own decision about whether they want to participate or continue participating in research. This is done through a process of informed consent in which individuals (1) are accurately informed of the purpose, methods, risks, benefits, and alternatives to the research, (2) understand this information and how it relates to their own clinical situation or interests, and (3) make a voluntary decision about whether to participate.

- **Respect for potential and enrolled subjects**

  Individuals should be treated with respect from the time they are approached for possible participation — even if they refuse enrollment in a study — throughout their participation and after their participation ends. This includes:

- Respecting the privacy and keeping the private information of the respondents confidential
- Respecting the right to change the mind of the respondents, if they feel that the research does not match their interests, and to withdraw without a penalty
- Informing them of new information that might emerge in the course of research, which might change their assessment of the risks and benefits of participating
- Monitoring their welfare and, if they experience adverse reactions, unexpected effects, or changes in clinical status, ensuring appropriate treatment and, when necessary, removal from the study
- Informing the respondants about what was learned from the research

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## 1.9 Hypothesis

A hypothesis is an assumption about how two or more variables are related; it makes a conjectural statement about the relationship between those variables. In social science the hypothesis will often predict how one form of human behaviour influences another. In research, independent variables are the *cause* of the change. The dependent variable is the *effect*, or thing that is changed.

For example, in a basic study, the researcher would establish one form of human behaviour as the independent variable and observe the influence it has on a dependent variable. How does gender (the independent variable) affect rate of income (the dependent variable)? How does one's religion (the independent variable) affect family size (the dependent variable)? How is social class (the dependent variable) affected by level of education (the independent variable)?

- Hypothesis are testable explanations of a problem, phenomenon, or observation.
- Both quantitative and qualitative research may involve formulating a hypothesis to address the research problem.
- Hypotheses that suggest a causal relationship involve at least one independent variable and at least one dependent variable; in other words, one variable which is presumed to affect the other.
- An independent Variable is one whose value is manipulated by the researcher or experimenter.
- A dependent variable is a variable whose values are presumed to change as a result of changes in the independent variable

A hypothesis is an assumption or suggested explanation about how two or more variables are related. It is a crucial step in the scientific method and, therefore, a vital aspect of all scientific research. 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 or refute the idea. While there is no single way to develop a hypothesis, a useful hypothesis will use deductive reasoning to make predictions that can be experimentally assessed. If results contradict the predictions, then the hypothesis under examination is incorrect or incomplete and must be revised or abandoned. If results confirm the predictions, then the hypothesis might be correct but is still subject to further testing.

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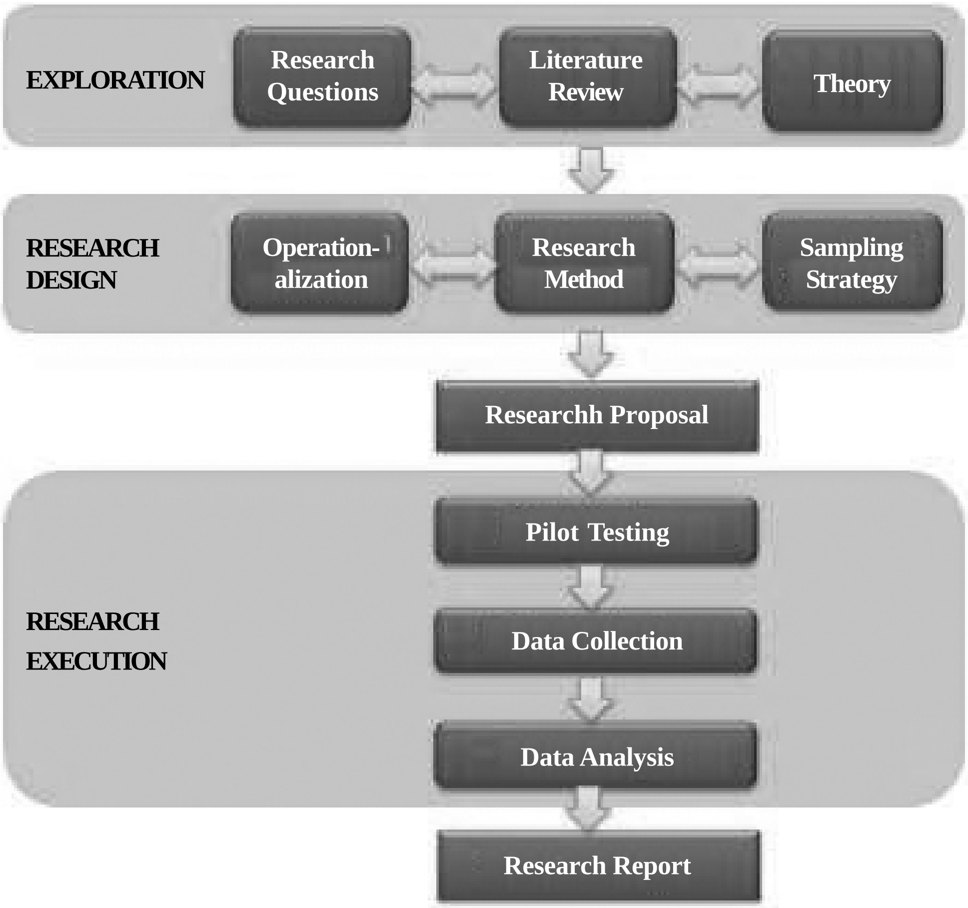
## 1.10 Steps in the process of research




**1 Problem Selection—**

The first step in the process of carrying out any kind of Research is to identify a problem. This problem may be something the researcher may identifies and which may need further investigation for building up new knowledge or information. This step involves identification of one or more research questions dealing with a specific behaviour, event, or phenomena of interest. Research questions are specific questions about a behaviour, event, or phenomena of interest that you wish to seek answers for in your research.Research questions can delve into issues of what, why, how, when, and so forth. More interesting research questions are those that appeal to a broader population. Narrowly focused research questions (often with a binary yes/no answer) tend to be less useful and less

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interesting and less suited to capturing the subtle nuances of social phenomena. Uninteresting research questions generally lead to uninteresting and unpublishable research findings.

The next step is to conduct a literature review of the domain of interest. The purpose of a literature review is three-fold: (1) to survey the current state of knowledge in the area of inquiry, (2) to identify key authors, articles, theories, and findings in that area, and (3) to identify gaps in knowledge in that research area. Literature review is commonly done today using computerized keyword searches in online databases. Keywords can be combined using "and" and "or" operations to narrow down or expand the search results. Once a shortlist of relevant articles is generated from the keyword search, the researcher must then manually browse through each article, or at least its abstract section, to determine the suitability of that article for a detailed review. Literature reviews should be reasonably complete, and not restricted to a few journals, a few years, or a specific methodology. Reviewed articles may be summarized in the form of tables, and can be further structured using organizing frameworks such as a concept matrix. A well-conducted literature review should indicate whether the initial research questions have already been addressed in the literature (which would obviate the need to study them again), whether there are newer or more interesting research questions available, and whether the original research questions should be modified or changed in light of findings of the literature review. The review can also provide some intuitions or potential answers to the questions of interest and/or help identify theories that have previously been used to address similar questions.

Since functionalist (deductive) research involves theory-testing, the third step is to identify one or more theories can help address the desired research questions. While the literature review may uncover a wide range of concepts or constructs potentially related to the phenomenon of interest, a theory will help identify which of these constructs is logically relevant to the target phenomenon and how. Forgoing theories may result in measuring a wide range of less relevant, marginally relevant, or irrelevant constructs, while also minimizing the chances of obtaining results that are meaningful and not by pure chance. In functionalist research, theories can be used as the logical basis for postulating hypotheses for empirical testing. Obviously, not all theories are well-suited for studying all social phenomena. Theories must be carefully selected based on their fit with the target problem and the extent to which their assumptions are consistent with that of the target problem.

**Selection and Formulation of Research Design—**

The next phase in the research process is research design. This process is concerned with creating a blueprint of the activities to take in order to satisfactorily answer the

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research questions identified in the exploration phase. This includes selecting a research method, operationalizing constructs of interest, and devising an appropriate sampling strategy.

Operationalization is the process of designing precise measures for abstract theoretical constructs. This is a major problem in social science research, given that many of the constructs, such as prejudice, alienation, and liberalism are hard to define, let alone measure accurately. Operationalization starts with specifying an "operational definition" (or "conceptualization") of the constructs of interest. Next, the researcher can search the literature to see if there are existing prevalidated measures matching their operational definition that can be used directly or modified to measure their constructs of interest. If such measures are not available or if existing measures are poor or reflect a different conceptualization than that intended by the researcher, new instruments may have to be designed for measuring those constructs. This means specifying exactly how exactly the desired construct will be measured (e.g., how many items, what items, and so forth). This can easily be a long and laborious process, with multiple rounds of pretests and modifications before the newly designed instrument can be accepted as "scientifically valid." Simultaneously with operationalization, the researcher must also decide what research method they wish to employ for collecting data to address their research questions of interest. Such methods may include quantitative methods such as experiments or survey research or qualitative methods such as case research or action research, or possibly a combination of both. If an experiment is desired, then what is the experimental design? If survey, do you plan a mail survey, telephone survey, web survey, or a combination? For complex, uncertain, and multi-faceted social phenomena, multi-method approaches may be more suitable, which may help leverage the unique strengths of each research method and generate insights that may not be obtained using a single method.

Researchers must also carefully choose the target population from which they wish to collect data, and a sampling strategy to select a sample from that population. For instance, should they survey individuals or firms or workgroups within firms? What types of individuals or firms they wish to target? Sampling strategy is closely related to the unit of analysis in a research problem. While selecting a sample, reasonable care should be taken to avoid a biased sample (e.g., sample based on convenience) that may generate biased observations.

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**Data Collection—**

Data can be defined as the quantitative or qualitative values of a variable. Data is plural of datum which literally means to give or something given. Data is thought to be the lowest unit of information from which other measurements and analysis can be done. Data can be numbers, images, words, figures, facts or ideas. Data in itself cannot be understood and to get information from the data one must interpret it into meaningful information. There are various methods of interpreting data. Data sources are broadly classified into primary and secondary data.

Data is one of the most important and vital aspect of any research studies. Researchers conducted in different fields of study can be different in methodology but every research is based on data which is analyzed and interpreted to get information. Data is the basic unit in statistical studies. Statistical information like census, population variables, health statistics, and road accidents records are all developed from data.

There are two sources of data collection techniques. Primary and Secondary data collection techniques, Primary data collection uses surveys, experiments or direct observations. Secondary data collection may be conducted by collecting information from a diverse source of documents or electronically stored information, census and market studies are examples of a common sources of secondary data. This is also referred to as "data mining."

Primary Date- Primary data means original data that has been collected specially for the purpose in mind. It means someone collected the data from the original source first hand. Data collected this way is called primary data.

**Survey**

Survey is most commonly used method in social sciences, management, marketing and psychology to some extent. Surveys can be conducted in different methods.

**Questionnaire**

Questionnaire is the most commonly used method in survey. Questionnaires are a list of questions either an open-ended or close -ended for which the respondent give answers. Questionnaire can be conducted via telephone, mail, live in a public area, or in an institute, through electronic mail or through fax and other methods.

**Interview**

Interview is a face-to-face conversation with the respondent. It is slow, expensive, and they take people away from their regular jobs, but they allow in-depth questioning and follow-up questions.

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**Observations**

Observations can be done while letting the observing person know that he is being observed or without letting him know. Observations can also be made in natural settings as well as in artificially created environment.

Primary data has not been published yet and is more reliable, authentic and objective. Primary data has not been changed or altered by human beings; therefore its validity is greater than secondary data.

Advantages of Primary Data—

- ❖ Data interpretation is better.
- ❖ Targeted Issues are addressed.
- ❖ Efficient Spending for Information.
- ❖ Decency of Data.
- ❖ Addresses Specific Research Issues.
- ❖ Greater Control.
- ❖ Proprietary Issues

Disadvantage of Primary Data

- ➢ High Cost
- ➢ Time Consuming
- ➢ Inaccurate Feed-backs
- ➢ More number of resources is required

**Secondary Data**

Secondary data is the data that has been already collected by and readily available from other sources. When we use Statistical Method with Primary Data from another purpose for our purpose we refer to it as Secondary Data. It means that one purpose's Primary Data is another purpose's Secondary Data. So that secondary data is data that is being reused. Such data aremore quickly obtainable than the primary data.

These secondary data may be obtained from many sources, including literature, industry surveys, compilations from computerized databases and information systems, and computerized or mathematical models of environmental processes.

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### Published Printed Sources

There are varieties of published printed sources. Their credibility depends on many factors. For example, on the writer, publishing company and time and date when published. New sources are preferred and old sources should be avoided as new technology and researches bring new facts into light.

#### Books

Books are available today on any topic that you want to research. The uses of books start before even you have selected the topic. After selection of topics books provide insight on how much work has already been done on the same topic and you can prepare your literature review. Books are secondary source but most authentic one in secondary sources.

#### Journals/periodicals

Journals and periodicals are becoming more important as far as data collection is concerned. The reason is that journals provide up-to-date information which at times books cannot and secondly, journals can give information on the very specific topic on which you are researching rather talking about more general topics.

#### Magazines/Newspapers

Magazines are also effective but not very reliable. Newspaper on the other hand is more reliable and in some cases the information can only be obtained from newspapers as in the case of some political studies.

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**Published Electronic Sources**

As internet is becoming more advance, fast and reachable to the masses; it has been seen that much information that is not available in printed form is available on internet. In the past the credibility of internet was questionable but today it is not. The reason is that in the past journals and books were seldom published on internet but today almost every journal and book is available online. Some are free and for others you have to pay the price.

E-journals: e-journals are more commonly available than printed journals. Latest journals are difficult to retrieve without subscription but if your university has an e-library you can view any journal, print it and those that are not available you can make an order for them.

General Websites; Generally websites do not contain very reliable information so their content should be checked for the reliability before quoting from them.

Weblogs: Weblogs are also becoming common. They are actually diaries written by different people. These diaries are as reliable to use as personal written diaries.

Advantage of Secondary Data

They are Inexpensive

They are Easily accessible

Immediately available

Will provide essential background and help to clarify or refine research problem – essential for literature review

Secondary data sources will provide research method alternatives.

Will also alert the researcher to any potential difficulties.

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Disadvantage of Secondary Data

1 They may not be immediately available – takes time to define problem, sampling frame, method and analysis.

2 It does not give us complete Information

Thus we say that Primary research entails the use of immediate data in determining the survival of the market. The popular ways to collect primary data consist of surveys, interviews and focus groups, which shows that direct relationship between potential customers and the companies. Whereas secondary research is a means to reprocess and reuse collected information as an indication for betterments of the service or product.

**Data Analysis: Assessment of Intervention effects/impacts**

Data collection,is followed by Data Analysis. The data is analyzed and interpreted for the purpose of drawing conclusions regarding the research questions of interest. Depending on the type of data collected (quantitative or qualitative), data analysis may be quantitative (e.g., employ statistical techniques such as regression or structural equation modeling) or qualitative (e.g., case studies Focus Group Discussions or Content analysis).

***Data Anaysis for Quantitative data—***

Numeric data collected in a research project can be analyzed quantitatively using statistical tools in two different ways. Descriptive analysis refers to statistically describing, aggregating, and presenting the constructs of interest or associations between these constructs. Inferential analysis refers to the statistical testing of hypotheses (theory testing).

We may nw examine statistical techniques used for descriptive analysis, and the next chapter will examine statistical techniques for inferential analysis. Much of today's quantitative data analysis is conducted using software programs such as SPSS or SAS.

*Data Preparation*

In research projects, data may be collected from a variety of sources: mail-in surveys, interviews, pretest or post test experimental data, observational data, and so forth. This data must be converted into a machine -readable, numeric format, such as in a spreadsheet or a text file, so that they can be analyzed by computer programs like SPSS or SAS. Data preparation usually follows the following steps.

*Data coding*. Coding is the process of converting data into numeric format. A codebook should be created to guide the coding process. A codebook is a comprehensive document containing detailed description of each variable in a research study, items or

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measures for that variable, the format of each item (numeric, text, etc.), the response scale for each item (i.e., whether it is measured on a nominal, ordinal, interval, or ratio scale; whether such scale is a five-point, seven-point, or some other type of scale), and how to code each value into a numeric format. For instance, if we have a measurement item on a seven-point

Likert scale with anchors ranging from "strongly disagree" to "strongly agree", we may code that item as 1 for strongly disagree, 4 for neutral, and 7 for strongly agree, with the intermediate anchors in between. Nominal data such as industry type can be coded in numeric form using a coding scheme such as: 1 for manufacturing, 2 for retailing, 3 for financial, 4 for healthcare, and so forth (of course, nominal data cannot be analyzed statistically). Ratio scale data such as age, income, or test scores can be coded as entered by the respondent. Sometimes, data may need to be aggregated into a different form than the format used for data collection. For instance, for measuring a construct such as "benefits of computers," if a survey provided respondents with a checklist of b enefits that they could select from (i.e., they could choose as many of those benefits as they wanted), then the total number of checked items can be used as an aggregate measure of benefits. Note that many other forms of data, such as interview transcripts, cannot be converted into a numeric format for statistical analysis. Coding is especially important for large complex studies involving many variables and measurement items, where the coding process is conducted by different people, to help the coding team code data in a consistent manner, and also to help others understand and interpret the coded data.

*Data entry*. Coded data can be entered into a spreadsheet, database, text file, or directly into a statistical program like SPSS. Most statistical programs provide a data editor for entering data. However, these programs store data in their own native format (e.g., SPSS stores data as .sav files), which makes it difficult to share that data with other statistical programs. Hence, it is often better to enter data into a spreadsheet or database, where they can be reorganized as needed, shared across programs, and subsets of data can be extracted for analysis. Smaller data sets with less than 65,000 observations and 256 items can be stored in a spreadsheet such as Microsoft Excel, while larger dataset with millions of observations will require a database. Each observation can be entered as one row in the spreadsheet and each measurement item can be represented as one column. The entered data should be frequently checked for accuracy, via occasional spot checks on a set of items or observations, during and after entry. Furthermore, while entering data, the coder should watch out for obvious evidence of bad data, such as the respondent selecting

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the "strongly agree" response to all items irrespective of content, including reverse-coded items. If so, such data can be entered but should be excluded from subsequent analysis.

*Missing values*. Missing data is an inevitable part of any empirical data set. Respondents may not answer certain questions if they are ambiguously worded or too sensitive. Such problems should be detected earlier during pretests and corrected before the main data collection process begins. During data entry, some statistical programs automatically treat blank entries as missing values, while others require a specific numeric value such as -1 or 999 to be entered to denote a missing value. During data analysis, the default mode of handling missing values in most software programs is to simply drop the entire observation containing even a single missing value, in a technique called list wise deletion. Such deletion can significantly shrink the sample size and make it extremely difficult to detect small effects. Hence, some software programs allow the option of replacing missing values with an estimated value via a process called imputation. For instance, if the missing value is one item in a multi-item scale, the imputed value may be the average of the respondent's responses to remaining items on that scale. If the missing value belongs to a single-item scale, many researchers use the average of other respondent's responses to that item as the imputed value. Such imputation may be biased if the missing value is of a systematic nature rather than a random nature. Two methods that can produce relatively unbiased estimates for imputation are the maximum likelihood procedures and multiple imputation methods, both of which are supported in popular software programs such as SPSS and SAS.

*Data transformation*. Sometimes, it is necessary to transform data values before they can be meaningfully interpreted. For instance, reverse coded items, where items convey the opposite meaning of that of their underlying construct, should be reversed (e.g., in a 1-7 interval scale, 8 minus the observed value will reverse the value) before they can be compared or combined with items that are not reverse coded. Other kinds of transformations may include creating scale measures by adding individual scale items, creating a weighted index from a set of observed measures, and collapsing multiple values into fewer categories (e.g., collapsing incomes into income ranges).

***Data Anaysis for Quaitative Study—***

Qualitative analysis is the analysis of qualitative data such as text data from interview transcripts. Unlike quantitative analysis, which is statistics driven and largely independent of the researcher, qualitative analysis is heavily dependent on the researcher's analytic and

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integrative skills and personal knowledge of the social context where the data is collected. The emphasis in qualitative analysis is "sense making" or understanding a phenomenon, rather than predicting or explaining. A creative and investigative mindset is needed for qualitative analysis, based on an ethically enlightened and participant-in-context attitude, and a set of analytic strategies.

Let us take two examples to explain how we carry on Qualitative analysis.

*Content Analysis*

Content analysis is the systematic analysis of the content of a text (e.g., who says what, to whom, why, and to what extent and with what effect) in a quantitative or qualitative manner. Content analysis typically conducted as follows. First, when there are many texts to analyze (e.g., newspaper stories, financial reports, blog postings, online reviews, etc.), the researcher begins by sampling a selected set of texts from the population of texts for analysis. This process is not random, but instead, texts that have more pertinent content should be chosen selectively. Second, the researcher identifies and applies rules to divide each text into segments or "chunks" that can be treated as separate units of analysis. This process is called unitizing. For example, a ssumptions, effects, enablers, and barriers in texts may constitute such units. Third, the researcher constructs and applies one or more concepts to each unitized text segment in a process called coding. For coding purposes, a coding scheme is used based on the themes the researcher is searching for or uncovers as she classifies the text. Finally, the coded data is analyzed, often both quantitatively and qualitatively, to determine which themes occur most frequently, in what contexts, and how they are related to each other.

A simple type of content analysis is sentiment analysis – a technique used to capture people's opinion or attitude toward an object, person, or phenomenon. Reading online messages about a political candidate posted on an online forum and classifying each message as positive, negative, or neutral is an example of such an analysis. In this case, each message represents one unit of analysis. This analysis will help identify whether the sample as a whole is positively or negatively disposed or neutral towards that candidate. Examining the content of online reviews in a similar manner is another example. Though this analysis can be done manually, for very large data sets (millions of text records), natural language processing and text analytics based software programs are available to automate the coding process, and maintain a record of how people sentiments fluctuate with time.

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A frequent criticism of content analysis is that it lacks a set of systematic procedures that would allow the analysis to be replicated by other researchers. Schilling (2006) **[20]** addressed this criticism by organizing different content analytic procedures into a spiral model. This model consists of five levels or phases in interpreting text: (1) convert recorded tapes into raw text data or transcripts for content analysis, (2) convert raw data into condensed protocols, (3) convert condensed protocols into a preliminary category system, (4) use the preliminary category system to generate coded protocols, and (5) analyze coded protocols to generate interpretations about the phenomenon of interest.

Content analysis has several limitations. First, the coding process is restricted to the information available in text form. For instance, if a researcher is interested in studying people's views on capital punishment, but no such archive of text documents is available, then the analysis cannot be done. Second, sampling must be done carefully to avoid sampling bias. For instance, if your population is the published research literature on a given topic, then you have systematically omitted unpublished research or the most recent work that is yet to be published.

*Hermeneutic Analysis*

Hermeneutic analysis is a special type of content analysis where the researcher tries to "interpret" the subjective meaning of a given text within its socio-historic context. Unlike content analysis, which ignores the context and meaning of text documents during the coding process, hermeneutic analysis is a truly interpretive technique for analyzing qualitative data. This method assumes that written texts narrate an author's experience within a socio-historic context, and should be interpreted as such within that context. Therefore, the researcher continually iterates between singular interpretation of the text (the part) and a holistic understanding of the context (the whole) to develop a fuller understanding of the phenomenon in its situated context, which German philosopher Martin Heidegger called the hermeneutic circle. The word hermeneutic (singular) refers to one particular method or strand of interpretation.

More generally, hermeneutics is the study of interpretation and the theory and practice of interpretation. Derived from religious studies and linguistics, traditional hermeneutics, such as biblical hermeneutics, refers to the interpretation of written texts, especially in the areas of literature, religion and law (such as the Bible). In the 20th century, Heidegger suggested that a more direct, non-mediated, and authentic way of understanding social reality is to experience it, rather than simply observe it, and proposed philosophical

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hermeneutics, where the focus shifted from interpretation to existential understanding. Heidegger argued that texts are the means by which readers can not only read about an author's experience, but also relive the author's experiences. Contemporary or modern hermeneutics, developed by Heidegger's students such as Hans-Georg Gadamer, further examined the limits of written texts for communicating social experiences, and went on to propose a framework of the interpretive process, encompassing all forms of communication, including written, verbal, and non-verbal, and exploring issues that restrict the communicative ability of written texts, such as presuppositions, language structures (e.g., grammar, syntax, etc.), and semiotics (the study of written signs such as symbolism, metaphor, analogy, and sarcasm). The term hermeneutics is sometimes used interchangeably and inaccurately with exegesis, which refers to the interpretation or critical explanation of written text only and especially religious texts.

Finally, standard software programs, such as ATLAS.ti.5, NVivo, and QDA Miner, can be used to automate coding processes in qualitative research methods. These programs can quickly and efficiently organize, search, sort, and process large volumes of text data using user-defined rules. To guide such automated analysis, a coding schema should be created, specifying the keywords or codes to search for in the text, based on an initial manual examination of sample text data. The schema can be organized in a hierarchical manner to organize codes into higher-order codes or constructs. The coding schema should be validated using a different sample of texts for accuracy and adequacy. However, if the coding schema is biased or incorrect, the resulting analysis of the entire population of text may be flawed and non-interpretable. However, software programs cannot decipher the meaning behind the certain words or phrases or the context within which these words or phrases are used (such as those in sarcasms or metaphors), which may lead to significant misinterpretation in large scale qualitative analysis

***Report Writing—***

The final phase of research involves preparing the final research report documenting the entire research process and its findings in the form of a research paper, dissertation, or monograph. This report should outline in detail all the choices made during the research process (e.g., theory used, constructs selected, measures used, research methods, sampling, etc.) and why, as well as the outcomes of each phase of the research process. The research process must be described in sufficient detail so as to allow other researchers to replicate your study, test the findings, or assess whether the inferences derived are scientifically acceptable. Of course, having a ready research proposal will greatly simplify and quicken the process of writing the finished report. Note that research is of no value

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unless the research process and outcomes are documented for future generations; such documentation is essential for the incremental progress of science.

## 1.11 Conclusion

From this unit we learnt that unless and until we design a Research systematically we will not be able to reach the goal. We must be careful enough to choose the appropriate steps to attain the final result.

## 1.12 Exercise

1. What do you mean by Scientific Research?
2. Differentiate between Social Research and Social Work Research
3. What do you understand by Hypothesis?
4. What are the different steps of Research Process?

## 1.13 Reference

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# Unit 2 ❑ Social Work Research

***Structure***



## 2.0 Objective

**Social work research** requires a focus on gaining an empathic understanding of an individual's feelings and the meaning that they give to everyday life with the goal to gaining greater understanding of the individual's behavior. For this reason is a very essential social work research.

## 2.1 Introduction

All social workers, from micro to macro, need to understand the root causes and policy solutions to social problems that their clients are experiencing. Social work supervisors and administrators at agency-based settings will likely have to demonstrate that their agency's programs are effective at achieving their goals. Most private and public grants will require evidence of effectiveness for your agency to receive funding and to keep the programs running. Social workers at community-based organizations commonly use research methods to target their interventions to the needs of their service area. Clinical social workers must also make sure that the interventions they use in practice are effective and not harmful to clients. In addition, social workers may want to track client progress on goals, help clients gather data about their clinical issues, or use data to advocate for change. As a whole, all social workers in all practice situations must remain current on the scientific literature to ensure competent and ethical practice.



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In all of these cases, a social worker needs to be able to understand and evaluate scientific information. **Evidence-based practice** (EBP) for social workers involves making decisions on how to help clients based on the best available evidence. A social worker must examine the current literature and understand both the theory and evidence relevant to the practice situation. According to Rubin and Babbie (2017), [4] EBP also involves understanding client characteristics, using practice wisdom and existing resources, and adapting to environmental context. It is not simply "doing what the literature says," but rather a process by which practitioners examine the literature, client, self, and context to inform interventions with clients and systems. As we discussed in Section 1.2, the patterns discovered by scientific research are not perfectly applicable to all situations. Instead, we rely on the critical thinking of social workers to apply scientific knowledge to real-world situations.

Let's consider an example of a social work administrator at a children's mental health agency. The agency uses a private grant to fund a program that provides low-income children with bicycles, teaches the children how to repair and care for their bicycles, and leads group bicycle outings after school. Physical activity has been shown to improve mental health outcomes in scientific studies, but is this social worker's program improving mental health in their clients? Ethically, the social worker should make sure that the program is achieving its goals. If the program is not beneficial, the resources should be spent on more effective programs. Practically, the social worker will also need to demonstrate to the agency's donors that bicycling truly helps children deal with their mental health concerns.

The example above demonstrates the need for social workers to engage in **evaluation research,** or research that evaluates the outcomes of a policy or program. She will choose from many acceptable ways to investigate program effectiveness, and those choices are based on the principles of scientific inquiry you will learn in this textbook. As the example above mentions, evaluation research is embedded into the funding of nonprofit, human service agencies. Government and private grants need to make sure their money is being spent wisely. If your program does not work, then the funds will be allocated to a program that has been proven effective or a new program that may be effective. Just because a program has the right goal doesn't mean it will actually accomplish that goal. Grant reporting is an important part of agency-based social work practice. Agencies, in a very important sense, help us discover what approaches actually help clients.

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Thus Social Work Research aims at—

(1) To solve social problems and issues that shape how our society is organized, thus you have to live with the results of research methods every day of your life.

(2) To understand Research Methods that will help us to evaluate the effectiveness of social work interventions.

## 2.2 Use of research in social work—Intervention research and Practice based research

### *Intervention Research*

Interventional studies are often prospective and are specifically tailored to evaluate direct impacts of treatment or preventive measures on some social phenomenon. Each study design has specific outcome measures that rely on the type and quality of data utilized. Additionally, each study design has potential limitations that are more severe and need to be addressed in the design phase of the study. Interventional study designs, also called experimental study designs, are those where the researcher intervenes at some point throughout the study. The most common and strongest interventional study design is a randomized controlled trial, however, there are other interventional study designs, including pre-post study design, non-randomized controlled trials, and quasi-experiments. Experimental studies are used to evaluate study questions related to either therapeutic agents or prevention. Therapeutic agents can include prophylactic agents, treatments, surgical approaches, or diagnostic tests. Prevention can include changes to protective equipment, engineering controls, management, policy or any element that should be evaluated as to a potential cause of disease or injury.

### *Practice Based Research*

Practice-based research is a conceptual framework that allows a researcher to incorporate their creative practice, creative methods and creative output into the research design and as a part of the research output.

Smith and Dean note that practice-based research arises out of two related ideas. Firstly, “that creative work in itself is a form of research and generates detectable research outputs”. The product of creative work itself contributes to the outcomes of a research

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process and contributes to the answer of a research question. Secondly, "creative practice — the training and specialised knowledge that creative practitioners have and the processes they engage in when they are making art — can lead to specialised research insights which can then be generalised and written up as research" Smith and Dean's point here is that the content and processes of a creative practice generate knowledge and innovations that are different to, but complementary with, other research styles and methods. Practice-based research projects are undertaken across all creative disciplines and, as a result, the approach is very flexible in its implementation able to incorporate a variety of methodologies and methods within its bounds.

A helpful way to understand this is to think of practice-based research as an approach that allows us to incorporate our creative practices into the research, legitimises the knowledge they reveal and endorses the methodologies, methods and research tools that are characteristic of Social Work discipline.

## 2.3 Types of social work research

Broadly speaking Social Work Research may be categorized in the following ways-

1 Needs Assessment studies

2 Situational Analysis

3 Monitoring and Evaluation,

4 Impact assessment

5 Policy research.

*Needs Assessment studies—*

A needs assessment is a systematic process that provides information about social needs or issues in a place or population group and determines which issues should be prioritised for action. The term 'social issue' as used here is intended to be deliberately broad and essentially denotes an identified problem in a place or population. Social issues, or 'needs', can include health-related topics such as the increased prevalence of poor mental health in a population or high smoking rates, or issues such as low levels of literacy or child development. In this context, a social need or social issue is something that can be addressed by service providers (or community members in a community development initiative), so a needs assessment gathers information about the issue that can then inform

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service provision or policy development. A needs assessment in this context moves beyond individual assessment and explores the needs of a community. Community is frequently defined in terms of a geographical area but a needs assessment could also explore the needs of a specific population group; for example, the needs of single-parent families. A needs assessment in a geographical area may also have a focus on priority population groups; for example, Aboriginal and Torres Strait Islander people. Needs assessment is most often undertaken in order to allocate or redistribute resources and design programs, policies and services. However, needs assessment can also be considered as a form of evaluation, or as a component of program evaluation, because it involves collecting information in order to make an evaluative judgement about what needs exist in a community, what needs should be prioritised and how a particular policy, service, program or suite of activities will address those needs. A needs assessment can also provide baseline data that can be used in an evaluation. Importantly, a needs assessment is best undertaken as a systematic process (Altschuld & Kumar, 2005; Rossi, Lipsey, & Freeman, 2004):

1. Decisions are made about the scope of the needs assessment.
2. There is a plan to collect information.
3. Data are collected and analysed.
4. These data are used to determine priorities and make decisions about resource allocation, program design and service delivery.

In practice, needs assessments are often done informally. For example, a number of clients might present with similar issues that are not met by current services, a gap in service delivery may be observed, or a new client group becomes known, and something is designed to address these issues. Without a systematic process of needs assessment that includes multiple forms of evidence, this ad hoc method of meeting client need can eventually result in a fragmented service system that may not be making the most effective use of scarce resources. There may also be client or community needs that are less visible and so not being met. Undertaking a systematic needs assessment is a transparent and defensible way of ensuring that resources are being used in the most effective way possible.

### *Situational Analysis*

Situational analysis is an approach to research using a grounded theorizing methodology to identify and describe social worlds and arenas of action and by representing complexity through mapmaking Clarke has taken grounded theory beyond the more

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constructivist approach of Charmaz and Morse to create a new process of analysis that is situation-centred (i.e., largely centred on context) and focused on a social worlds/arenas/ negotiations framework. Situational analysis is beneficial to open up the data by providing a comprehensive framework for considering multiple connections and relationships that can influence activities – in this case, elements of the situation that influence implementation of core public health programs. Using explanatory maps, situational analysis provides unique visuals for understanding the phenomenon of interest and considerable potential for visual representation of data to aid in knowledge translation activities. Visual complexity, as a means to recognize patterns and to clarify complex systems, is part of a growing trend in social science. It allows the reader to see how complex the situation is, while demonstrating how various parts, through interaction, influence outcomes.

Situational analysis provides a means to specify and map all the important human and nonhuman elements of a situation, emphasizing relationships, social worlds and discursive positions Specifically, the methodology for situational analysis involves substantive theorizing and story-telling through the use of maps with a goal of critical analysis to produce a possible 'truth,' or the underlying structure or mechanism of action

## *Monitoring & Evaluation*

In the world of monitoring and evaluation (M&E) three approaches can be identified: result-oriented, constructivist and reflexive. Every approach includes principles, methods and tools that can be used for projects that have the ambition to contribute to (system) innovation. But they differ widely in their vision on reality, the on-going processes and their results and how to support, manage or adjust these processes. Deciding which method is the best depends heavily on the nature of the project, its context, and the monitoring and evaluation objectives. In practice, it may be desirable to use a selection of methods from the different approaches in order to combine their strong points.

*Social Impact Assessment (SIA)*

A Social Impact Assessment is a process of research, planning and the management of social change or consequences (positive and negative, intended and unintended) arising from policies, plans, developments and projects (UNEP, 2007). The core focus of an SIA is on the important impacts of projects and developments beyond the impacts on natural resources. Examples of social impacts include (Vanclay, 2003):

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People's way of life – that is, how they live, work, play and interact with one another on a day-to-day basis.

Their culture – that is, their shared beliefs, customs, values and language or dialect.

Their community – its cohesion, stability, character, services and facilities.

Their political systems – the extent to which people are able to participate in decisions that affect their lives, the level of democratization that is taking place, and the resources provided for this purpose.

Their health and well-being – health is a state of complete physical, mental, social and spiritual well-being and not merely the absence of disease or infirmity.

From the listed examples above, it is clear that the SIA must look not only at social issues but also at the environmental impacts and their interactions. For example, if the planned project impacts the availability of water and land for local food production it also leads to social impacts, such as increases in food prices, the need to travel longer distances to buy and/or grow food.

In general, an SIA calls for close collaboration with community members, as well as other stakeholders and experts. This usually covers the following specific areas to identify impacts and mitigation measures (State of Queensland, 2013):

- Community and stakeholder engagement
- Workforce management
- Housing and accommodation
- Local business and industry content
- Health and community well-being.

During the SIA, the proponent is usually expected to (State of Queensland, 2013):

- Identify stakeholders' groups and communities impacted by the project.
- Collect baseline data covering key social issues of the impacted communities such as community history, indigenous communities, culture and key events that have shaped economic and social development, key industries presently and in the past (if relevant); pressures or vulnerabilities experienced by these industry sectors.
- Provide an overview of government legislation and policies that complement the mitigation measures for social impacts that are directly related to the project.

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- Explain methods used to gather information, including a description of how the communities of interest were engaged during the development of the SIA.
- Identify potential direct social impacts and prediction of the significance of any impacts and duration and extent of each impact.
- List proposed mitigation measures
- Describe the monitoring framework that informs stakeholders on the progress of implementing mitigation measures and overall project implementations.

*Policy Research*

Organizations whether they are private or public, for-profit or not for profit are governed by a set of policies and procedures. To ensure the optimum efficiency and utilization these policies and procedures need to be reviewed periodically. The review process not only assesses the success or failure of the policy or procedure it also encapsulates the implementation of these policies. The research that undertakes this role is applied policy research, which means that the research is required to gather specific information and has the potential to create actionable outcomes (Ritchie & Spencer, 1994). Over the last three decades qualitative research methods have been recognized as a valuable tool in the social sciences and in particular management studies (Denzin & Linclon, 2000, Locke, 2001) and this has spilled over into applied social policy research.A good Policy can be framed by strong Advocacy.

Advocacy effort or campaign is a structured and sequenced plan of action with the purpose to start, direct, or prevent a specific policy change. The ultimate target of any advocacy effort is to influence those who hold decision-making power. In some cases, advocates can speak directly to these people in their advocacy efforts; in other cases, they need to put pressure on these people by addressing secondary audiences.

Thus-"*Policy advocacy is the process of negotiating and mediating a dialogue through which influential networks, opinion leaders, and ultimately, decision makers take ownership of your ideas, evidence, and proposals, and subsequently act upon them.*"

Therefore Policy Research is a very important part of Social Work Research as it ultimately leads to Policy making to establish Social Justice in our society.

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## 2.4 Conclusion

The learner would learn to develop a Research Approach, which is help there to explore various social phenomens.

## 2.5 Exercise

1. What is Social Work Research. Write down the various types of Social Work Research.
2. What do you mean by Evidence-based Practice in Social Work Research.
3. What is Education Research, discuss with example.
4. Discuss about Policy Research.
5. How do we carry out Social Impact Assessment.

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# Unit 3 ❑ Research Design

*Structure*



## 3.0 Objective

The learner will get an idea about various lands of Research Design. The Research Design would be help to plan the Research Methodology ways of Data collection.

## 3.1 Introduction

Research design is a comprehensive plan for data collection in an empirical research project. It is a "blueprint" for empirical research aimed at answering specific research questions or testing specific hypotheses, and must specify at least three processes:

(1) The data collection process, (2) The instrument development process, and (3) The sampling process.

Broadly speaking, data collection methods can be broadly grouped into two categories: positivist and interpretive. Positivist methods, such as laboratory experiments and survey research, are aimed at theory (or hypotheses) testing, while interpretive methods, such as action research and ethnography, are aimed at theory building. Positivist methods employ a deductive approach to research, starting with a theory and testing theoretical



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postulates using empirical data. In contrast, interpretive methods employ an inductive approach that starts with data and tries to derive a theory about the phenomenon of interest from the observed

data. Often times, these methods are incorrectly equated with quantitative and qualitative research. Quantitative and qualitative methods refers to the type of data being collected (quantitative data involve numeric scores, metrics, and so on, while qualitative data includes interviews, observations, and so forth) and analyzed (i.e., using quantitative techniques such as regression or qualitative techniques such as coding). Positivist research uses predominantly quantitative data, but can also use qualitative data. Interpretive research relies heavily on qualitative data, but can sometimes benefit from including quantitative data as well. Sometimes, joint use of qualitative and quantitative data may help generate unique insight into a complex social phenomenon that are not available from either types of data alone, and hence, mixed-mode designs that combine qualitative and quantitative data are often highly desirable.

Thus the research design refers to the overall strategy that you choose to integrate the different components of the study in a coherent and logical way, thereby, ensuring you will effectively address the research problem; it constitutes the blueprint for the collection, measurement, and analysis of data. We may note that research problem determines the type of design we would apply. **The function of a research design is to ensure that the evidence obtained enables us to effectively address the research problem logically and as unambiguously as possible**. In social sciences research, obtaining information relevant to the research problem generally entails specifying the type of evidence needed to test a theory, to evaluate a program, or to accurately describe and assess meaning related to an observable phenomenon.

With this in mind, a common mistake made by researchers is that they begin their investigations far too early, before they have thought critically about what information is required to address the research problem. Without attending to these design issues beforehand, the overall research problem will not be adequately addressed and any conclusions drawn will run the risk of being weak and unconvincing. As a consequence, the overall validity of the study will be undermined.

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## 3.2 Key Attributes of a Research Design

The quality of research designs can be defined in terms of four key design attributes: internal validity, external validity, construct validity, and statistical conclusion validity.

Internal validity, also called causality, examines whether the observed change in a dependent variable is indeed caused by a corresponding change in hypothesized independent variable, and not by variables extraneous to the research context. Causality requires three conditions: (1) covariation of cause and effect (i.e., if cause happens, then effect also happens; and if cause does not happen, effect does not happen), (2) temporal precedence: cause must precede effect in time, (3) no plausible alternative explanation (or spurious correlation). Certain research designs, such as laboratory experiments, are strong in internal validity by virtue of their ability to manipulate the independent variable (cause) via a treatment and observe the effect (dependent variable) of that treatment after a certain point in time, while controlling for the effects of extraneous variables. Other designs, such as field surveys, are poor in internal validity because of their inability to manipulate the independent variable (cause), and because cause and effect are measured at the same point in time which defeats temporal precedence making it equally likely that the expected effect might have influenced the expected cause rather than the reverse. Although higher in internal validity compared to other methods, laboratory experiments are, by no means, immune to threats of internal validity, and are susceptible to history, testing, instrumentation, regression, and other threats that are discussed later in the chapter on experimental designs. Nonetheless, different research designs vary considerably in their respective level of internal validity.

External validity or generalizability refers to whether the observed associations can be generalized from the sample to the population (population validity), or to other people, organizations, contexts, or time (ecological validity). For instance, can results drawn from a sample of financial firms in the United States be generalized to the population of financial firms (population validity) or to other firms within the United States (ecological validity)? Survey research, where data is sourced from a wide variety of individuals, firms, or other units of analysis, tends to have broader generalizability than laboratory experiments where

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artificially contrived treatments and strong control over extraneous variables render the findings less generalizable to real-life settings where treatments and extraneous variables cannot be controlled. The variation in internal and external validity for a wide range of research designs are shown in Figure 3.1.

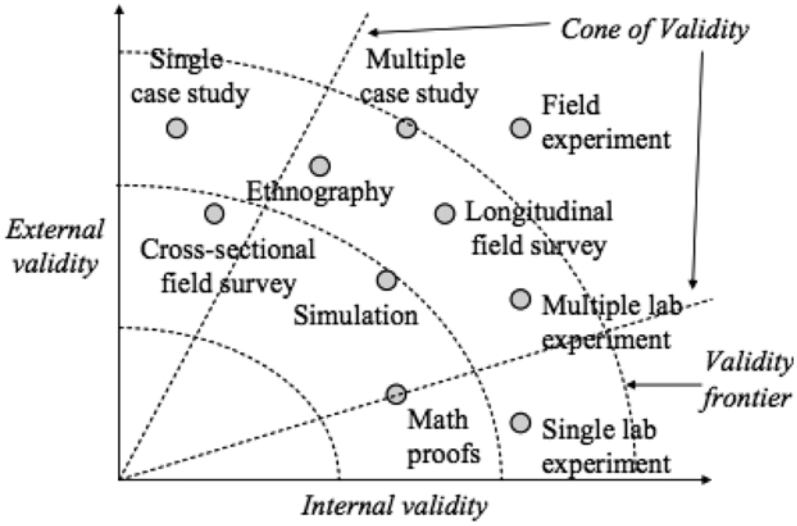


Figure 3.1 : Internal and external validity.

Some researchers claim that there is a trade off between internal and external validity: higher external validity can come only at the cost of internal validity and vice-versa. But this is not always the case. Research designs such as field experiments, longitudinal field surveys, and multiple case studies have higher degrees of both internal and external validities. Personally, I prefer research designs that have reasonable degrees of both internal and external validities, i.e., those that fall within the cone of validity shown in Figure 5.1. But this should not suggest that designs outside this cone are any less useful or valuable. Researchers' choice of designs is ultimately a matter of their personal preference and competence, and the level of internal and external validity they desire.

Construct validity examines how well a given measurement scale is measuring the theoretical construct that it is expected to measure. Many constructs used in social science research such as empathy, resistance to change, and organizational learning are difficult to define, much less measure. For instance, construct validity must assure that a measure of empathy is indeed measuring empathy and not compassion, which may be difficult since these constructs are somewhat similar in meaning. Construct validity is assessed in positivist research based on correlational or factor analysis of pilot test data.

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Statistical conclusion validity examines the extent to which conclusions derived using a statistical procedure is valid. For example, it examines whether the right statistical method was used for hypotheses testing, whether the variables used meet the assumptions of that statistical test (such as sample size or distributional requirements), and so forth. Because interpretive research designs do not employ statistical test, statistical conclusion validity is not applicable for such analysis. The different kinds of validity and where they exist at the theoretical/empirical levels are illustrated in Figure 5.2.

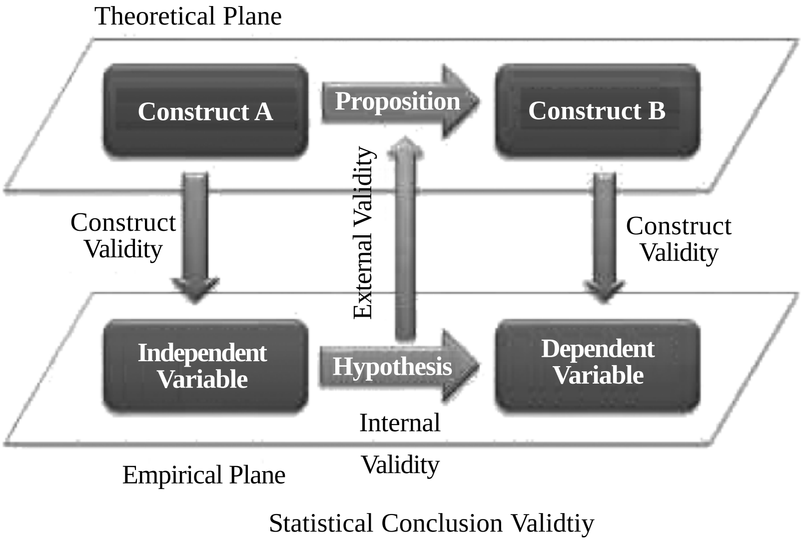


Figure 5.2. Different Types of Validity in Scientific Research

## Improving Internal and External Validity

The best research designs are those that can assure high levels of internal and external validity. Such designs would guard against spurious correlations, inspire greater faith in the hypotheses testing, and ensure that the results drawn from a small sample are generalizable to the population at large. Controls are required to assure internal validity (causality) of research designs, and can be accomplished in four ways: (1) manipulation, (2) elimination, (3) inclusion, and (4) statistical control, and (5) randomization.

In manipulation, the researcher manipulates the independent variables in one or more levels (called "treatments"), and compares the effects of the treatments against a control group where subjects do not receive the treatment. Treatments may include a new drug or different dosage of drug (for treating a medical condition), a, a teaching style (for students), and so forth. This type of control is achieved in experimental or quasi-experimental designs but not in non-experimental designs such as surveys. Note that if subjects cannot distinguish adequately between different levels of treatment manipulations, their responses across treatments may not be different, and manipulation would fail.

The elimination technique relies on eliminating extraneous variables by holding them constant across treatments, such as by restricting the study to a single gender or a single socio-economic status. In the inclusion technique, the role of extraneous variables is considered by including them in the research design and separately estimating their effects on the dependent variable, such as via factorial designs where one factor is gender (male versus female). Such technique allows for greater generalizability but also requires substantially larger samples. In statistical control, extraneous variables are measured and used as covariates during the statistical testing process.

Finally, the randomization technique is aimed at canceling out the effects of extraneous variables through a process of random sampling, if it can be assured that these effects are of a random (non-systematic) nature. Two types of randomization are: (1) random selection, where a sample is selected randomly from a population, and (2) random assignment, where subjects selected in a non-random manner are randomly assigned to treatment groups.

Randomization also assures external validity, allowing inferences drawn from the sample to be generalized to the population from which the sample is drawn. Note that random assignment is mandatory when random selection is not possible because of resource or access constraints. However, generalizability across populations is harder to ascertain since populations may differ on multiple dimensions and you can only control for few of those dimensions.

## 3.3 Popular Research Designs

As noted earlier, research designs can be classified into two categories – positivist and interpretive – depending how their goal in scientific research. Positivist designs are meant for theory testing, while interpretive designs are meant for theory building. Positivist designs seek generalized patterns based on an objective view of reality, while interpretive designs seek subjective interpretations of social phenomena from the perspectives of the subjects involved. Some popular examples of positivist designs include laboratory experiments, field experiments, field surveys, secondary data analysis, and case research while examples of interpretive designs include case research, phenomenology, and ethnography. Note that case research can be used for theory building or theory testing, though not at the same time.

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Not all techniques are suited for all kinds of scientific research. Some techniques such as focus groups are best suited for exploratory research, others such as ethnography are best for descriptive research, and still others such as laboratory experiments are ideal for explanatory research. Following are brief descriptions of some of these designs.

## Experimental Research Design

Experimental studies are those that are intended to test cause-effect relationships (hypotheses) in a tightly controlled setting by separating the cause from the effect in time, administering the cause to one group of subjects (the "treatment group") but not to another group ("control group"), and observing how the mean effects vary between subjects in these two groups. For instance, if we design a laboratory experiment to test the efficacy of a new drug in treating a certain ailment, we can get a random sample of people afflicted with that ailment, randomly assign them

to one of two groups (treatment and control groups), administer the drug to subjects in the treatment group, but only give a placebo (e.g., a sugar pill with no medicinal value). More complex designs may include multiple treatment groups, such as low versus high dosage of the drug, multiple treatments, such as combining drug administration with dietary interventions. In a true experimental design, subjects must be randomly assigned between each group. If random assignment is not followed, then the design becomes quasi-experimental. Experiments can be conducted in an artificial or laboratory setting such as at a university (laboratory experiments) or in field settings such as in an organization where the phenomenon of interest is actually occurring (field experiments). Laboratory experiments allow the researcher to isolate the variables of interest and control for extraneous variables, which may not be possible in field experiments. Hence, inferences drawn from laboratory experiments tend to be stronger in internal validity, but those from field experiments tend to be stronger in external validity. Experimental data is analyzed using quantitative statistical techniques. The primary strength of the experimental design is its strong internal validity due to its ability to isolate, control, and intensively examine a small number of variables, while its primary weakness is limited external generalizability since real life is often more complex (i.e., involve more extraneous variables) than contrived lab settings. Furthermore, if the research does not identify ex ante relevant extraneous variables and control for such variables, such lack of controls may hurt internal validity and may lead to spurious correlations.

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The blueprint of the procedure that enables the researcher to maintain control over all factors that may affect the result of an experiment. In doing this, the researcher attempts to determine or predict what may occur. Experimental research is often used where there is time priority in a causal relationship (cause precedes effect), there is consistency in a causal relationship (a cause will always lead to the same effect), and the magnitude of the correlation is great. The classic experimental design specifies an experimental group and a control group. The independent variable is administered to the experimental group and not to the control group, and both groups are measured on the same dependent variable. Subsequent experimental designs have used more groups and more measurements over longer periods. True experiments must have control, randomization, and manipulation.

***What do Experimental Research tells us?***

1. Experimental research allows the researcher to control the situation. In so doing, it allows researchers to answer the question, “What causes something to occur?”
2. Permits the researcher to identify cause and effect relationships between variables and to distinguish placebo effects from treatment effects.
3. Experimental research designs support the ability to limit alternative explanations and to infer direct causal relationships in the study.
4. Approach provides the highest level of evidence for single studies.

## Exploratory Design

An exploratory design is conducted about a research problem when there are few or no earlier studies to refer to or rely upon to predict an outcome. The focus is on gaining insights and familiarity for later investigation or undertaken when research problems are in a preliminary stage of investigation. Exploratory designs are often used to establish an understanding of how best to proceed in studying an issue or what methodology would effectively apply to gathering information about the issue.It seeks to find out how people get along in the setting under questions, what meanings they give to their actions, and what issues concern them; frequently involves qualitative methods, Marketing research to gather preliminary information that will help define problems and suggest hypotheses

**The goals of exploratory research are intended to produce the following possible insights:**

- Familiarity with basic details, settings, and concerns.

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- Well grounded picture of the situation being developed.
- Generation of new ideas and assumptions.
- Development of tentative theories or hypotheses.
- Determination about whether a study is feasible in the future.
- Issues get refined for more systematic investigation and formulation of new research questions.
- Direction for future research and techniques get developed.

## Descriptive Research

Descriptive research designs help provide answers to the questions of who, what, when, where, and how associated with a particular research problem; a descriptive study cannot conclusively ascertain answers to why. Descriptive research is used to obtain information concerning the current status of the phenomena and to describe "what exists" with respect to variables or conditions in a situation. In a descriptive design, a researcher is solely interested in describing the situation or case under their research study. It is a theory-based design method which is created by gathering, analyzing, and presenting collected data. This allows a researcher to provide insights into the why and how of research. Descriptive design helps others better understand the need for the research. If the problem statement is not clear, we can conduct exploratory research. Descriptive research involves the gathering of facts. Measurement and sampling are central concerns; survey research is often used for descriptive purposes.

Descriptive research seeks to describe the current status of an identified variable. These research projects are designed to provide systematic information about a phenomenon. The researcher does not usually begin with an hypothesis, but is likely to develop one after collecting data. The analysis and synthesis of the data provide the test of the hypothesis. Systematic collection of information requires careful selection of the units studied and careful measurement of each variable.

### What do these Design tell us?

1. The subject is being observed in a completely natural and unchanged natural environment. True experiments, whilst giving analyzable data, often adversely influence the normal behavior of the subject [a.k.a., the Heisenberg effect whereby measurements of certain systems cannot be made without affecting the systems].

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2. Descriptive research is often used as a pre-cursor to more quantitative research designs with the general overview giving some valuable pointers as to what variables are worth testing quantitatively.
3. If the limitations are understood, they can be a useful tool in developing a more focused study.
4. Descriptive studies can yield rich data that lead to important recommendations in practice.
5. Appoach collects a large amount of data for detailed analysis.

## Case Study

Case Study is an in-depth investigation of a problem in one or more real-life settings (case sites) over an extended period of time. Data may be collected using a combination of interviews, personal observations, and internal or external documents. Case studies can be positivist in nature (for hypotheses testing) or interpretive (for theory building). The strength of this research method is its ability to discover a wide variety of social, cultural, and political factors potentially related to the phenomenon of interest that may not be known in advance. Analysis tends to be qualitative in nature, but heavily contextualized and nuanced. However, interpretation of findings may depend on the observational and integrative ability of the researcher, lack of control may make it difficult to establish causality, and findings from a single case site may not be readily generalized to other case sites. Generalizability can be improved by replicating and comparing the analysis in other case sites in a multiple case design.

Focus group research is a type of research that involves bringing in a small group of subjects (typically 6 to 10 people) at one location, and having them discuss a phenomenon of interest for a period of 1.5 to 2 hours. The discussion is moderated and led by a trained facilitator, who sets the agenda and poses an initial set of questions for participants, makes sure that ideas and experiences of all participants are represented, and attempts to build a holistic understanding of the problem situation based on participants' comments and experiences.

Internal validity cannot be established due to lack of controls and the findings may not be generalized to other settings because of small sample size. Hence, focus groups are not generally used for explanatory or descriptive research, but are more suited for exploratory research.

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## Action Research

Action research assumes that complex social phenomena are best understood by introducing interventions or "actions" into those phenomena and observing the effects of those actions. In this method, the researcher is usually a consultant or an organizational member embedded within a social context such as an organization, who initiates an action such as new organizational procedures or new technologies, in response to a real problem such as declining profitability or operational bottlenecks. The researcher's choice of actions must be based on theory, which should explain why and how such actions may cause the desired change. The researcher then observes the results of that action, modifying it as necessary, while simultaneously learning from the action and generating theoretical insights about the target problem and interventions. The initial theory is validated by the extent to which the chosen action successfully solves the target problem. Simultaneous problem solving and insight generation is the central feature that distinguishes action research from all other research methods, and hence, action research is an excellent method for bridging research and practice. This method is also suited for studying unique social problems that cannot be replicated outside that context, but it is also subject to researcher bias and subjectivity, and the generalizability of findings is often restricted to the context where the study was conducted.

The essentials of action research design follow a characteristic cycle whereby initially an exploratory stance is adopted, where an understanding of a problem is developed and plans are made for some form of interventionary strategy. Then the intervention is carried out [the "action" in action research] during which time, pertinent observations are collected in various forms. The new interventional strategies are carried out, and this cyclic process repeats, continuing until a sufficient understanding of [or a valid implementation solution for] the problem is achieved. The protocol is iterative or cyclical in nature and is intended to foster deeper understanding of a given situation, starting with conceptualizing and particularizing the problem and moving through several interventions and evaluations.

**What do Action Research studies tell us?**

1. This is a collaborative and adaptive research design that lends itself to use in work or community situations.
2. Design focuses on pragmatic and solution-driven research outcomes rather than testing theories.

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3. When practitioners use action research, it has the potential to increase the amount they learn consciously from their experience; the action research cycle can be regarded as a learning cycle.
4. Action research studies often have direct and obvious relevance to improving practice and advocating for change.
5. There are no hidden controls of direction by the researcher.

## Grounded Theory

Grounded theory is a systematic qualitative research methodology, originating in the social sciences and emphasizing the generation of theory from qualitative data in the process of conducting research. Grounded theory, in its original form, was proposed by Glaser and Strauss. Grounded theory is a systematic qualitative research methodology that emphasizes the generation of theory from data. Grounded theory operates almost in a reverse fashion to the traditional scientific method. Rather than proposing a hypothesis and gathering data to support it, data collection is pursued first without any preconceptions. Key points in the data are marked with a series of "codes," which are then grouped into similar concepts or categories. These categories become the basis of a theory. The coding process is typically performed in two steps, initial then focused coding. The categorization process is normally referred to as *axial coding*.

Grounded theory emerged as a research methodology in the 1960s, during a time when sociological research practices were particularly reliant on quantitative methodologies. In 1967, Glaser and Strauss coined the term grounded theory in their book *The Discovery of Grounded Theory.* The term refers to the idea of a theory that is generated by—or grounded in—an iterative process of analysis and sampling of qualitative data gathered from concrete settings, such as interviews, participant observation, and archival research. Grounded theory offers educational researchers a method that complements varied forms of qualitative data collection and that will expedite their work. Adopting more grounded theory strategies will enable educational researchers to further the theoretical reach of their studies and to make tacit meanings and processes explicit. Constructivists have not only re-envisioned grounded theory, but also revised it in ways that make the method more flexible and widely adoptable than its earlier versions.

In the past, grounded theory has often been viewed as separate from other methods. Now, the constructivist version makes the usefulness of combining grounded theory with other approaches more apparent, as is evident in grounded theory studies in education.

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Grounded theory can make ethnography more analytic, interview research more in-depth, and content analysis more focused. Several computer-assisted qualitative data analysis programs are built on grounded theory, and this method can add innovation to mixed methods research. Grounded theory emphasizes focusing data collection and checking and developing analytic ideas. Hence, grounded theory offers the tools for building strong evidence within the analysis and for explicating processes. Consequently, grounded theorists in education have a bright future for making powerful arguments in areas such as curricular studies, educational leadership, and educational policy

## Ethnographic Research Design

Sometimes referred to as participant observation, Ethnographic Research designs, revolves around field research encompass a variety of interpretative procedures [e.g., observation and interviews] rooted in **qualitative approaches** to studying people individually or in groups while inhabiting their natural environment as opposed to using survey instruments or other forms of impersonal methods of data gathering. Information acquired from observational research takes the form of "**field notes**" that involves documenting what the researcher actually sees and hears while in the field. Findings do not consist of conclusive statements derived from numbers and statistics because field research involves analysis of words and observations of behavior. Conclusions, therefore, are developed from an interpretation of findings that reveal overriding themes, concepts, and ideas. **More information can be found here**.

**What do Ethnographic Research Design tell us?**

1. Field research is often necessary to fill gaps in understanding the research problem applied to local conditions or to specific groups of people that cannot be ascertained from existing data.
2. The research helps contextualize already known information about a research problem, thereby facilitating ways to assess the origins, scope, and scale of a problem and to gage the causes, consequences, and means to resolve an issue based on deliberate interaction with people in their natural inhabited spaces.
3. Enables the researcher to corroborate or confirm data by gathering additional information that supports or refutes findings reported in prior studies of the topic.
4. Because the researcher in embedded in the field, they are better able to make observations or ask questions that reflect the specific cultural context of the setting being investigated.

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5. Observing the local reality offers the opportunity to gain new perspectives or obtain unique data that challenges existing theoretical propositions or long-standing assumptions found in the literature.

Ethnography is an interpretive research design inspired by anthropology that emphasizes that research phenomenon must be studied within the context of its culture. The researcher is deeply immersed in a certain culture over an extended period of time (8 months to 2 years), and during that period, engages, observes, and records the daily life of the studied culture, and theorizes about the evolution and behaviors in that culture. Data is collected primarily via observational techniques, formal and informal interaction with participants in that culture, and personal field notes, while data analysis involves "sense-making". The researcher must narrate her experience in great detail so that readers may experience that same culture without necessarily being there. The advantages of this approach are its sensitiveness to the context, the rich and nuanced understanding it generates, and minimal respondent bias. However, this is also an extremely time and resource-intensive approach, and findings are specific to a given culture and less generalizable to other cultures.

## 3.4 Mixed-Method or Eclectic Method

Mixed methods research represents more of an approach to examining a research problem than a methodology. Mixed method is characterized by a focus on research problems that require, 1) an examination of real-life contextual understandings, multi-level perspectives, and cultural influences; 2) an intentional application of rigorous quantitative research assessing magnitude and frequency of constructs and rigorous qualitative research exploring the meaning and understanding of the constructs; and, 3) an objective of drawing on the strengths of quantitative and qualitative data gathering techniques to formulate a holistic interpretive framework for generating possible solutions or new understandings of the problem. Tashakkori and Creswell (2007) and other proponents of mixed methods argue that the design encompasses more than simply combining qualitative and quantitative methods but, rather, reflects a new "third way" epistemological paradigm that occupies the conceptual space between positivism and interpretivism.

**What do Mixed- Method tell us?**

1. Narrative and non-textual information can add meaning to numeric data, while numeric data can add precision to narrative and non-textual information.

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2. Can utilize existing data while at the same time generating and testing a grounded theory approach to describe and explain the phenomenon under study.
3. A broader, more complex research problem can be investigated because the researcher is not constrained by using only one method.
4. The strengths of one method can be used to overcome the inherent weaknesses of another method.
5. Can provide stronger, more robust evidence to support a conclusion or set of recommendations.
6. May generate new knowledge new insights or uncover hidden insights, patterns, or relationships that a single methodological approach might not reveal.
7. Produces more complete knowledge and understanding of the research problem that can be used to increase the generalizability of findings applied to theory or practice.

## 3.5 Selecting Research Designs

Given the above multitude of research designs, which design should researchers choose for their research? Generally speaking, researchers tend to select those research designs that they are most comfortable with and feel most competent to handle, but ideally, the choice should depend on the nature of the research phenomenon being studied. In the preliminary phases of research, when the research problem is unclear and the researcher wants to scope out the nature and extent of a certain research problem, a focus group (for individual unit of analysis) or a case study (for organizational unit of analysis) is an ideal strategy for exploratory research. As one delves further into the research domain, but finds that there are no good theories to explain the phenomenon of interest and wants to build a theory to fill in the unmet gap in that area, interpretive designs such as case research or ethnography may be useful designs. If competing theories exist and the researcher wishes to test these different theories or integrate them into a larger theory, positivist designs such as experimental design, survey research, or secondary data analysis are more appropriate.

Regardless of the specific research design chosen, the researcher should strive to collect quantitative and qualitative data using a combination of techniques such as questionnaires, interviews, observations, documents, or secondary data. For instance, even

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in a highly structured survey questionnaire, intended to collect quantitative data, the researcher may leave some room for a few open-ended questions to collect qualitative data that may generate unexpected insights not otherwise available from structured quantitative data alone. Likewise, while case research employ mostly face-to-face interviews to collect most qualitative data, the potential and value of collecting quantitative data should not be ignored. As an example, in a study of organizational decision making processes, the case interviewer can record numeric quantities such as how many months it took to make certain organizational decisions, how many people were involved in that decision process, and how many decision alternatives were considered, which can provide valuable insights not otherwise available from interviewees' narrative responses. Irrespective of the specific research design employed, the goal of the researcher should be to collect as much and as diverse data as possible that can help generate the best possible insights about the phenomenon of interest.

## 3.6 Conclusion

An impactful research design usually creates a minimum bias in data and increases trust in the accuracy of collected data. A design that produces the least margin of error in experimental research is generally considered the desired outcome. Proper research design sets your study up for success. Successful research studies provide insights that are accurate and unbiased The essential elements of the research design are:

1. Accurate purpose statement
2. Techniques to be implemented for collecting and analyzing research
3. The method applied for analyzing collected details
4. Type of research methodology
5. Probable objections for research
6. Settings for the research study
7. Timeline
8. Measurement of analysis

Social Science Research: Principles, Methods, and Practices. **Authored by**: Anol Bhattacherjee.

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## 3.7 Exercise

1. Explain Mixed-Method or Electic Method, and also discuss its advantages.
2. What do you understand by the tern Research Design why is it necessary to Carryout Research.
3. Differentiate between Qualitative & Quantitative Research.
4. In what ways Research Design help as to improve Internal & External Validity.
5. Discuss any two Popular Research Design.

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# Unit 4 ❑ Sampling and Methods of Data collection

***Structure***



## 4.0 Objective

This unit will give us a detail information about sampling, various method of sampling of the precautions to be taken in using sampling.

## 4.1 Introduction

**A. Idea and Importance:** Sampling is very important in a research work. There are two methods which are followed to collect data. Data can be collected ftom all the sources or few representative sources may be identified and then the data be is collectedfrom that source.

When the number of sources are very high and the periphery is also very wide spread I then the second. method is followed. All possible sources are termed as ‘population’. But



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it may out be always possible to collect data from this ‘population’. But it may not be always possible to collected data from this ‘population’, because it becomes almost impossible to meet the expense and give necessary effort to this work for a researcher. Apart ftom this, it also becomes quite difficult and complexed for a researcher to properly momage, analyse and explain such huge volume of data. Generally a small population that represent the actual population is selected and fron here the data, is collected, This selection procedure is called sampling.

Suppose a research will be done on the slum dwellers of Rajabagan area in Kolkata to ascertain their socio economic status. Suppose 10,000 family lives in that slum then the population for data collection will be 1000. Even though it is quite difficult, expensive as well as time consuming andliaborious to collect data from these 1000 family. So to. minimize his work load the researched will select 1 family in every 10 family’ out of this 1'000 family which sums up to a total of family trom where he will collect the relevant (lata. The process of selecting the 100 family out of 1000 family is called sampling. Although the researcher can not choose this 1 00 family as per his discretion. Specific rules are followed during selecting the family so that the selected small population can correctly represt the entire population. Otherwise the desired result can not be obtained from the research. The research becomes ineffective.

Sampling is a very important, extensively used and popular aspects of a research. This helps the research work to be more easier and faster. It has its own merit and demerits. If the small sample can not correctly represent the entire population then their is each always a chance of failure of the research work. That is why selection of sample is done very carefully and continously, some special statistical techniques are used. These me called sampling techniques.

Therefore sampling may be defined as. ‘It is to select a portion of the entire source of data in such manner so that the inference can be drawn based on this sample. In this process a survey is conducted on a portion of the total population and then it is decided whether to take them as sample or not In research terminology this population is called universal. But the term population is very popular and widely used. The population may be definite or indefinite depending upon the number of components. For example the number of books published .by a publisher is finite but the number of reader of that book is not finite, rather it is infinite. The infmite population can be divided into two from another view point .. ‘Real’ and Hypothetical or Imaginary. As example the number of employees in an organisation is finite but their ins iration factors are imaginary because nothing can be said for certain in this regard.

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**A researcher should have a clear conception about samples which are as follows.**

i) **Sampling design:** It is a specific plan regarding sampling so that the representative sample can be obtained from the population. It is also to be determined that what kind of statistical approach should be taken to draw the design.

ii) **Sampling distribution:** In some cases where more than one sample is taken there the statistical mean, standard deviation, range, correlation etc. or each of the sample is considered. All these value of a sample is then listed and thus sampling distribution is done. The reliability" (confidence) level of a sample is assessed through sample distribution.

Suppose a researcher sets the confidence level of 95% in that case it is assumed that out of 100 sample, 95 of them correctly represents the total population. Significance level tells the opposite to confidence level that is some of the sample naturally does not represent or support the entire population. Thus confidence level and significance level complements each other. The sum of two level is always 100. Hence if the confidence level is 95% then automatically the significance level becomes 5%. Therefore 5% significance level proves, that out of every 100 samples 5 of them does not represent the population.

**iii) Sampling errors :** As the sampling is made with a portion of huge population therefore one cannot expect that the sample will always correctly express all the characteristics of a total population. There is always a chance of sampling error, it is often noted that even after; making two or three samples from same population produces different results. This difference is called 'sampling errors' on the other hand errors that occurs in data collection and analysis are human error hence they are known as non sampling error.

**B. Rules relating to selection of samples** : The relase that are followed for selection of sample are like – if the topics are set at random and are more in numbers than that of the total population then they may represt the population almost with no-error. For examples if 1000 leaves of a tree is randomly plucked and measured then if may be seen that the average length of the leaf will be almost near to the length of all the leaves of the tree. The following two points are very important in case of statistical analysis.

i) The large the size or volume of sample the more it can represent the population. The equation is Dependancy on sample $\alpha$ Number of topics included in the sample.

From the above example we can say that if 500 leaves were plucked invested of 1000 leaves as sample then dependancy/reliability of sample would decrease.

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In 1st situation the dependancy on sample = K 1000 (K is constant)

2nd situation dependancy on sample = K 500

Therefore in the 1 st case the value of dependancy is 31.62K where as in 2nd case the value is 22.36K.

ii) Sample selection must be done at random.

As per the abovementioned rule a portion of a large population is able to express the characteristic of the entire population. But lack of time, find and effort prevents to collect the data from the entire population and due to this random data collection has been the most conventional method. This rules supports the idea that if data is collected randomly then there is a chance of inclusion of all the traits and attributes of a lage population in equal population.

At the time of sample selection few cautions must be followed. The selection have to be unbiased. Otherwise if there is any mistake in sample selection then it can not properly express the characteristics of the entire population. So the sample must be alike with the actual population. If more topics are included in the sample then as per the law of inertia r the chances of error is reduced and the same is increased in case of small sample.

## 4.3 Theory of Sampling

The selection of sampling (Theory) means the way to bring out the interrelation between the sample and its original population. The theory of sampling helps to have an idea about the large population at the same time it helps to correct them. Following are the joints based on which the sampling theory is evolved:

**i) Statistical estimation :** The sampling theory with the help of statistical estimation enables to derive some unknown characteristic of a population. This estimation can be of two types - point estimate and internal estimate. In case of the first type the result is expressed by a single number and in the second case the result is expressed by an expansion which has an upper and lower limit. For example in a sample of la spare parts round defective, therefore it may be assumed that out of 100 such sample the number of defective parts will be 10. When more than one sample is tested in similar way then on this basis it may be expressed that the probability of defective parts may vary from 8 to 12 out of 100.

ii) **Testing of Hypothesis :** The second objective of sampling theory is to test the hypothesis and then either to reject or accept. This theory help to determine the logic

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behind the difference of results as whether it is just due to chance or the difference is really significant when the hypothesis is tested.

iii) **Statistical Inference:** This theory helps to draw inference about the characteristic of total population from the sample. Apart from this it helps to draw correct inference about the population.

**D. Importance of sampling techniques :** Sampling techniques are extensively used

in case of quantitative research. It is also important in the other spheres of research. Sampling techniques are used in the field of education, Economy, Commerce and scientific research. In fact in our day to day life we follow some sampling techniques, because at the time of buying vegetables and daily commodities we take decision just by testing. some sample of them, we don't test the entire quantity. For example, the pathologists tests only 1 or 2 drops of blood to draw inference about any disease. Therefore sampling technique is not only followed in case of research but it is followed in our daily life. Following are the significant reason for which shows the importance of sampling techniques.

i) **Economy:** It is quite expensive, time consuming and laborious task to analyse all the aspects of a population. This can be reduced and controlled through sampling techniques.

ii) **Reliability :** If the characteristic of a population is not heterogenous and the sampling is done with proper precaution then the sampling result should able to correctly reflect some special characteristics of the population therefore the sampling.becomes fully reliable.

iii) **Detailed study:** As the sample contains lesser amount of elements therefore they can be studied deeply and in details. Since the sample is tested trom different angle, hence chances of error in the result is much less.

iv) **Scientific base:** There is a scientific basis of sampling techniques. Sampling is done trom the entire population in such a way (impertially) so that the sample remain unbiase.

v) **Suitability in most situations:** The study which are carried out for a research work are mostly sample study. Conducting a study or survey on an entire population is a very rare case, because if the there is a similarity in characteristic of a population then there is no deviation found in the sample too. Therefore in most situations sampling techniques are followed. It is true that though. in case of research work sampling techniques is widely followed but it is not applicable in all sphere. In the following areas sampling techniques may not be effective, following are the areas where this technique is very much effective.

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i) **Data is vast :** When the population for research is huge and required volume of data is also vast in such cases sampling techniques is very much essential. It not only saves time, money and labour but reduces the complexity of the research.

ii) **Where cent percent accuracy is not required :** There is no alternative of sampling techniques where cent percent error tree result is not required from die research.

iii) **Where census is not feasible :** Generally cent percent accurate result is possible to get on studying all the elements of a population for research. Where census is not feasible in those cases sampling technique is considered as the only solution. For example if the total quanity of mineral and ores of India is to be'measured then it is not possible to dig all the mines and measure the quantity. So there is no alternative way than sampling techniques.

iv) **Homogeneity :** If the overall characteristics of a population is same then it becomes easier to use the sampling techniques and the obtained result is accurate.

This is quite true that if the sampling is faulty then the research result will also be confusing. For example if the per family expense of slums dwellers is the subject of a research and at the time of sampling the data is collected from only those family who lives in a concrete house then the obtained result will be in correct, because while preparing the sample, the family who does not have a concrete house were not included.

So it can be said that sampling techniques will be successful only when it is done with proper precaution and without any biase. If the elements are collected with direction then chances of error in the result becomes very high. Therefore it increases the chances, of failure of a research. Hence it is advisible that selection of sample should be done' entifically and carefully then only a research work may be carried out.

## 4.4 Methods of sampling

It becomes very effective to work with a .small sample which is derived from a huge population. It was mentioned earlier that sampling method should be scientific it has to have, a scientific basis and it should be able to represent the entire population. Otherwise there is a chance of deviation in the research. The sampling method is divided into two parts, they are:

i) Random Sampling method.

ii) Non-random Sampling method.

**i) Random Sampling method:**

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According to this method when sample is prepared from a large population then it includes all the elements of the population. This kind of selection is always unbiased. That is the sampling is not influenced by the persons likings and dislikings. The elements of these sample are called indiscriminately from the population. This method avoids personal preference. The merits of this method are as follows :

i) Potential sampling gives an idea. The assumption are unbiased and neutral.

ii) The potential sample and its effectiveness does not depend upon the details of the information,

iii) In those research works where there is more number of samples are obtained by this method, there the relative potentiality of every samples can be assertained, which is not possible in other by other methods.

**The demerits of this methods are :**

i) Selection of sample depends upon the skill and experience of the person.

ii) It requires enough time to prepare the sample. Without preplan the sampling can not be done.

iii) This relatively a costly method. If the sampling is done unbiasedly then the cost may proportionately reduce.

**Type of probability sampling**

There are four kinds of probability sampling. They are:

1) Simple random sampling
2) Stratified sampling
3) Systematic sampling
4) Cluster sampling.

The above four are discussed below:

**1. Simple random sampling:**

When all the elements of an sample is selected unbiasedly then it is called simple random sampling. The significance of this sampling is that the sample contains all the elements of the population from which it was taken.

Here importance is not given to the personal choice of the researcher. It can be said in another way that if a sample is prepared with ‘n’ number of elements and if the sample includes as many as possible combination of ‘n’ number elements then this method is called simple random sampling. Follow are the areas where application of this method is ofteri seen.

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a) Lottery method

b) Tipet's number method

c) Selection trom sequential list

d) Grid method

Let us have a preliminary idea about all the above methods.

(a) **Lottery metbod:** In this method, at first all the elements of a population is segregated and written on separate piece of paper, then they are kept in a container. The pieces of paper are then mixed and well shaken there after each of the pieces are picked. All the elements written in those pieces are included in the sample. This way the number of pieces are taken out depending upon the number of elements of a sample. This is called the lottery method.

(b) **Tipet's number method:** This has been named after the name of L.B.C. Tipet. Tipet prepared a table with 4 digit where all the number were unbiased by written. An unbaised, impertial sampling can be produced from this table. For example if some one wants to prepare 50 samples out of 500 population then trom any page of Tipets table he can choose first 50 numbers. The test result showed that sampling done through this method is quite dependable.

(c) **Selection from sequential List:** The elements of population is listed in a sequence. The sequence may be done on the first alphabet of the name, or may be done Geographically or just serially. The elements that are oriented in this method, can easily be included in the sample and the selection may be started from any point. For example, if a sample consists of 10 student of a class where the total number of student in 100 then this may be done based on the roll number like 5,15,25, 95 or 10, 20, 30, 100 likewise.

(d) **Grid system:** This system is followed in case of area wise sample seleetion.Tn this system at first a complete map of the area is drawn. Then a rectangular screen is placed on the map and some rectangles are unbiasely selected. The areas in the map that are indicated by the rectangles are then included in the sample.

**Merits and demerits of simple random sampling.**

**Following are the merits of this method :-**

i) The method is relatively simple and the researcher need not have to be very much attentive as to which element is to be included and which one to be excluded in the sample.

ii) Since this is an unbiased method so chances of human error is nil.

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iii) As the chances of inclusion of all the elements in the sample is equal therefore the sample can well represent the entire population.

iv) Since this is a disciplined method therefore if there is error in the results they can be easily corrected.

Follwing are the demerits of the method :-

i) This method is not applicable when the size of the population is large.

ii) In this method the selector does not have any control over the elements of a sample. As a result the range of selected elements may be quite wide and it becomes impossible to keep control over each and every element.

iii) This method becomes ineffective if the population is heterogeneous.

**2. Stratified sampling:** At first the entire population is divided into number of classes, and each class is considered as strata. The significance of this method is that, that emphatically the population is divided into number of subgroups and for stratification some precautionery measures are taken as per the following.

i) Proportionate stratified sampling : In this method the proportion of elements in a sample is same with the various strata of the total population. For example if a population evolves 5 strata then from each strata 5 joints are identified and included in the sample. So in both situation the ratio is 1.5.

ii) Disproportionate stratified sampling: In this method equal number of element is selected to preapre the sample. This method is also known as controlled sampling.

iii) Stratified weight sampling: This method is applied where the size and volume of the strata differes from the original population. According to this method initially equal amount of element is selected from the strata, and their weighted average is calculated. How much weight is to be put on to which strata that depends upon the proportion of total population and the size of the strata. This is known as stratified weight sampling method.

**Merits & demerits of stratified sampling method :**

Following are the merits of this method :

i) The selector have more control over the selection procedure, because in a simple random sampling method there is always a chance that some important sample may not have all the elements which is almost absolutely nil in case of stratified sampling method.

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ii) Samples can be prepared with a small number of elements in such cases where the statra are of similar nature there the sample are prepare with very little amount of elements even though there is no deviation the results.

iii) Another significant advantage of this method is the inaccessible can be replaced with the accessible aspects.

The demerits of the method are as follows :

i) This method has been developed based on the stratification of population. Therefore if there is any fault in stratification the sampling will also be faulty.

ii) Scientific method is not properly applied while stratification. It depends upon the personal decision and choice of the selector to prepare the strata. Therefore there is always a probability of biasness, which poses problem in future.

iii) In case of stratified weight sampling method if there is a difference of weight assigned to various strata then there is a chance of deterioration of the quality of the sample.

**3. Systematic sampling:**

This is another version of simple random sampling method. In this method the elements of a population is initially organised in such a manner so that all the elements a properly distributed in the table. The Voter list,. the Telephone directory these are the ideal example of this method. Suppose a sample with 50 elements is to be prepared out of a population that consists of 500 elements. In this situation we can select a number between 1 to 10 let us assume that the digit is 6 then the sample will be prepared based on the matrix 6,16,26,36, ........, 486,496 likewise. This is known as systemetic sampling method.

The significance of this method is the selection of elements of a sample is done in a particular sequence. All the elements maintain equal difference. But the reliability and depend ability of the sample depends upon their position in the table.

Following are the merits of this method:

i) Sample preparation is easy:

ii) This method is effective on every sphere of population accept the extinct population.

The demerits of thus methods are:

i) If the difference between two element are very high then the effectiveness of the sample reduces. Therefore. it is not useful in case of preparing small sample out of a large population,

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ii) The quantity of error increases if more than one strata is present in the population.

The other demerits of this method are:

i) If the elements of the population is not oriented properly in the table, if they have a tendency of becoming restless instead of being stable, then it cannot correctly reflect the characteristics of the population.

ii) The possibility of error is very high in this method if the stratification has a good influence on the total population.

iii) The elements are selected from the table based on their consistancy. In this way if the difference between the elements are very high then the sample can not be considered as an ideal sample.

**4) Cluster sampling:**

This method is also known as multilayer samplings, because in this method the preparation of sample is done through various layer and steps. This method is extensively used while preparing a sample from a huge population. Generally the sampling is done in three or four stages. At the first stage the initial classification of the elements are done and in the second stage they are again divided into subclass in the third stage the sample is prepared with the first, second and third graded elements.

This method is comparatively complex in respect to the other methods. An example may clarify the method. Suppose a sample of 100 prefessors is to be prepared who teaches in the colleges the score affiliated by the University of Calcutta. Suppose there is a list of professor which has 100 number of pages and each page contains 20 names which are alphabetically sorted. Now 20 pages are chosen unbiasedly out of 100 pages then from each page 5 names are randomly chosen. Therefore to choose 20 pages out of 100 any number between 1 to 5 is to be choosed first, suppose the number is 4 then the order of the selected page will be 4,8,12,16, .........96 and 100. After this if 5 names are taken randomly from each page then a sample of such 100 names will be prepared. Therefore this is, a true example of combination of systematic sampling and random sampling method. But this method is not very widely used, because the method is quite expensive and it is difficult to keep control over the non sampling error.

**Non-probability sampling methods:**

We must have an idea about non probability sampling method along with side by side probability sampling methods. In fact the method which is incapable of preparing samples with all the elements of a population is known as non-probability sampling method. In this

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method the elements are non taken randomly. In another way, this may be said that while sampling it partly depends upon the personal preference of the selector, this means that in this method the probability of inclusion of an element ir a sample depends upon the convenience and consideration of the individual. This sampling method is again divided into three parts:

i) Judgement or purposive sampling

ii) Convenience sampling

iii) Quota sampling.

i) **Judgement of purposive sampling:** This methods completely depends upon the consideration and personal preference of the researcher. Though the researcher tries upto the best of his capability to make the sample a true representative of the entire population. Even then the sample is dependent upon this judiciousness.

When a small number of element is taken from the population to prepare a sample, then thus method becomes very much effective. If simple random sampling method is applied in such situation then there is always a chance of exclusion some important elements in the sample. Here judgement or purposive sampling becomes very effective. For example, if the effectiveness of the workers of an organisation is to be judged then a sample is prepared by randomly selecting 10 employees out of 100 employees of the organisation. This sample may not have representatives from all the departments, the total sample may consists of one / two departments. Therefore the sample result can not give a general idea about the effectivness of all the employees of the organisation. In other way this may be said that the sample study fails to give correct idea about the objective of the research. There is no scope to judge the reliability of the result obtained. from the sample, this is another demerit of this method.

Even though when a research is conducted to determine some unknown characteristics and features of a population then the entire population is divided into few categories then the elements are selected by examining each and every category. This makes the sample more reliable and representating.

**ii) Convenience sampling :**

When importance is given on the convenience of the researcher then· it is known as convenience sampling. This kind of sampling Goes not consider the 'probability- factor' as well and does not depends upon the rationality of the individulas, Iristead of this sample is prepared in such a way so that it can provide the maximum advantage to the research. When a sampling is done from a telephone directory, registration list of automobiles then

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it is called convenience sampling. If the simple random sampling method is applied to prepare the sample even though it can not be considered as random sampling. The elements of the sample can not represent the entire population. Therefore this sort of sampling remain biased and never accepted satisfactorily. Even though if some exceptional cases where the complete data is not available of the total population the elements can not be clearly identified and where just the pilot study are conducted in such cases thus method is applied.

iii) **Quota Sampling :** Quota sampling is a special version of stratified sampling. In this method the population is divided into different class based on some known characteristics of the population. After this the ratio of all the elements of each class and

the elements of the total population is determined. Now the responsibility of the researchers are laid out, that is the study is to be carried out on what part of which classes etc. This way the proportionate data is collected from a total population. The advantage of this method is it helps to collect information from each strata which includes various elements of the population. Thus the collected data represents the population and reduces the expense of research. The main drawback of this method is during stratification the biasness of the sampler becomes predominant. Apart from this, since the sampling is not randomly done therefore the errors in result can not be statistically measured.

## 4.5 Precautions in using Sampling Methods

Few points are considered as precautionary measures while selecting samplingmethods.

a) The sample must represent the entire population.

b) If the sample is enable to express all the characteristics of the population then it is as cannot completely represent the population and the goal of the research remains unreached if the research is carried out with this sample:

c) Therefore the researcher has to be very much cautions to ensure that the samples are not prepared with biasness.

Following are the precautions which are followed to do the above:

1. The survey, study and data collection has to be done in definite intervals where the characteristic change occurs quite often in a population.
2. It is to be ensured that the size of the sample should not be small. Because a small sample fails to properly represent the population. Thereforethe size of the sample should be such so that it can express all the characteristic: of the population.

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Sampling should not be done with intension, because then it increases the chance ofbiasness.

3. If the stratification method is applied for sampling even then principle of perfect stratification should not be followed.
4. If sampling is done from an incomplete table then also it becomes biased.
5. If freedom is given to the data accumulator for preparing sample without any guideline then they prepare the sample as per their convenience. In such cases situation the probabillity of unbiasness and representativeness reduces.
6. Improper selection method makes the sample biased. Special precaution is required incase of preparing sample from a complex, heterogeneous and huge population.
7. The researcher should always be careful to ensure that the sample is unbias and can correctly represents. the population.

**(G) Sampling Reliability:**

Two aspects are important for selection of sample for a research work. (i) If should be unbias and random (ii) It should be reliable. The reliability of a sample depends on correctly the characteristics of the population. Following are the joints based on which the reliability of a sample is judged.

i) **Size of the sample :** Size of the sample is very important to correctly express the characterstics of the population. The bigger the size of sample, the more it is expressive. The realibility is less when the sample is small in size. The researcher have to examine and judge whether the sample is competent enough for scientific research.

ii) **By testing the representative character of a sample :** The realibility of a sample can be judged by testing the representating feature of the sample.

ii) **Parallel Sampling:** To test the reliability of a sample another sample is prepared from the same population. After testing the reliability of the parallel sample the primary sample is tested. A clear idea about the two samples are obtained by comparing their results.

iv) **Homogeneity of the sample :** A sample which is prepared out of a large population must express all the characteristics of the population. Therefore by testing the homogeneity the reliability of a sample is judged.

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v) **Unbias selection :** The sampling should be done in such a way that there should be no biasness at the time of selecting the elements. The unbias selection method is more reliable.

vi) **Preparing sample from the main sample :** This is a process of preparing sample to sample. Many a time this is done just to test the reliability of the sample. The newly prepared sample is then well tested and the obtained result is compared with the results of the main sample. This enables to identify any error in the main sample.

## 4.6 Sampling and Non-sampling errors

In case of statistical analysis the error which occurs at the time of data collection, analysis and processing they may be categorised in two part, 1. non-sampling errors and 2. sampling errors. These are discussed below :

**1. Sampling errors :** Generally the survey is conducted on a small portion of a large population, by taking a sample of the same. Therefore it is quite natural that there is a possibility of differences with the result of actual population. Moreover if the survey is conducted on more than one sample prepared from a large population even then slight deviation is seen in the results.

i) **Error in sample selection :** Intentional sample selection can not be unbias. Therefore it evolves error. It the elements of samples are intentionally selectedthen it becomes biased. In case of sample selection the probability of error is very high when it is urorginisedly selected.

ii) **Incomplete Investigation :** If investigation is not carried out on all the elements of a sample then the obtained information becomes biased. In such situation the questionnaire method is applied. It is often seen that in such situation all the questions are not answered.

iii) **Error in Data Collection:** It there is any error in the method of data collection then it is reflected in the entire process. The possible reason for error in data collection is as follows :

a) If the data collector is not careful enough at the time of data collection then the accumulated data becomes faculty for example if the data collector does not ask questions or record the answers correctly then the information becomes faulty.

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b) If the answerer lacks in knowledge then the answers are not correct and proper.

c) If the questionnaire is weak.

d) If data is collected other than any approved method.

iv) **Replacement :** If an element or a persons on whatsoever in not present in the sample and the data collector collects the data from a replacement, due to this the sample becomes biased and result remains incorrect.

iv) **Faulty analysis :** The inference of a research is drawn by analysing the collected data. But if the analysis is faulty then the sampling error occurs.

From the above discussion it is observed that the biased attitude of the data collector, answerer and information supplier creats lot of errors. But many a times it. is also seen that with no fault of the data collector or answerer just due to accident some error occurs. This types of error are known as unbiased error, most of the time these errors are set off just by complementary each other, and does not influence the result of the research.

2. **Non sampling errors:** If the sampling is done correctly even though it can not be said that the surveyor the research is error free. In fact in all stages of a research such as data collection, data processing, data analysis, an error may occur. Therefore even if there is not error in sampling still the following errors may occur which are known as Non-Sampling errors;

i) The incorrect presentation and improper planning about the subject of research

ii) If there is wrong selection of population on which the research will be carriec out.

iii) If data collection is done with incomplete and faulty questionnaire.

iv) Wrong approach for data collection.

v) If the data collector collects in consistant and errounious data.

vi) Personal inclination or biased attitude of the presenter.

vii) In correct knowledge about the variables of the research.

viii) Misutilization of average value.

ix) Adapting wrong methodology for research.

x) If there is any fault in different measuring methods of the research.

There may be more reasons apart from the above for Non-Sampling errors. But if the above reason can be removed or eradicated then the research can be made error free.

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## 4.7 Methods of Data collection

We will now learn about the methods of data collection**.**

**Types of Data**

t is essential to have knowledge about some common terms that is crucial for us to know. While collection of data is concerned, we must know that there are two types of data-

1 Primary data

2 Secondary data

**1 Primary data**

The Data which is collected directly from the area of investigation for a specific reason are called primary data. thus characteristically primary data are unique.. such as a doctor can prepare a weight chart for his patient directly with the help of a weighing machine these types of data set are primary data set.At the time of population census data is directly collected.These are primary data set primary data set are more reliable but to collect primary data it requires more money time and labour.

**2 Secondary data**

The data which has been previously collected by some agency an later for some specific investigation if the investigator uses the same set of data then they are called secondary data. Secondary data is not unique in character.

when a data is availed from a census report for investigation then the collected data are transformed into secondary data to the investigator..It is less expensive to collect secondary data because comparatively it requires less money time and energy. The secondary data is apparrently rest reliable because while transcription or rounding up from the source it may carry some error. It is therefore revealed from the above discussion that a data which is primary 2. an individual the same data may be secondary to another individual,for example the data in the census report publishedBy Government of India is primary data and the same data published in another book a reporr secondary data.

- most of the time the source of data are divided into two primary source an second resource. The authority,Which directly collects the data from the investigation area or called primary source, while the agency that uses the data collected from primary source to somewhere else they're called the second resource.

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- in case of statistical investigation the primary data is most fruitful although because of limited time an money the secondary data are also used. therefore special precaution is needed to be taken to avoid errors of using secondary data.

Examples of primary data are the census report, the annual report of the Chief Inspector of mines in India, the common textile bulletin published from Mumbai etc.Examples of secondary data sources are statistical abstract of the Indian union published by the central statistical organisation New Delhi, survey report published by the statistical institution etc.

**Methods of data collection**

Data collection is a primary job before going into a statistical work. in relation to this there are some common terms that we must know like questionnaires, schedules etc.

**Questionnaire**

Questionnaire means a set of well defined questions about the investigation.The questionnaire should be prepared in such a way that it should be capable of collecting all relevant data.Generally in the first phase of observation it draught questionnaire is prepared and though their experiment answers are collected from a group of people.. the draught questionnaire is prepared to identify the flaws and defects in the questions so that they do not appear in the actual questionnaire.. the flaws and errors in the draught questionnaires are then removed and revised a good question is should have the following features-

- The question is should be written in simple language and it must be relevant with the topic or subject of investigation
- number of questions must be limited else the answerer will lose interest to respond to every question.
- The questions should not be doubtful and difficult to understand.
- Most of the questions should have multiple choice of answering.
- It is better to earn avoid such questions which may hurt the ego or sentiments of the answer.

**Schedule**

In this context schedule means a list of topics or subjects on which data will be collected. Preparation of questionnaire publishing of relevant information these are not mentioned in the schedule.These activities are interested upon the investigator

The different types of data collection can be discussed generally in the following ways during numeric data collection-

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Interview method

Mail questionnaire method

Direct personal observation method

Indirect oral investigation method

**1. Interview method -** Data is collected directly from the spot of investigation through this method with the help of trained and experienced investigator. The investigators are addressed as enumerator of field staff.The field staff reaches the specific locality and collect data from the local people through personal interaction an interview with a set of specific questions.. the local people who acts as data suppliers are to be intimated about the investigation topic and the answers obtained from the interview are carefully recorded. this is very popular method of data collection by appointing field staff and is considered to be very effective.

**2. Questionnaire through postal -** The questionnaire is the most important tool in this method the questionnaire is prepared with a bunch of questions about the subject of investigation.. the required data are collected from the answers of these questions. the questionnaire is sent to a group of selected data supplier by post requesting them to duly filled up the questions with their answers an return the same by post. the correspondence include the objectives of investigation an instruction to fill up the answers.. the confidentiality of the total method is also assured. This method is quite faster an comparatively cheaper. Some of the problem with this methods include - reliability of the collected data through this method is relatively low lot of questionnaire return without any answer.

**3. Direct personal observation -** In this method the investigator personally stays in the place of investigation an collects the data directly through personal observation counting an measurement.The investigator does not depends upon any other person for data collection and the collected data through this method are reliable.Up to a large extent. Although the priority of the data depends upon the honesty wholeheartedness Anne fine observation power of the Investigator is also included in this method.

**4. In direct oral investigation -** Relevant data can be obtained from some indirect sources persons with vast. experience about this surroundings and problems are identified and then they are interviewed to collect the data. The investigation Commission an government. committees mostly followed this method as the primary data collection method.It is needless to mention that the sanctity of the data collected through this method entirely dependsOpondo unbiasedness of the data supplier an honesty of the investigator.

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- apart from these ways of data collection there can be other ways where data is collected locally by appointing agents this method is followed where supply of data is required on a regular basis. the media sector specially follow this technique.

## 4.8 Conclusion

In this unit we learnt about the concept of sampling. This will help to carry out out research more system its celly.

## 4.9 Exercise

1. Explain the importance of sampling.
2. What are the methodologies followed.
3. Explain the main methodologies for sampling.

## 4.10 Reference

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# Unit 5 ❑ Measurement in research

*Structure*



## 5.0 Objective

In this unit we will get an idea about different levels of measurements as well as scales.

## 5.1 Introduction

When social scientists measure concepts, they sometimes use the language of variables and attributes (also called *values*). A **variable** refers to a phenomenon that can vary. It can be thought of as a grouping of several characteristics. For example, hair color could be a variable because it has varying characteristics. **Attributes** are the characteristics that make up a variable. For example, the variable hair color would contain attributes like blonde, brown, black, red, gray, etc.

A variable's attributes determine its **level of measurement**. There are four possible levels of measurement: *nominal*, *ordinal*, *interval*, and *ratio*. The first two levels of measurement are **categorical**, meaning their attributes are categories rather than numbers. The latter two levels of measurement are **continuous**, meaning their attributes are numbers, not categories.



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## 5.2 Nominal level of measurement

Hair color is an example of a nominal level of measurement. **Nominal** measures are categorical, and those categories cannot be mathematically ranked. There is no ranking order between hair colors. They are simply different. That is what constitutes a nominal level of measurement. Gender and race are also measured at the nominal level.

When using nominal level of measurement in research, it is very important to assign the attributes of potential answers very precisely. The attributes need to be *exhaustive* and *mutually exclusive*. Let's think about the attributes contained in the variable *hair color*. Black, brown, blonde, and red are common colors. But, if we listed only these attributes, people with gray hair wouldn't fit anywhere. That means our attributes were not exhaustive. **Exhaustiveness** means that all possible attributes are listed. We may have to list a lot of colors before we can meet the criteria of exhaustiveness. Clearly, there is a point at which trying to achieve exhaustiveness can get to be too much. If a person insists that their hair color is *light burnt sienna*, it is not your responsibility to list that as an option. Rather, that person could reasonably be described as brown-haired. Perhaps listing a category for *other color* would suffice to make our list of colors exhaustive.

What about a person who has multiple hair colors at the same time, such as red and black? They would fall into multiple attributes. This violates the rule of **mutual exclusivity**, in which a person cannot fall into two different attributes. Instead of listing all of the possible combinations of colors, perhaps you might include a list of attributes like *all black, all brown, all blonde, all red, multi-color, other* to include people with more than one hair color, but keep everyone in only one category.

The discussion of hair color elides an important point with measurement—reification. You should remember reification from our previous discussion in this chapter. For many years, the attributes for gender were male and female. Now, our understanding of gender has evolved to encompass more attributes including transgender, non-binary, or gender queer. We shouldn't confuse our labeling of attributes or measuring of a variable with the objective truth "out there." Another example could be children of parents from different races were often classified as one race or another in the past, even if they identified with both cultures equally. The option for bi-racial or multi-racial on a survey not only more accurately reflects the racial diversity in the real world but validates and acknowledges people who identify in that manner.

**Characteristics of Nominal Scale**

1. In nominal scale a variable is divided into two or more categories, for example, agree/disagree, yes or no etc. It's is a measurement mechanism in which answer to a particular question can fall into either category.

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2. Nominal scale is qualitative in nature, which means numbers are used here only to categorize or identify objects. For example, football fans will be really excited, as the football world cup is around the corner! Have you noticed numbers on a jersey of a football player? These numbers have nothing to do with the ability of players, however, they can help identify the player.
3. In nominal scale, numbers don't define the characteristics related to the object, which means each number is assigned to one object. The only permissible aspect related to numbers in a nominal scale is "counting."

In nominal scale, it is easy to generate responses using close ended questions, a lot of responses can be collected in short period of time, which in turn increases reliability. However, there is a downside to the scale, without a linear scale, participants are unable to express their degrees of response.

## 5.3 Ordinal level of measurement

Unlike nominal-level measures, attributes at the **ordinal** level can be rank ordered. For example, someone's degree of satisfaction in their romantic relationship can be ordered by rank. That is, you could say you are not at all satisfied, a little satisfied, moderately satisfied, or highly satisfied. Note that even though these have a rank order to them (not at all satisfied is certainly worse than highly satisfied), we cannot calculate a mathematical distance between those attributes. We can simply say that one attribute of an ordinal-level variable is more or less than another attribute. Ordinal scale is the 2nd level of measurement that reports the ranking and ordering of the data without actually establishing the degree of variation between them. Ordinal level of measurement is the second of the four measurement scales.

"Ordinal" indicates "order". Ordinal data is quantitative data which have naturally occurring orders and the difference between is unknown. It can be named, grouped and also ranked.

This can get a little confusing when using **Likert scales**. If you have ever taken a customer satisfaction survey or completed a course evaluation for school, you are familiar with Likert scales. "On a scale of 1-5, with one being the lowest and 5 being the highest, how likely are you to recommend our company to other people?" Sound familiar? Likert scales use numbers but only as a shorthand to indicate what attribute (highly likely, somewhat likely, etc.) the person feels describes them best. You wouldn't say you are "2" more likely to recommend the company. But you could say you are not very likely to recommend the company.

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Ordinal-level attributes must also be exhaustive and mutually exclusive, as with nominal-level variables.

*Ordinal Scale Characteristics*

- Along with identifying and describing the magnitude, the ordinal scale shows the relative rank of variables.
- The properties of the interval are not known.
- Measurement of non-numeric attributes such as frequency, satisfaction, happiness etc.
- In addition to the information provided by nominal scale, ordinal scale identifies the rank of variables.
- Using this scale, survey makers can analyze the degree of agreement among respondents with respect to the identified order of the variables.

*Advantages of Ordinal Scale*

- The primary advantage of using ordinal scale is the ease of comparison between variables.
- Extremely convenient to group the variables after ordering them.
- Effectively used in surveys, polls, and questionnaires due to the simplicity of analysis and categorization. Collected responses are easily compared to draw impactful conclusions about the target audience.
- As the values are indicated in a relative manner using a linear rating scale, the results are more informative than the nominal scale.

## 5.4 Interval level of measurement

At the **interval** level, the distance between attributes is known to be equal. Interval measures are also continuous, meaning their attributes are numbers, rather than categories. IQ scores are interval level, as are temperatures. Interval-level variables are not particularly common in social science research, but their defining characteristic is that we can say how much more or less one attribute differs from another. We cannot, however, say with certainty what the ratio of one attribute is in comparison to another. For example, it would not make sense to say that 50 degrees is half as hot as 100 degrees. But we can say it is 50 degrees cooler than 100. At the interval level, attributes must also be exhaustive and mutually exclusive. The interval scale is a quantitative measurement scale where there is order, the difference between the two variables is meaningful and equal, and the presence

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of zero is arbitrary. It measures variables that exist along a common scale at equal intervals. The measures used to calculate the distance between the variables are highly reliable.

The interval scale is the third level of measurement after the nominal scale and the ordinal scale. Understanding the first two levels will help you differentiate interval measurements. A nominal scale is used when variables do not have a natural order or ranking. Questions that can be measured on the interval scale are the most commonly used question types in research studies. To receive answers in the form of interval data, you need to limit feedback options to variables that can be assigned a numerical value where the difference between the two variables is equal.

## 5.5 Ratio level of measurement

Finally, at the **ratio** level, attributes can be rank ordered, the distance between attributes is equal, and attributes have a true zero point. Thus, with these variables, we *can* say what the ratio of one attribute is in comparison to another. Examples of ratio-level variables include age and years of education. We know, for example, that a person who is 12 years old is twice as old as someone who is 6 years old. Just like all other levels of measurement, at the ratio level, attributes must be mutually exclusive and exhaustive.

Ratio scale has most of the characteristics of the other three variable measurement scale i.e nominal, ordinal and interval. Nominal variables are used to "name," or label a series of values. Ordinal scales provide a sufficiently good amount of information about the order of choices, such as one would be able to understand from using a customer satisfaction survey. Interval scales give us the order of values and also about the ability to quantify the difference between each one. Ratio scale helps to understand the ultimate-order, interval, values, and the true zero characteristic is an essential factor in calculating ratios.

A ratio scale is the most informative scale as it tends to tell about the order and number of the object between the values of the scale. The most common examples of ratio scale are height, money, age, weight etc. With respect to market research, the common examples that are observed are sales, price, number of customers, market share etc.

**Characteristics of Ratio Scale**

1. Ratio scale, as mentioned earlier has an absolute zero characteristic. It has orders and equally distanced value between units. The zero point characteristic makes it relevant or meaningful to say, "one object has twice the length of the other" or "is twice as long."

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2. Ratio scale doesn't have a negative number, unlike interval scale because of the absolute zero or zero point characteristic. To measure any object on a ratio scale, researchers must first see if the object meets all the criteria for interval scale plus has an absolute zero characteristic.
3. Ratio scale provides unique possibilities for statistical analysis. In ratio scale, variables can be systematically added, subtracted, multiplied and divided (ratio). All statistical analysis including mean, mode, the median can be calculated using ratio scale. Also, chi-square can be calculated on ratio scale variable.
4. Ratio scale has ratio scale units which have several unique and useful properties. One of them is they allow unit conversion. Take an example of calculation of energy flow. Several units of energy occur like Joules, gram-calories, kilogram-calories, British thermal units. Still more units of energy per unit time (power) exist kilocalories per day, liters of oxygen per hour, ergs, and Watts.

**Advantages of Ratio Scale**

- A ratio scale has a point zero characteristic, where the value of the variable has no value at all. Weight, height etc can be calculated on ratio scale because they have a real zero value. However, the temperature cannot be measured on this scale because zero degree celsius doesn't mean there is no cold or heat for that matter. But most of the scientific variables can be measured on a ratio scale.
- Point zero is an essential characteristic to measure a ratio between any two variables because in the absence of zero there is no ratio. So without a zero would it make any sense to say, "Tom is driving at a speed of 100 km/hour, which is double the speed at which Thelma is driving, which is 50 Km/hr?"
- This scale is used to calculate all the scientific variables. In fact, in the absence of a ratio scale, scientific variables cannot be measured.

## 5.6 Thurstone's scaling method

Louis Thurstone. one of the earliest and most famous scaling theorists, published a method of equal-appearing intervals in 1925. This method starts with a clear conceptual definition of the construct of interest. Based on this definition, potential scale items are generated to measure this construct. These items are generated by experts who know something about the construct being measured. The initial pool of candidate items (ideally 80 to 100 items) should be worded in a similar manner, for instance, by framing them as

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statements to which respondents may agree or disagree (and not as questions or other things). Next, a panel of judges is recruited to select specific items from this candidate pool to represent the construct of interest. Judges may include academics trained in the process of instrument construction or a random sample of respondents of interest (i.e., people who are familiar with the phenomenon). The selection process is done by having each judge independently rate each item on a scale from 1 to 11 based on how closely, in their opinion, that item reflects the intended construct (1 represents extremely unfavorable and 11 represents extremely favorable). For each item, compute the median and inter-quartile range (the difference between the 75th and the 25th percentile – a measure of dispersion), which are plotted on a histogram, as shown in Figure 6.1. The final scale items are selected as statements that are at equal intervals across a range of medians. This can be done by grouping items with a common median, and then selecting the item with the smallest inter-quartile range within each median group. However, instead of relying entirely on statistical analysis for item selection, a better strategy may be to examine the candidate items at each level and selecting the statement that is the most clear and makes the most sense. The median value of each scale item represents the weight to be used for aggregating the items into a composite scale score representing the construct of interest. We now have a scale which looks like a ruler, with one item or statement at each of the 11 points on the ruler (and weighted as such). Because items appear equally throughout the entire 11-pointrange of the scale, this technique is called an equal-appearing scale.

Thurstone also created two additional methods of building unidimensional scales – the *method of successive intervals* and the *method of paired comparisons* – which are both very similar to the method of equal-appearing intervals, except for how judges are asked to rate the data. For instance, the method of paired comparison requires each judge to make a judgment between each pair of statements (rather than rate each statement independently on a 1 to 11 scale). Hence, the name paired comparison method. With a lot of statements, this approach can be enormously time consuming and unwieldy compared to the method of equal-appearing intervals.

## 5.7 Likert scale.

Designed by Rensis Likert, this is a very popular rating scale for measuring ordinal data in social science research. This scale includes Likert items that are simply-worded statements to which respondents can indicate their extent of agreement or disagreement on a five or seven-point scale ranging from 'strongly disagree' to 'strongly agree'. A typical example of a six-item Likert scale for the 'employment self-esteem' construct is shown in

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Table 6.3. Likert scales are summated scales—that is, the overall scale score may be a summation of the attribute values of each item as selected by a respondent.

| | **Strongly Disagree** | **Somewhat Disagree** | **Neutral** | **Somewhat Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| I feel good about my job | 1 | 2 | 3 | 4 | 5 |
| I get along well with others at work | 1 | 2 | 3 | 4 | 5 |
| | **Strongly Disagree** | **Somewhat Disagree** | **Neutral** | **Somewhat Agree** | **Strongly Agree** |
| I'm proud of my relationship with my supervisor at work | 1 | 2 | 3 | 4 | 5 |
| I can tell that other people at work are glad to have me there | 1 | 2 | 3 | 4 | 5 |
| I can tell that my co-workers respect me | 1 | 2 | 3 | 4 | 5 |
| I feel like I make a useful contribution at work | 1 | 2 | 3 | 4 | 5 |

A six-item Likert scale for measuring employment self-esteem

Likert items allow for more granularity (more finely tuned response) than binary items, including whether respondents are neutral to the statement. Three or nine values (often called 'anchors') may also be used, but it is important to use an odd number of values to allow for a 'neutral' (or 'neither agree nor disagree') anchor. Some studies have used a 'forced choice approach' to force respondents to agree or disagree with the Likert statement by dropping the neutral mid-point and using an even number of values, but this is not a good strategy because some people may indeed be neutral to a given statement, and the forced choice approach does not provide them the opportunity to record their neutral stance. A key characteristic of a Likert scale is that even though the statements vary in different items or indicators, the anchors ('strongly disagree' to 'strongly agree') remain the same. Likert scales are ordinal scales because the anchors are not necessarily equidistant, even though sometimes we treat them like interval scales.

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## 5.8 Guttman scale

Designed by Louis Guttman, this composite scale uses a series of items arranged in increasing order of intensity of the construct of interest, from least intense to most intense. What does that mean? Essentially, we would like a set of items or statements so that a respondent who agrees with any specific question in the list will also agree with all previous questions. Put more formally, we would like to be able to predict item responses perfectly knowing only the total score for the respondent The key to Guttman scaling is in the analysis. We construct a matrix or table that shows the responses of all the respondents on all of the items. We then sort this matrix so that respondents who agree with more statements are listed at the top and those agreeing with fewer are at the bottom. For respondents with the same number of agreements, we sort the statements from left to right from those that most agreed to to those that fewest agreed to.

As an example, the construct 'attitude toward immigrants' can be measured using five items shown in the Table. Each item in the above Guttman scale has a weight (not indicated above) which varies with the intensity of that item, and the weighted combination of each response is used as an aggregate measure of an observation.

| How will you rate your opinions on the following statements about immigrants? | | |
|---|---|---|
| Do you mind immigrants being citizens of your country? | Yes | No |
| Do you mind immigrants living in your own neighbourhood? | Yes | No |
| Would you mind living next door to an immigrant? | Yes | No |
| Would you mind having an immigrant as your close friend? | Yes | No |
| Would you mind if someone in your family married an immigrant? | Yes | No |

## 5.9 Reliability and Validity

A measure can be reliable but not valid, if it is measuring something very consistently but is consistently measuring the wrong construct. Likewise, a measure can be valid but not reliable if it is measuring the right construct, but not doing so in a consistent manner. Using the analogy of a shooting target, as shown below, a multiple-item measure of a construct that is both reliable and valid consists of shots that clustered within a narrow range near the center of the target.

A measure that is valid but not reliable will consist of shots centered on the target but not clustered within a narrow range, but rather scattered around the target. Finally, a

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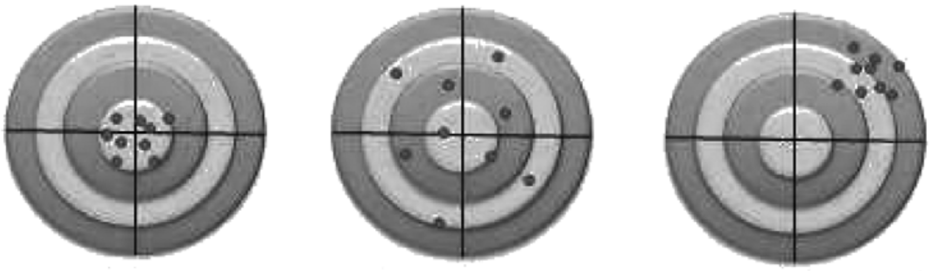
measure that is reliable but not valid will consist of shots clustered within a narrow range but off from the target. Hence, reliability and validity are both needed to assure adequate measurement of the constructs of interest.



Reliable and valid    Valid but not reliable    Reliable but not valid

Fig. Comparison of reliability and validity

## Reliability

Reliability is the degree to which the measure of a construct is consistent or dependable. In other words, if we use this scale to measure the same construct multiple times, do we get pretty much the same result every time, assuming the underlying phenomenon is not changing? An example of an unreliable measurement is people guessing your weight. Quite likely, people will guess differently, the different measures will be inconsistent, and therefore, the "guessing" technique of measurement is unreliable. A more reliable measurement may be to use a weight scale, where you are likely to get the same value every time you step on the scale, unless your weight has actually changed between measurements.

Note that reliability implies consistency but not accuracy. In the previous example of the weight scale, if the weight scale is calibrated incorrectly (say, to shave off ten pounds from your true weight, just to make you feel better!), it will not measure your true weight and is therefore not a valid measure. Nevertheless, the miscalibrated weight scale will still give you the same weight every time (which is ten pounds less than your true weight), and hence the scale is reliable.

What are the sources of unreliable observations in social science measurements? One of the primary sources is the observer's (or researcher's) subjectivity. If employee morale in a firm is measured by watching whether the employees smile at each other, whether they make jokes, and so forth, then different observers may infer different measures of morale

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if they are watching the employees on a very busy day (when they have no time to joke or chat) or a light day (when they are more jovial or chatty). Two observers may also infer different levels of morale on the same day, depending on what they view as a joke and what is not. "Observation" is a qualitative measurement technique. Sometimes, reliability may be improved by using quantitative measures, for instance, by counting the number of grievances filed over one month as a measure of (the inverse of) morale. Of course, grievances may or may not be a valid measure of morale, but it is less subject to human subjectivity, and therefore more reliable. A second source of unreliable observation is asking imprecise or ambiguous questions. For instance, if you ask people what their salary is, different respondents may interpret this question differently as monthly salary, annual salary, or per hour wage, and hence, the resulting observations will likely be highly divergent and unreliable. A third source of unreliability is asking questions about issues that respondents are not very familiar about or care about, such as asking an American college graduate whether he/she is satisfied with Canada's relationship with Slovenia, or asking a Chief Executive Officer to rate the effectiveness of his company's technology strategy – something that he has likely delegated to a technology executive.

So how can you create reliable measures? If your measurement involves soliciting information from others, as is the case with much of social science research, then you can start by replacing data collection techniques that depends more on researcher subjectivity (such as observations) with those that are less dependent on subjectivity (such as questionnaire), by asking only those questions that respondents may know the answer to or issues that they care about, by avoiding ambiguous items in your measures (e.g., by clearly stating whether you are looking for annual salary), and by simplifying the wording in your indicators so that they not misinterpreted by some respondents (e.g., by avoiding difficult words whose meanings they may not know). These strategies can improve the reliability of our measures, even though they will not necessarily make the measurements completely reliable. Measurement instruments must still be tested for reliability. There are many ways of estimating reliability, which are discussed next.

Inter-rater reliability. Inter-rater reliability, also called inter-observer reliability, is a measure of consistency between two or more independent raters (observers) of the same construct. Usually, this is assessed in a pilot study, and can be done in two ways, depending on the level of measurement of the construct. If the measure is categorical, a set of all categories is defined, raters check off which category each observation falls in, and the

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percentage of agreement between the raters is an estimate of inter-rater reliability. For instance, if there are two raters rating 100 observations into one of three possible categories, and their ratings match for 75% of the observations, then inter-rater reliability is 0.75. If the measure is interval or ratio scaled (e.g., classroom activity is being measured once every 5 minutes by two raters on 1 to 7 response scale), then a simple correlation between measures from the two raters can also serve as an estimate of inter-rater reliability.

Test-retest reliability. Test-retest reliability is a measure of consistency between two measurements (tests) of the same construct administered to the same sample at two different points in time. If the observations have not changed substantially between the two tests, then the measure is reliable. The correlation in observations between the two tests is an estimate of test-retest reliability. Note here that the time interval between the two tests is critical. Generally, the longer is the time gap, the greater is the chance that the two observations may change during this time (due to random error), and the lower will be the test-retest reliability.

Split-half reliability. Split-half reliability is a measure of consistency between two halves of a construct measure. For instance, if you have a ten-item measure of a given construct, randomly split those ten items into two sets of five (unequal halves are allowed if the total number of items is odd), and administer the entire instrument to a sample of respondents. Then, calculate the total score for each half for each respondent, and the correlation between the total scores in each half is a measure of split-half reliability. The longer is the instrument, the more likely it is that the two halves of the measure will be similar (since random errors are minimized as more items are added), and hence, this technique tends to systematically overestimate the reliability of longer instruments.

Internal consistency reliability. Internal consistency reliability is a measure of consistency between different items of the same construct. If a multiple-item construct measure is administered to respondents, the extent to which respondents rate those items in a similar manner is a reflection of internal consistency. This reliability can be estimated in terms of average inter-item correlation, average item-to-total correlation, or more commonly.

## Validity

Validity, often called construct validity, refers to the extent to which a measure adequately represents the underlying construct that it is supposed to measure. For instance, is a measure of compassion really measuring compassion, and not measuring a different

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construct such as empathy? Validity can be assessed using theoretical or empirical approaches, and should ideally be measured using both approaches. Theoretical assessment of validity focuses on how well the idea of a theoretical construct is translated into or represented in an operational measure. This type of validity is called translational validity (or representational validity), and consists of two subtypes: face and content validity. Translational validity is typically assessed using a panel of expert judges, who rate each item (indicator) on how well they fit the conceptual definition of that construct, and a qualitative technique called Q-sort.

Empirical assessment of validity examines how well a given measure relates to one or more external criterion, based on empirical observations. This type of validity is called criterion-related validity, which includes four sub-types: convergent, discriminant, concurrent, and predictive validity. While translation validity examines whether a measure is a good reflection of its underlying construct, criterion -related validity examines whether a given measure behaves the way it should, given the theory of that construct. This assessment is based on quantitative analysis of observed data using statistical techniques such as correlational analysis, factor analysis, and so forth. The distinction between theoretical and empirical assessment of validity is illustrated in Figure 7.2. However, both approaches are needed to adequately ensure the validity of measures in social science research.

Note that the different types of validity discussed here refer to the validity of the measurement procedures, which is distinct from the validity of hypotheses testing procedures, such as internal validity (causality), external validity (generalizability), or statistical conclusion validity. The latter types of validity are discussed in a later chapter.

Face validity. Face validity refers to whether an indicator seems to be a reasonable measure of its underlying construct “on its face”. For instance, the frequency of one’s attendance at religious services seems to make sense as an indication of a person’s religiosity without a lot of explanation. Hence this indicator has face validity. However, if we were to suggest how many books were checked out of an office library as a measure of employee morale, then such a measure would probably lack face validity because it does not seem to make much sense. Interestingly, some of the popular measures used in organizational research appears to lack face validity. For instance, absorptive capacity of an organization (how much new knowledge can it assimilate for improving organizational processes) has often been measured as research and development intensity (i.e., R&D expenses divided by gross revenues)! If your research includes constructs that are highly

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abstract or constructs that are hard to conceptually separate from each other (e.g., compassion and empathy), it may be worthwhile to consider using a panel of experts to evaluate the face validity of your construct measures.

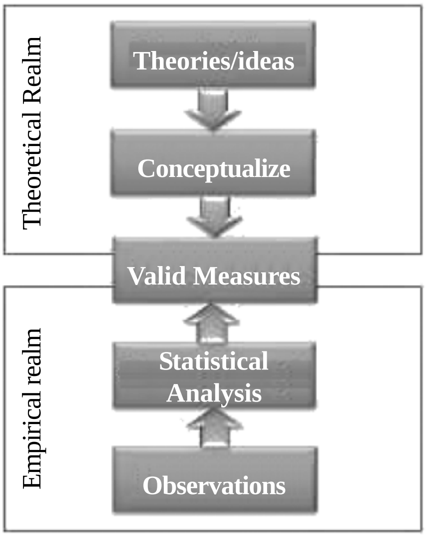


Fig. : Two approaches of validity assessment

Content validity. Content validity is an assessment of how well a set of scale items matches with the relevant content domain of the construct that it is trying to measure. For instance, if you want to measure the construct "satisfaction with restaurant service," and you define the content domain of restaurant service as including the quality of food, courtesy of wait staff, duration of wait, and the overall ambience of the restaurant (i.e., whether it is noisy, smoky, etc.), then for adequate content validity, this construct should be measured using indicators that examine the extent to which a restaurant patron is satisfied with the quality of food, courtesy of wait staff, the length of wait, and the restaurant's ambience. Of course, this approach requires a detailed description of the entire content domain of a construct, which may be difficult for complex constructs such as self-esteem or intelligence. Hence, it may not be always possible to adequately assess content validity. As with face validity, an expert panel of judges may be employed to examine content validity of constructs.

Convergent validity refers to the closeness with which a measure relates to (or converges on) the construct that it is purported to measure, and discriminant validity refers to the degree to which a measure does not measure (or discriminates from) other constructs that it is not supposed to measure. Usually, convergent validity and discriminant

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validity are assessed jointly for a set of related constructs. For instance, if you expect that an organization's knowledge is related to its performance, how can you assure that your measure of organizational knowledge is indeed measuring organizational knowledge (for convergent validity) and not organizational performance (for discriminant validity)? Convergent validity can be established by comparing the observed values of one indicator of one construct with that of other indicators of the same construct and demonstrating similarity (or high correlation) between values of these indicators. Discriminant validity is established by demonstrating that indicators of one construct are dissimilar from (i.e., have low correlation with) other constructs. In the above example, if we have a three-item measure of organizational knowledge and three more items for organizational performance, based on observed sample data, we can compute bivariate correlations between each pair of knowledge and performance items. If this correlation matrix shows high correlations within items of the organizational knowledge and organizational performance constructs, but low correlations between items of these constructs, then we have simultaneously demonstrated convergent and discriminant validity

Criterion-related validity can also be assessed based on whether a given measure relate well with a current or future criterion, which are respectively called concurrent and predictive validity. Predictive validity is the degree to which a measure successfully predicts a future outcome that it is theoretically expected to predict. For instance, can standardized test scores (e.g., Scholastic Aptitude Test scores) correctly predict the academic success in college (e.g., as measured by college grade point average)? Assessing such validity requires creation of a "nomological network" showing how constructs are theoretically related to each other.

Concurrent validity examines how well one measure relates to other concrete criterion that is presumed to occur simultaneously. For instance, do students' scores in a calculus class correlate well with their scores in a linear algebra class? These scores should be related concurrently because they are both tests of mathematics. Unlike convergent and discriminant validity, concurrent and predictive validity is frequently ignored in empirical social science research.

## 5.10 Conclusion

- Nominal—level of measurement that is categorical and those categories cannot be mathematically ranked, though they are exhaustive and mutually exclusive

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- Ordinal—level of measurement that is categorical, those categories can be rank ordered, and they are exhaustive and mutually exclusive
- Ratio level—level of measurement in which attributes are mutually exclusive and exhaustive, attributes can be rank ordered, the distance between attributes is equal, and attributes have a true zero point

## 5.11 Exercise

1. What do you mean by level of measurment.
2. Discuss the characteristic of Nominal Scale.
3. What is ordinal level of measurement.
4. Discuss about Likart & Guttman scale.
5. Write a note on Reliability and Validity.

## 5.12 Reference

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# Unit 6 ❑ Introduction to Statistical Methodology and exploring data with graphs

*Structure*



## 6.0 Objectives

By the end of this chapter, you will be able to

1. Describe the limited but crucial role of statistics in social research.
2. Distinguish between different components of statistics and identify situations in which each is appropriate.
3. Construct and analyse frequency distributions for both quantitative and qualitative variables.
4. Construct and analyse bar and pie charts, histograms, and line graphs.

## 6.1 Introduction

Students sometimes wonder about the value of studying statistics. What, after all, do numbers and statistics have to do with understanding people and society? The value of statistics will become clear as we move from chapter to chapter but, for now, we can



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demonstrate the importance of statistics by considering research. Scientists conduct research to answer questions, examine ideas, and test theories. Research is a disciplined inquiry that can take numerous forms. Statistics are relevant for quantitative research projects, or projects that collect information in the form of numbers or data. Statistics, then, are a set of mathematical techniques used by social scientists to organize and manipulate data for the purpose of answering questions and testing theories. Research results do not speak for themselves. They must be organized and manipulated so that whatever meaning they have can be quickly and easily understood by the researcher and by his or her readers.

Researchers use statistics to clarify their results and communicate effectively. In this unit, we consider some commonly used techniques for presenting research results, including percentages, rates, tables, and graphs. These univariate descriptive statistics are not mathematically complex (although they are not as simple as they might seem at first glance), but they are extremely useful for presenting research results clearly and concisely.

## 6.2 Definition of Statistics, its Components and its Role in Social Research:

Recent years have seen a dramatic increase in the use of statistical methods by social scientists, whether they work in academia, government, or the private sector. Social scientists study their topics of interest, such as analysing how well a program works or investigating the factors associated with beliefs and opinions of certain types, by analysing quantitative evidence provided by data. The growth of the Internet and computing power has resulted in an increase in the amount of readily available quantitative information. At the same time, the evolution of new statistical methodology and software makes new methods available that can more realistically address the questions that social scientists seek to answer.

You already have a sense of what the word statistics means. You hear statistics quoted about sports events (number of points scored by each player on a basketball team), statistics about the economy (median income, unemployment rate), and statistics about opinions, beliefs, and behaviours (percentage of students who indulge in binge drinking). In this sense, a statistic is merely a number calculated from data. But statistics as a field can

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be broadly viewed as a way of thinking about data and quantifying uncertainty, not a maze of numbers and messy formulas.

**Definition.** Statistics is the art and science of designing studies and analysing the data that those studies produce. Its ultimate goal is translating data into knowledge and understanding of the world around us. In short, statistics is the art and science of learning from data.

Statistical methods help us investigate questions in an objective manner. Statistical problem solving is an investigative process that involves four components: (1) formulate a statistical question, (2) collect data, (3) analyse data, and (4) interpret results.

There are the three main components of statistics for answering a statistical question:

- Design: Planning how to obtain data to answer the questions of interest
- Description: Summarizing and analysing the data that are obtained
- Inference: Making decisions and predictions based on the data for answering the statistical question.

**Design** refers to planning how to obtain data that will efficiently shed light on the problem of interest. How could you conduct an experiment to determine reliably whether regular large doses of vitamin C are beneficial? In marketing, how do you select the people to survey so you'll get data that provide good predictions about future sales?

**Description** means exploring and summarizing patterns in the data. Files of raw data are often huge. For example, over time the General Social Survey has collected data about hundreds of characteristics on many thousands of people. Such raw data are not easy to assess—we simply get bogged down in numbers. It is more informative to use a few numbers or a graph to summarize the data, such as an average amount of TV watched or a graph displaying how number of hours of TV watched per day relates to number of hours per week exercising.

**Inference** means making decisions or predictions based on the data. Usually, the decision or prediction refers to a larger group of people, not merely those in the study. For instance, in elections, television networks often declare the winner well before all the votes have been counted. They do this using exit polling, interviewing voters after they leave the voting booth. Using an exit poll, a network can often predict the winner after learning how several thousand people voted, out of possibly millions of voters.

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The 2010 California gubernatorial race pitted Democratic candidate Jerry Brown against Republican candidate Meg Whitman. In the exit poll of 3889 voters sampled, 53.1% said they voted for Jerry Brown. Using these data, we can predict (infer) that a majority of the 9.5 million voters voted for him. Stating the percentages for the sample of 3889 voters is description, while predicting the outcome for all 9.5 million voters is inference.

Statistical description and inference are complementary ways of analysing data. Statistical description provides useful summaries and helps you find patterns in the data, while inference helps you make predictions and decide whether observed patterns are meaningful. You can use both to investigate questions that are important to society. For instance, "Has there been global warming over the past decade?" "Is having the death penalty available for punishment associated with a reduction in violent crime?" "Does student performance in school depend on the amount of money spent per student, the size of the classes, or the teachers' salaries?"

Despite its importance and usefulness, the science of statistics is looked upon with suspicion. Quite often it is discredited, by people who do not know its real purpose and limitations. We often hear statements such as:

"There are three types of lies: lies, damned lies, and statistics". "Statistics can prove anything". "Statistics cannot prove anything". "Statistics are lies of the first order". These are expressions of distrust in statistics. By distrust of statistics, we mean lack of confidence in statistical data, statistical methods and the conclusions drawn. You may ask, why distrust in statistics? Some of the important reasons for distrust in statistics are as follows:

- Arguments based upon data are more convincing. But data can be manipulated according to wishes of an individual. To prove a particular point of view, sometimes arguments are supported by inaccurate data.
- Even if correct figures are used, they may be incomplete and presented in such a manner that the reader is misled. Suppose, it has been found that the number of traffic accidents is lower in foggy weather than on clear weather days. It may be concluded that it is safer to drive in fog. The conclusion drawn is wrong. To arrive at a valid conclusion, we must take into account the difference between the rush of traffic under the two weather conditions.

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- Statistical data does not bear on their face the label of their quality. Sometimes even unintentionally inaccurate or incomplete data is used leading to faulty conclusions.
- The statistical tools have their own limitations. The investigator must use them with precaution. But sometimes these tools or methods are handled by those who have little or no knowledge about them. As a result, by applying wrong methods to even correct and complete data, faulty conclusions may be obtained. This is not the fault of statistical methods, but of the persons who use them.

## 2. Displaying and Describing Categorical Data

What happened on the Titanic at 11:40 on the night of April 14, 1912, is well-known. Frederick Fleet' s cry of Iceberg, right ahead and the three accompanying pulls of the crow s nest bell signalled the beginning of a nightmare that has become legend. By 2:15 a.m., the Titanic, thought by many to be unsinkable, had sunk, leaving more than 1500 passengers and crew members on board to meet their icy fate.

Here are some data about the passengers and crew aboard the Titanic. Each case (row) of the data table represents a person on board the ship. The variables are the person's Survival (Dead or Alive) and the person's Age (Adult or Child), Sex (Male or Female), and ticket Class (First, Second, Third, or Crew), etc.

| Name | Survived | Age | Adult/Child | Sex | Price (£) | Class |
|---|---|---|---|---|---|---|
| ABBING, Mr Anthony | Dead | 42 | Adult | Male | 7.55 | 3 |
| ABBOTT, Mr Ernest Owen | Dead | 21 | Adult | Male | 0 | Crew |
| ABBOTT, Mr Eugene Joseph | Dead | 14 | Child | Male | 20.25 | 3 |
| ABBOTT, Mr Rossmore Edward | Dead | 16 | Adult | Male | 20.25 | 3 |
| ABBOTT, Mrs Rhoda Mary "Rosa" | Alive | 39 | Adult | Female | 20.25 | 3 |
| ABELSETH, Miss Karen Marie | Alive | 16 | Adult | Female | 7.65 | 3 |
| ABELSETH, Mr Olaus Jörgensen | Alive | 25 | Adult | Male | 7.65 | 3 |
| ABELSON, Mr Samuel | Dead | 30 | Adult | Male | 24 | 2 |
| ABELSON, Mrs Hannah | Alive | 28 | Adult | Female | 24 | 2 |
| ABRAHAMSSON, Mr Abraham August Johannes | Alive | 20 | Adult | Male | 7.93 | 3 |
| ABRAHIM, Mrs Mary Sophie Halaut | Alive | 18 | Adult | Female | 7.23 | 3 |

Table 1: Part of a data table showing four variables for nine people aboard the Titanic

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The problem with a data table like this and in fact with all data tables is that you can't see what's going on. And seeing is just what we want to do. We need ways to show the data so that we can see patterns, relationships, trends, and exceptions.

**Frequency Tables: Making Piles**

To make a picture of data, the first thing we have to do is to make piles. Making piles is the beginning of understanding about data. We pile together things that seem to go together, so we can see how the cases distribute across different categories. For categorical data, piling is easy. We just count the number of cases corresponding to each category and pile them up.

One way to put all 2201 people on the Titanic into piles is by ticket Class, counting up how many had each kind of ticket. We can organize these counts into a frequency table, which records the totals and the category names.

Even when we have thousands of cases, a variable like ticket Class, with only a few categories, has a frequency table that's easy to read. A frequency table with dozens or hundreds of categories would be much harder to read. We use the names of the categories to label each row in the frequency table. For ticket Class, these are First, Second, Third, and Crew.

Counts are useful, but sometimes we want to know the fraction or proportion of the data in each category, so we divide the counts by the total number of cases. Usually, we multiply by 100 to express these proportions as percentages. A relative frequency table displays the percentages, rather than the counts, of the values in each category. Both types of tables show how the cases are distributed across the categories. In this way, they describe the distribution of a categorical variable because they name the possible categories and tell how frequently each occurs.

| Class | Count |
|---|---|
| First | 325 |
| Second | 285 |
| Third | 706 |
| Crew | 885 |

**Table2: A frequency table of for the Titanic passengers The Area Principle**

| Class | % |
|---|---|
| First | 14.77 |
| Second | 12.95 |
| Third | 32.08 |
| Crew | 40.21 |

**Table 3: A relative frequency table for the same data**

The best data displays observe a fundamental principle of graphing data called the area principle. The area principle says that the area occupied by a part of the graph should correspond to the magnitude of the value it represents. Violations of the area principle are a common way to lie (or, since most mistakes are unintentional, we should say err) with Statistics.

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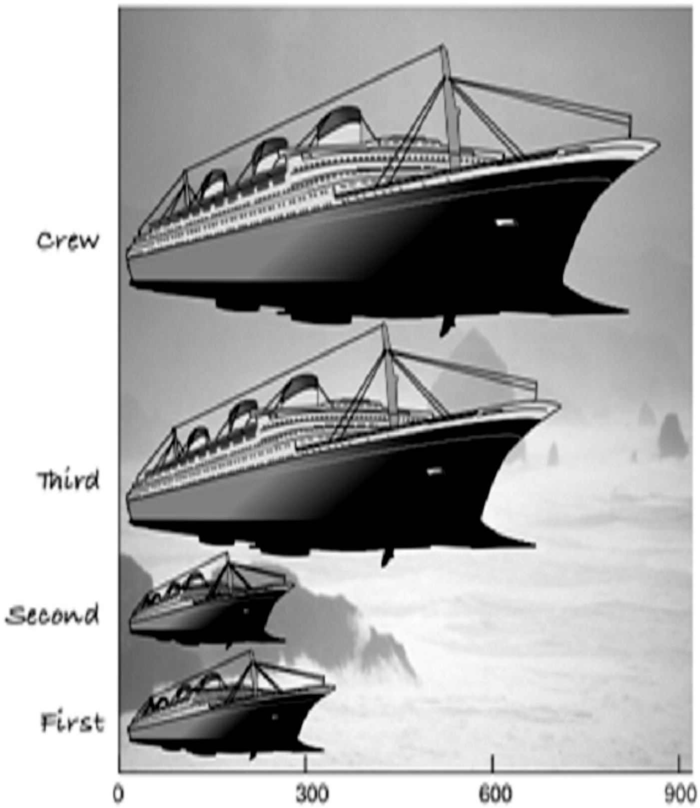


FIGURE: How many people were in each class on the Titanic? From this display, it looks as though the service must have been great, since most aboard were crew members. Although the length of each ship here corresponds to the correct number, the impression is all wrong. In fact, only about 40% were crew.

## 6.3 Bar Charts

A bar chart displays the distribution of a categorical variable, showing the counts for each category next to each other for easy comparison. Bar charts should have small spaces between the bars to indicate that these are freestanding bars that could be rearranged into any order. The bars are lined up along a common base.

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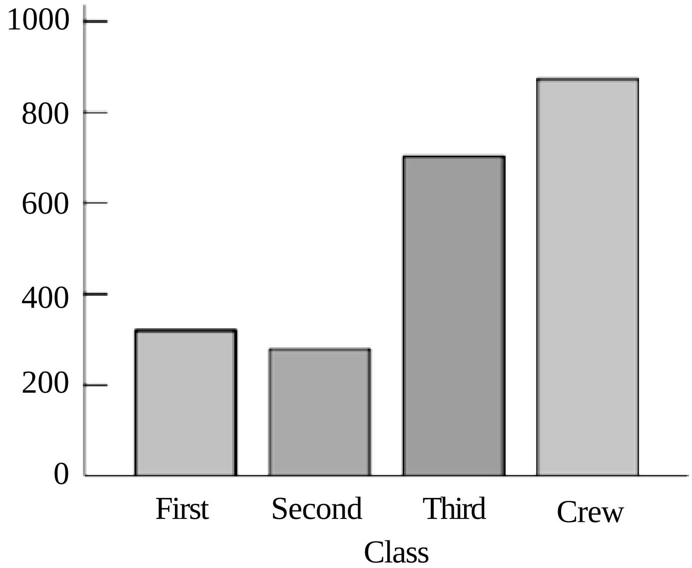


**FIGURE: People on the Titanic by Ticket Class With the area principle satisfied, we can see the true distribution more clearly**

Here's a chart that obeys the area principle. It's not as visually entertaining as the ships, but it does give an accurate visual impression of the distribution. The height of each bar shows the count for its category. The bars are the same width, so their heights determine their areas, and the areas are proportional to the counts in each class. Now it's easy to see that the majority of people on board were not crew, as the ships picture led us to believe. We can also see that there were about 3 times as many crews as second-class passengers. And there were more than twice as many third-class passengers as either first or second-class passengers, something you may have missed in the frequency table. Bar charts make these kinds of comparisons easy and natural.

If we really want to draw attention to the relative proportion of passengers falling into each of these classes, we could replace the counts with percentages and use a relative frequency bar chart.

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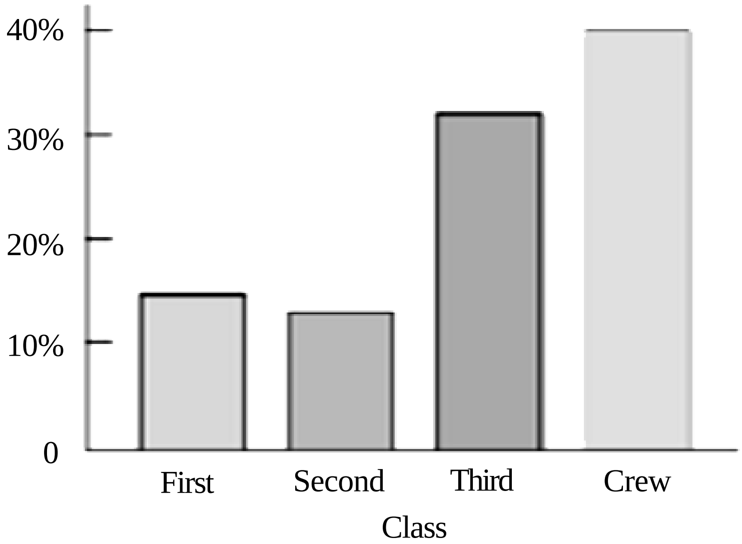


FIGURE: The relative frequency bar chart looks the same as the bar chart, but shows the proportion of people in each category rather than the counts

**Contingency Tables**

To look at two categorical variables together, we often arrange the counts in a two-way table. Here is a two-way table of those aboard the Titanic, classified according to the class of ticket and whether the ticket holder survived or didn't. Because the table shows how the individuals are distributed along each variable, contingent on the value of the other variable, such a table is called a contingency table.

| | | Class | | | | |
|---|---|---|---|---|---|---|
| | | First | Second | Third | Crew | Total |
| Survival | Alive | 203 | 118 | 178 | 212 | **711** |
| | Dead | 122 | 167 | 528 | 673 | **1490** |
| | Total | **325** | **285** | **706** | **885** | **2201** |

**Table: Contingency table of ticket Class and Survival. The bottom line of Totals is the same as the previous frequency table.**

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The margins of the table, both on the right and at the bottom, give totals. The bottom line of the table is just the frequency distribution of ticket Class. The right column of the table is the frequency distribution of the variable Survival. When presented like this, in the margins of a contingency table, the frequency distribution of one of the variables is called its marginal distribution.

Each cell of the table gives the count for a combination of values of the two variables. If you look down the column for second-class passengers to the first cell, you can see that 118 second-class passengers survived. Looking at the third-class passengers, you can see that more third-class passengers (178) survived. Were second-class passengers more likely to survive? Questions like this are easier to address by using percentages. The 118 survivors in second class were 41.4% of the total 285 second-class passengers, while the 178 surviving third-class passengers were only 25.2% of that class's total.

We know that 118 second-class passengers survived. We could display this number as a percentage, but as a percentage of what? The total number of passengers? (118 is 5.4% of the total, 2201.) The number of second-class passengers? (118 is 41.4% of the 285 second-class passengers.) The number of survivors? (118 is 16.6% of the 711 survivors.) All of these are possibilities, and all are potentially useful or interesting. You'll probably wind-up calculating (or letting your technology calculate) lots of percentages. Most statistics programs offer a choice of total percent, row percent, or column percent for contingency tables. Unfortunately, they often put them all together with several numbers in each cell of the table. The resulting table holds lots of information, but it can be hard to understand:

| Survival | | Class: First | Second | Third | Crew | Total |
|---|---|---|---|---|---|---|
| **Alive** | **Count** | **203** | **118** | **178** | **212** | **711** |
| | **% of Row** | 28.6% | 16.6% | 25.0% | 29.8% | 100% |
| | **% of Column** | 62.5% | 41.4% | 25.2% | 24.0% | 32.3% |
| | **% of Table** | 9.2% | 5.4% | 8.1% | 9.6% | 32.3% |
| **Dead** | **Count** | **122** | **167** | **528** | **673** | **1490** |
| | **% of Row** | 8.2% | 11.2% | 35.4% | 45.2% | 100% |
| | **% of Column** | 37.5% | 58.6% | 74.8% | 76.0% | 67.7% |
| | **% of Table** | 5.6% | 7.6% | 24.0% | 30.6% | 67.7% |
| Total | **Count** | **325** | **285** | **706** | **885** | **2201** |
| | **% of Row** | 14.8% | 12.9% | 32.1% | 40.2% | 100% |
| | **% of Column** | 100% | 100% | 100% | 100% | 100% |
| | **% of Table** | 14.8% | 12.9% | 32.1% | 40.2% | 100% |

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To simplify the table, let s first pull out the percent of table values:

| Survival | | Class | | | | |
|---|---|---|---|---|---|---|
| | | First | Second | Third | Crew | Total |
| | **Alive** | 9.2% | 5.4% | 8.1% | 9.6% | 32.3% |
| | **Dead** | 5.6% | 7.6% | 24.0% | 30.6% | 67.7% |
| | Total | 14.8% | 12.9% | 32.1% | 40.2% | 100% |

These percentages tell us what percent of all passengers belong to each combination of column and row category. For example, we see that although 8.1% of the people aboard the Titanic were surviving third-class ticket holders, only 5.4% were surviving second-class ticket holders.

## Conditional Distribution

The more interesting questions are contingent. We'd like to know, for example, what percentage of second-class passengers survived and how that compares with the survival rate for third-class passengers.

It's more interesting to ask whether the chance of surviving the Titanic sinking depended on ticket class. We can look at this question in two ways. First, we could ask how the distribution of ticket Class changes between survivors and non-survivors. To do that, we look at the row percentages:

| Survival | | Class | | | | |
|---|---|---|---|---|---|---|
| | | First | Second | Third | Crew | Total |
| | **Alive** | 203<br>28.6% | 118<br>16.6% | 178<br>25.0% | 212<br>29.8% | 711<br>100% |
| | **Dead** | 122<br>8.2% | 167<br>11.2% | 528<br>35.4% | 673<br>45.2% | 1490<br>100% |

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By focusing on each row separately, we see the distribution of class under the condition of surviving or not. The sum of the percentages in each row is 100%, and we divide that up by ticket class. In effect, we temporarily restrict the Who first to survivors and make a pie chart for them. Then we refocus the Who on the non-survivors and make their pie chart. These pie charts show the distribution of ticket classes for each row of the table: survivors and non-survivors. The distributions we create this way are called conditional distributions, because they show the distribution of one variable for just those cases that satisfy a condition on another variable.

But we can also turn the question around. We can look at the distribution of Survival for each category of ticket Class. To do this, we look at the column percentages. Those show us whether the chance of surviving was roughly the same for each of the four classes. Now the percentages in each column add to 100%, because we've restricted the Who, in turn, to each of the four ticket classes:

| | | | Class | | | | |
|---|---|---|---|---|---|---|---|
| | | | First | Second | Third | Crew | Total |
| Survival | Alive | Count | 203 | 118 | 178 | 212 | 711 |
| | | % of Column | 62.5% | 41.4% | 25.2% | 24.0% | 32.3% |
| | Dead | Count | 122 | 167 | 528 | 673 | 1490 |
| | | % of Column | 37.5% | 58.6% | 74.8% | 76.0% | 67.7% |
| | Total | Count | 325 | 285 | 706 | 885 | 2201 |
| | | | 100% | 100% | 100% | 100% | 100% |

Looking at how the percentages change across each row, it sure looks like ticket class mattered in whether a passenger survived. To make it more vivid, we could show the distribution of Survival for each ticket class in a display. Here's a side-by-side bar chart showing percentages of surviving and not for each category:

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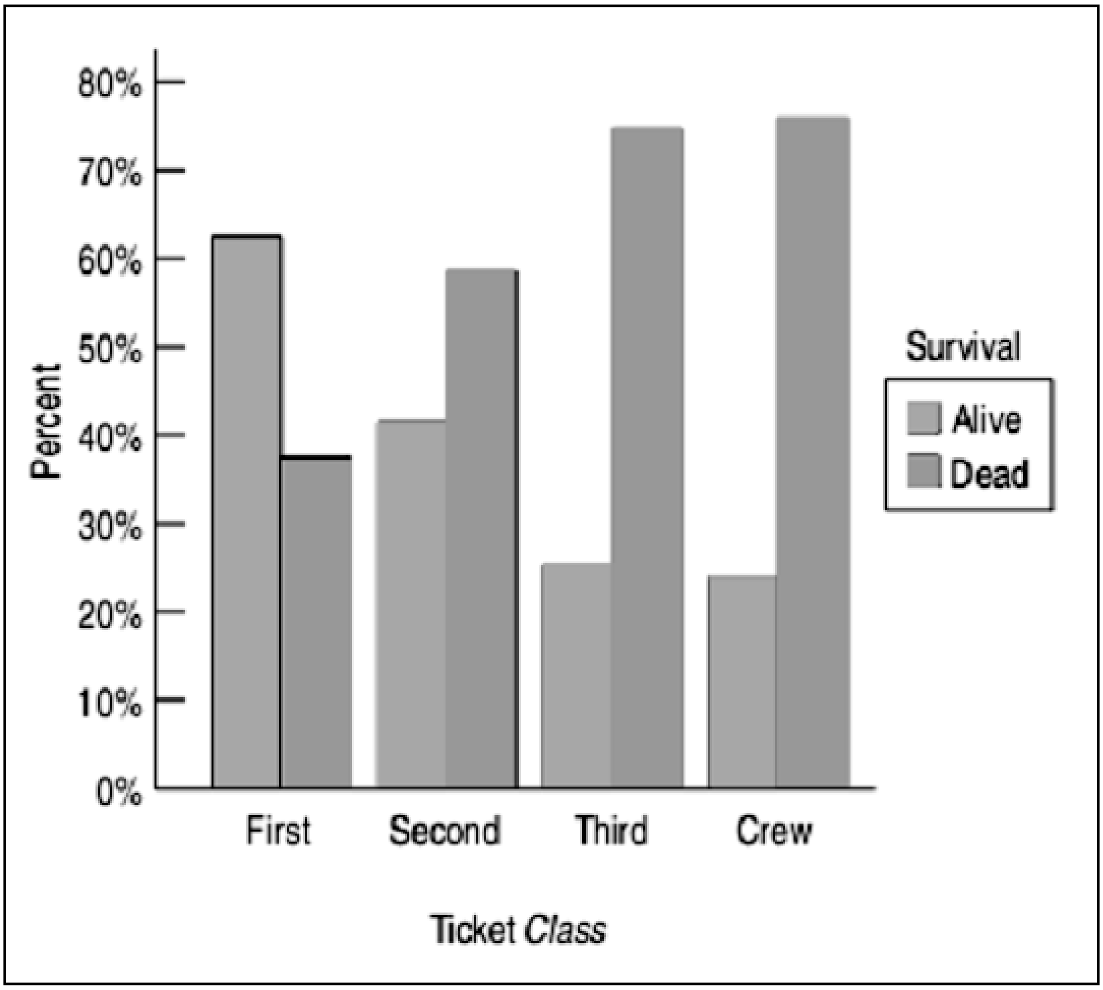


**Figure: Side-by-side bar chart showing the conditional distribution of Survival for each category of ticket Class. The corresponding pie charts would have only two categories in each of four pies, so, bar charts seem the better alternative.**

**Segmented Bar Charts:**

We could display the Titanic information by dividing up bars rather than circles. The resulting segmented bar chart treats each bar as the whole and divides it proportionally into segments corresponding to the percentage in each group. We can clearly see that the distributions of ticket Class are different, indicating again that survival was not independent of ticket Class.

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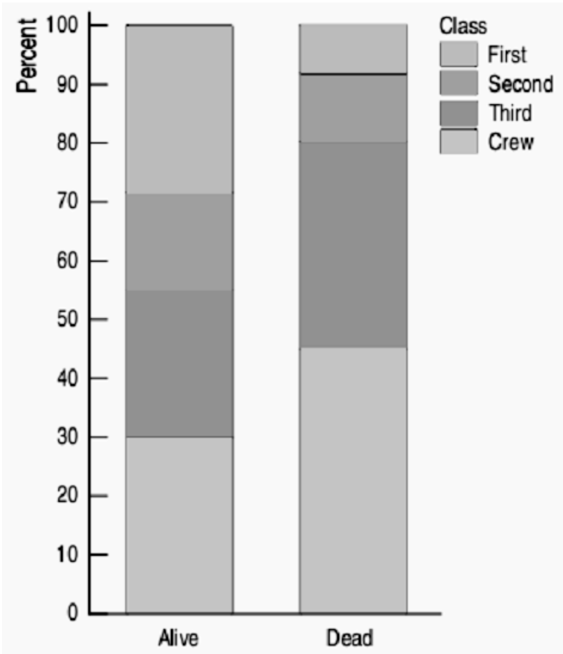


**FIGURE: A segmented bar chart for Class by Survival Notice that although the totals for survivors and non-survivors are quite different, the bars are the same height because we have converted the numbers to percentages.**

## 6.4 Pie Diagram

A pie chart is a circular graph which is used to represent the total value with its components. The area of a circle represents the total values and the different sectors of the circle represents the different component parts. The circle is divided into sectors by radii and the areas of the sectors are proportional to the angles at the centre.

In a pie chart the data are expressed as percentage. Each component is expressed as a percentage of the total value. 100% is represented by $360^0$ angles at the centre of the circle, and hence 1% is represented by $3.6^0$ angle. If P be the percentage of a certain component, the angle which represents the percentage of such component is ($3.6^0$ X P) degrees.

A pie chart is used to show comparison between different components, and between components and the total value. A pie chart is also known as a Circular Chart.

Example: Draw a pie chart to represent the following data on the proposed outlay during the Fourth Five Year Plan:

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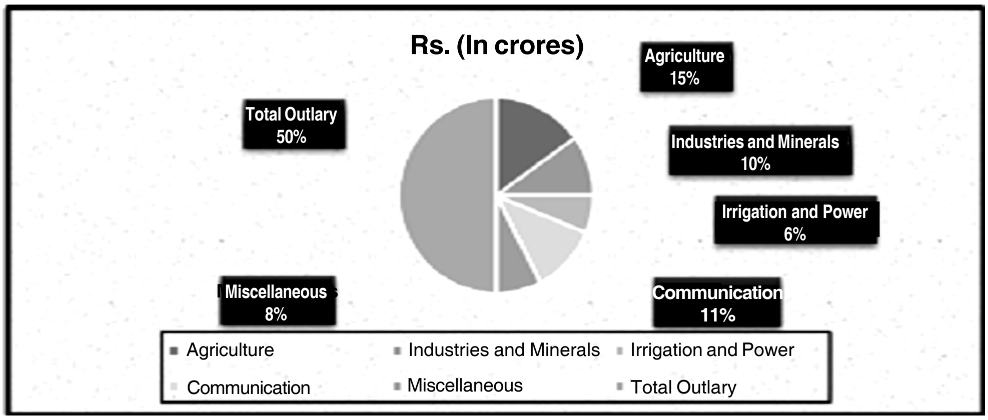
| Item | Rs. (In crores) |
|---|---|
| Agriculture | 6,000 |
| Industries and Minerals | 4,000 |
| Irrigation and Power | 2,500 |
| Communication | 4,500 |
| Miscellaneous | 3000 |
| Total Outlay | 20,000 |

**Solution:**

| Items | Amount (Rs. In Crores) | Percentage on Total (%) | Angle for each percentage (360°/100) | Angle for each item at the centre of the Pie chart |
|---|---|---|---|---|
| Agriculture | 6,000 | (6000 × 100)/ 20000 =30 | 3.6° | 30 × 3.6° = 108° |
| Industries and Minerals | 4,000 | (4000 × 100) /20,000 = 20 | 3.6° | 20 × 3.6° = 72° |
| Irrigation and Power | 2,500 | (2,500 × 100) /20,000 = 12.5 | 3.6° | 12.5 × 3.6° = 45° |
| Communication | 4,500 | (4,5000 × 100)/ 20,000 = 220 | 3.6° | 22.5 × 3.6° = 81° |
| Miscellaneous | 3000 | (3,000 × 100)/ 20,000 = 15 | 3.6° | 15 × 3.6° = 54° |
| Total Outlay | 20,000 | 100 | 3.6° | 360° |

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**NOTE:** Pie charts display all the cases as a circle whose slices have areas proportional to each category's fraction of the whole. Pie charts give a quick impression of the distribution. Because we're used to cutting up pies into 2, 4, or 8 pieces, pie charts are particularly good for seeing relative frequencies near 1>2, 1>4, or 1>8. Bar charts are almost always better than pie charts for comparing the relative frequencies of categories. Pie charts are widely understood and colourful, and they often appear in but the following figures show why statisticians prefer bar charts.

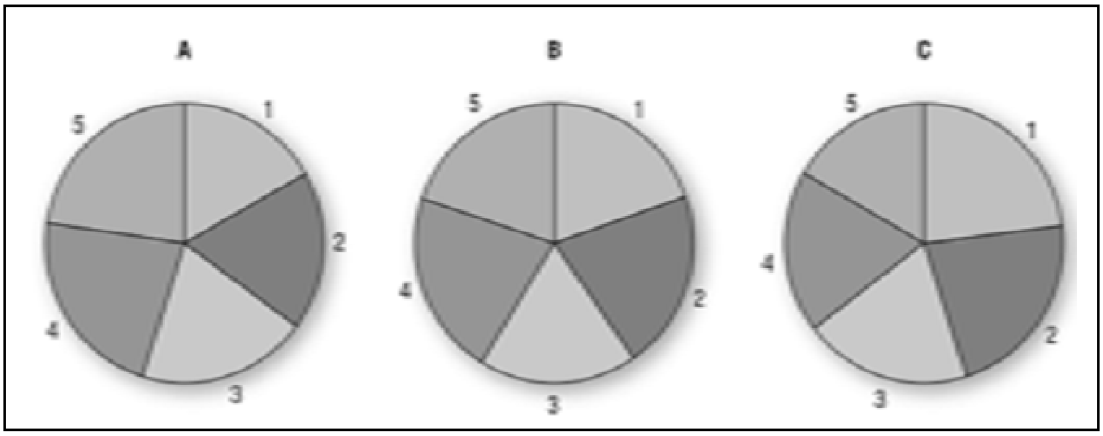


**Figure:** Pie charts may be attractive, but it can be hard to see patterns in them. Can you discern the differences in distributions depicted by these pie charts?

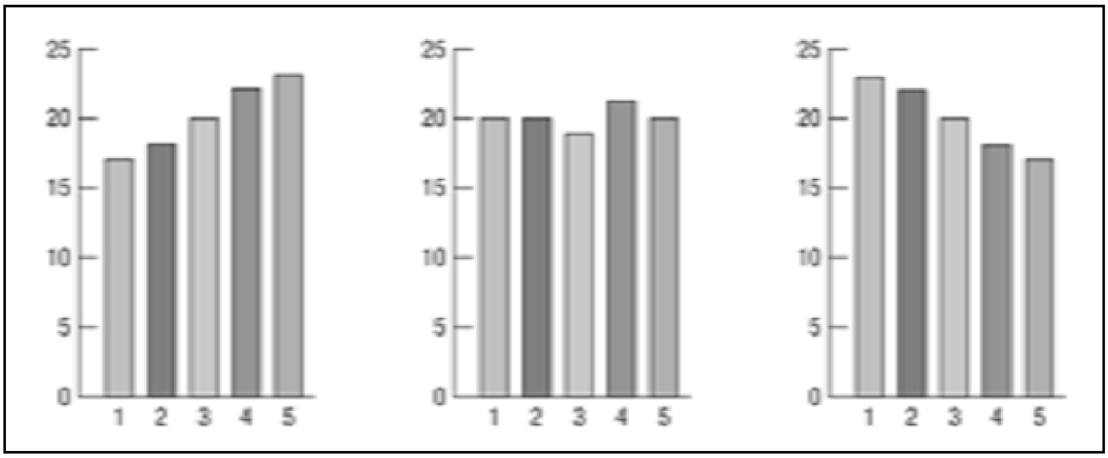


**Figure:** Bar charts of the same values as shown in figure above make it much easier to compare frequencies in groups.

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### 3. Displaying a Quantitative Variable

The production manager of the Dalmon Carpet Company is responsible for the output of over 500 carpet looms. So that he does not have to measure the daily output (in yards) of each loom, he samples the output from 30 looms each day and draws a conclusion as to the average carpet production of the entire 500 looms. The table below shows the yards produced by each of the 30 looms in yesterday's sample. These production amounts are the raw data from which the production manager can draw conclusions about the entire population of looms yesterday.

**16.2 15.4 16.0 16.6 15.9 15.8 16.0 16.8 16.9 16.8**

**15.7 16.4 15.2 15.8 15.9 16.1 15.6 15.9 15.6 16.0**

**16.4 15.8 15.7 16.2 15.6 15.9 16.3 16.3 16.0 16.3**

**ARRANGING DATA USING THE DATA ARRAY AND THE FREQUENCY DISTRIBUTION**

The data array is one of the simplest ways to present data. It arranges values in ascending or descending order. First table repeats the carpet data from our chapter-opening problem, and second table rearranges these numbers in a data array in ascending order.

| | | | | | |
|---|---|---|---|---|---|
| **16.2** | **15.8** | **15.8** | **15.8** | **16.3** | **15.6** |
| **15.7** | **16.0** | **16.2** | **16.1** | **16.8** | **16.0** |
| **16.4** | **15.2** | **15.9** | **15.9** | **15.9** | **16.8** |
| **15.4** | **15.7** | **15.9** | **16.0** | **16.3** | **16.0** |
| **16.4** | **16.6** | **15.6** | **15.6** | **16.9** | **16.3** |

**TABLE: SAMPLE OF DAILY PRODUCTION IN YARDS OF 30 CARPET LOOMS**

| | | | | | |
|---|---|---|---|---|---|
| **15.2** | **15.7** | **15.9** | **16.0** | **16.2** | **16.4** |
| **15.4** | **15.7** | **15.9** | **16.0** | **16.3** | **16.6** |
| **15.6** | **15.8** | **15.9** | **16.0** | **16.3** | **16.8** |
| **15.6** | **15.8** | **15.9** | **16.1** | **16.3** | **16.8** |
| **15.6** | **15.8** | **16.0** | **16.2** | **16.4** | **16.9** |

**TABLE: DATA ARRAY OF DAILY PRODUCTION IN YARDS OF 30 CARPET LOOMS**

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**Data arrays offer several advantages over raw data:**

1. We can quickly notice the lowest and highest values in the data. In our carpet example, the range is from 15.2 to 16.9 yards.
2. We can easily divide the data into sections. In the second table, the first 15 values (the lower half of the data) are between 15.2 and 16.0 yards, and the last 15 values (the upper half) are between 16.0 and 16.9 yards. Similarly, the lowest third of the values range from 15.2 to 15.8 yards, the middle third from 15.9 to 16.2 yards, and the upper third from 16.2 to 16.9 yards.
3. We can see whether any values appear more than once in the array. Equal values appear together. The second table shows that nine levels occurred more than once when the sample of 30 looms was taken.
4. We can observe the distance between succeeding values in the data. In the second table,16.6 and 16.8 are succeeding values. The distance between them is 0.2 yards (16.8–16.6).

In spite of these advantages, sometimes a data array isn't helpful. Because it lists every observation, it is a cumbersome form for displaying large quantities of data. We need to compress the information and still be able to use it for interpretation and decision making. How can we do this?

**A Better Way to Arrange Data: The Frequency Distribution**

One way we can compress data is to use a frequency table or a frequency distribution. A frequency distribution is a table that organizes data into classes, that is, into groups of values describing one characteristic of the data. A frequency distribution shows the number of observations from the data set that fall into each of the classes. If you can determine the frequency with which values occur in each class of a data set, you can construct a frequency distribution.

**CONSTRUCTING A FREQUENCY DISTRIBUTION:**

1. Decide on the type and number of classes for dividing the data. In this case, we have already chosen to classify the data by the quantitative measure of the number of yards produced rather than by a qualitative attribute such as colour or pattern. Next, we need to decide how many different classes to use and the range each class should cover. The range must be divided by equal classes; that is, the width of the interval from the beginning of one class to the beginning of the next class must be the same for every class. If we choose a width of 0.5 yard for each class in our distribution, the classes will be those shown in table below:

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**TABLE: DAILY PRODUCTION IN A SAMPLE OF 30 CARPET LOOMS WITH 0.5-YARDCLASS INTERVALS**

| Class in Yards | Frequency | Relative Frequency |
|---|---|---|
| 15.1–15.5 | 2 | 2/30 = 0.067 |
| 15.6–16.0 | 16 | 16/30 = 0.533 |
| 16.1–16.5 | 8 | 8/30 = 0.267 |
| 16.6–17.0 | 4 | 4/30 = 0.133 |
| Total | 30 | 1 |

**Note: A *relative frequency* distribution presents frequencies in terms of fractions or percentages.**

The number of classes depends on the number of data points and the range of the data collected. The more data points or the wider the range of the data, the more classes it takes to divide the data. Of course, if we have only 10 data points, it is senseless to have as many as 10 classes. As a rule, statisticians rarely use fewer than 6 or more than 15 classes.

Because we need to make the class intervals of equal size, the number of classes determines the width of each class. To find the intervals, we can use this equation:

| Width of class intervals = (Next unit value after largest value in data – Smallest value in data)/Total number of class intervals |
|---|

We must use the next value of the same units because we are measuring the interval between the first value of one class and the first value of the next class. In our carpet-loom study, the last value is 16.9, so 17.0 is the next value. We shall use six classes in this example, so the width of each class will be:

(Next unit value after largest value in data – Smallest value in data) ÷Total number of class intervals.

= (17.0 – 15.2)/6

= 1.8/6

= 0.3 yd ← 0. width of class intervals

Step 1 is now complete. We have decided to classify the data by the quantitative measure of how many yards of carpet were produced. We have chosen 6 classes to cover the range of 15.2 to 16.9 and, as a result, will use 0.3 yard as the width of our class intervals.

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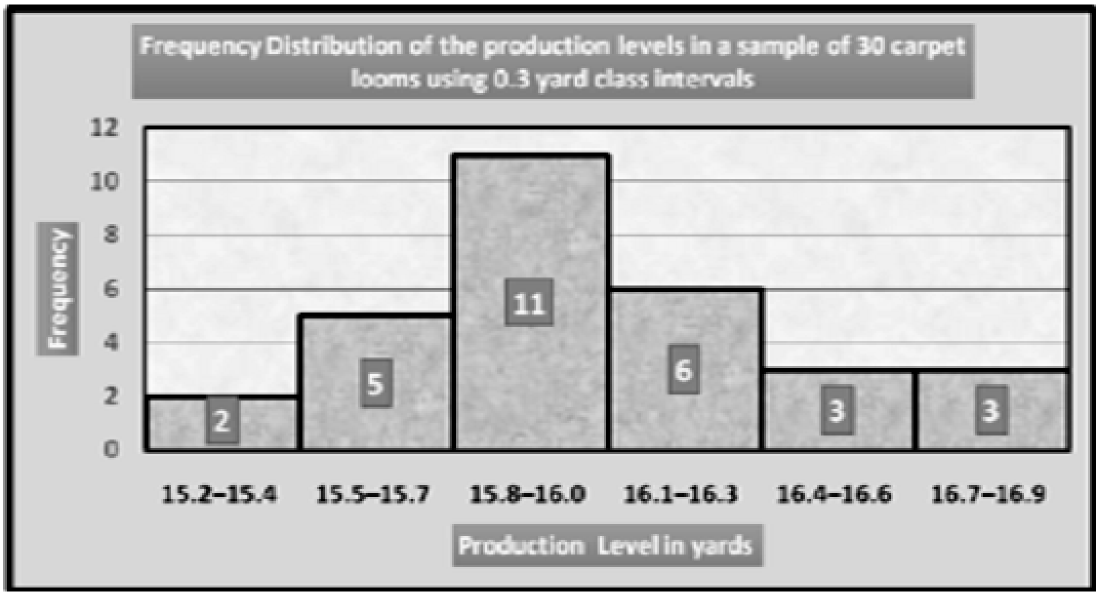
2. **Sort the data points into classes and count the number of points in each class.** This we have done in table below. Every data point fits into at least one class, and no data point fits into more than one class. Therefore, our classes are all-inclusive and mutually exclusive. Notice that the lower boundary of the first class corresponds with the smallest data point in our sample, and upper boundary of the last class corresponds with the largest data point.

3. **Illustrate the data in a chart.** These three steps enable us to arrange the data in both tabular and graphic form. In this case, our information is displayed in table and in figure below. These two frequency distributions omit some of the detail contained in the raw data of Table mentioned above, but they make it easier for us to notice patterns in the data. One obvious characteristic, for example, is that the class 15.8–16.0 contains the most elements; class 15.2–15.4, the fewest.

| Class | Frequency | Relative Frequency |
|---|---|---|
| 15.2–15.4 | 2 | 2/30 = 0.067 |
| 15.5–15.7 | 5 | 5/30 = 0.167 |
| 15.8–16.0 | 11 | 11/30 = 0.367 |
| 16.1–16.3 | 6 | 6/30 = 0.200 |
| 16.4–16.6 | 3 | 3/30 = 0.100 |
| 16.7–16.9 | 3 | 3/30 = 0.100 |
| | **30** | **1.000** |

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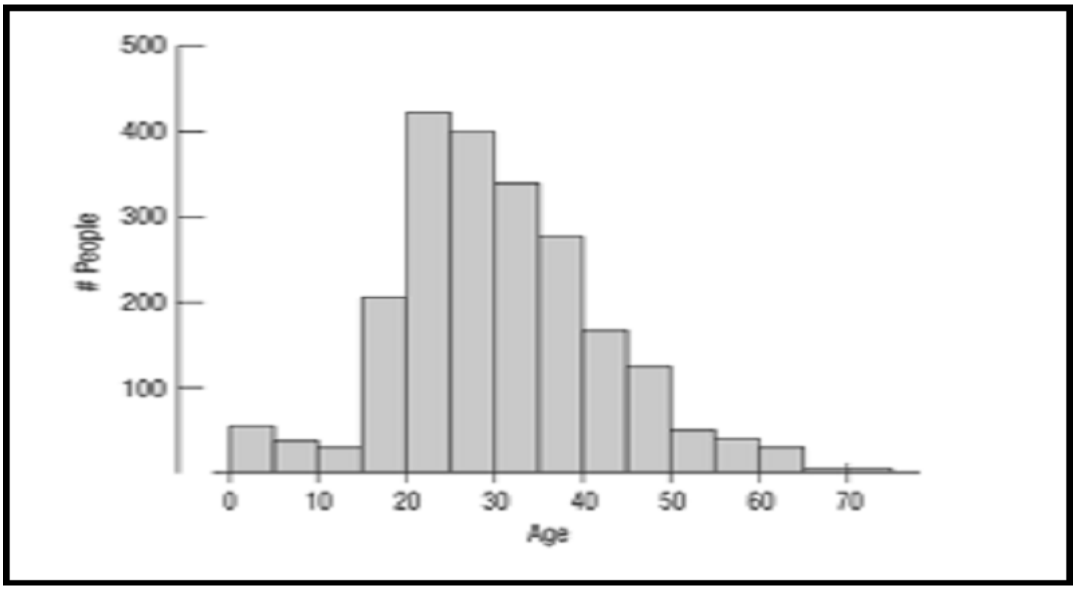
## 6.5 Histograms

How can we make a bar chart for a quantitative variable? We can't, because quantitative variables don't have categories. Instead, we make a histogram.

Histograms and bar charts both use bars, but they are fundamentally different. The bars of a bar chart display the count for each category, so they could be arranged in any order (and should be displayed with a space between them). The horizontal axis of a bar chart just names the categories. The horizontal axis of a histogram shows the values of the variable in order. A histogram slices up that axis into equal-width bins, and the bars show the counts for each bin. Now gaps are meaningful; they show regions with no observations.

Figure below shows a histogram of the ages of those aboard the Titanic. In this histogram, each bin has a width of 5 years, so, for example, the height of the tallest bar shows that the most populous age group was the 20- to 24-year-olds, with over 400 people. The youngest passengers were infants, and the oldest was more than 70 years old.




The fact that there are fewer and fewer people in the 5-year bins from age 25 on probably doesn't surprise you either. After all, there are increasingly fewer people of advancing age in the general population as well, and there were no very elderly people on board the Titanic. But the bins on the left are a little strange. It looks like there were more infants and toddlers (0–5 years old) than there were preteens.

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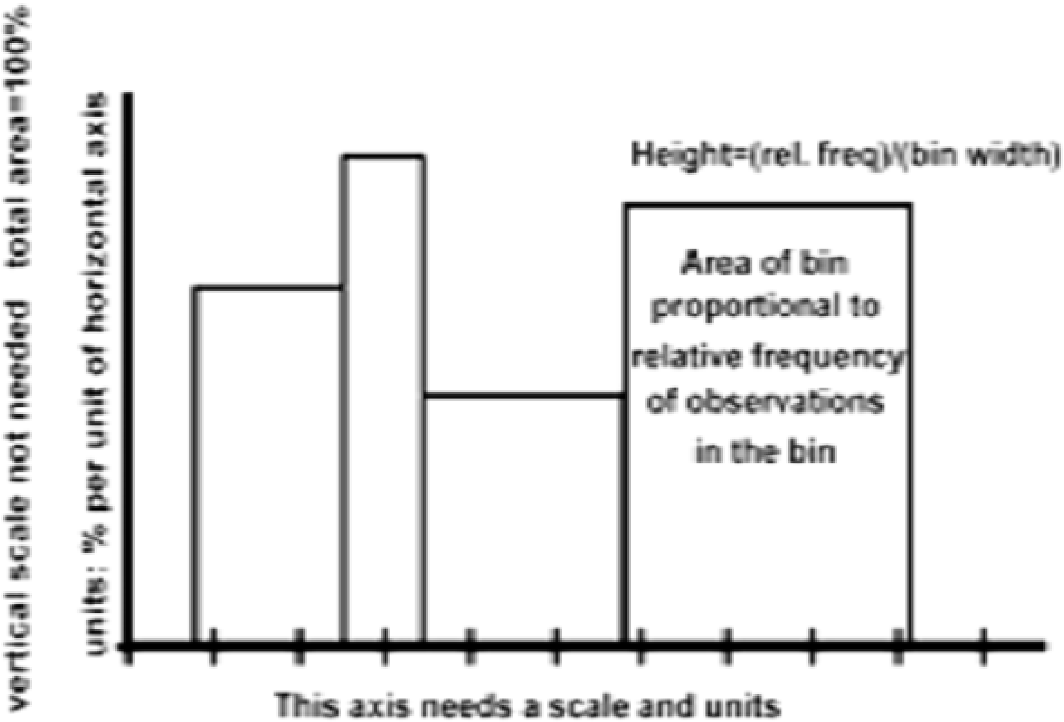
The frequency table is easier to interpret than the raw data, but it is still hard to get an overall impression of the data from it. The histogram is an excellent tool for studying the distribution of a list of quantitative measurements. A histogram is a way of visualizing a frequency table graphically—of making a picture from a frequency table. The fraction of data in each class interval is represented by a rectangle (bin) whose base is the class interval and whose area is the fraction of data (relative frequency of data) that fall in the class interval:

$$\text{area of bin} = \text{fraction of data in class interval} = \frac{\text{\#observations in the class intervel}}{\text{total number of observations}}$$

so that

$$\text{height of the bin} = \frac{\text{fraction of data in the class interval}}{\text{width of class interval}}$$




The key to a histogram is that it is the area of the bin, not the height of the bin, that represents the relative frequency of data in the bin. The area of the bin is proportional to the relative frequency of observations in the class interval. The horizontal axis of a

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histogram needs a scale with units. The vertical axis of a histogram always has units of percent per unit of the horizontal axis, so that the areas of bins have units of (horizontal units) × (percent per horizontal unit) = percent.

The scale of the vertical axis is automatically imposed by the fact that the total area of the histogram must be 100% (100% of the data fall somewhere on the plot). The vertical scale is called a density scale. The height of a bin is the density of observations in the bin: the percentage of observations in the bin per unit of the horizontal axis. Typically, it is not the percentage of observations in the bin.

A histogram is not the same as a bar chart: In a bar chart, the height of a rectangle (bar), rather than the area of the bar, indicates the relative frequency of observations. The width of the bar does not matter; it does not even need to have units. This makes bar charts especially useful for displaying categorical and qualitative data, where the horizontal axis does not have a scale—it is just a way to separate groups. Histograms are more appropriate for quantitative data.

• **Example:A distribution table**

Annual incomes of U.S. adults in 2010

| Income (Thousands of dollars) | Percent |
|---|---|
| 0 – 10 | 20 |
| 10 – 25 | 28 |
| 25 – 50 | 27 |
| 50 – 100 | 18 |
| 100 – 150 | 7 |

Where are the people who earned exactly $25; 000: in 10-25 or 25-50?

**Endpoint convention:** Intervals include the left end-point but not the right.

• Total percent = 100%

• Did nobody make $150,000 or more?

Yes, but they are such a small percent that they have been \swept in" just below $150,000.

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• **Something like a bar graph?**

• Want to draw a diagram analogous to a bar graph, to show how the incomes are distributed.

• Want income on the horizontal axis, and vertical rectangular bars.

Can't simply use the precents as the heights of the bars, because *the widths of the bars are unequal.*

- **Area = percent**
- **How tall should the bars be?**
- **20% of the people are in the 0-to-10-thousand-dollar interval.**
- **Main idea: area of the bar = percent in the interval**
- **area of bar over the 0–10-thousand-dollar interval = 20%**

  **= height of bar × width of bar**

  **= height × 10 thousand dollars**
- **height of bar × 10 thousand dollars = 20%**
- **height of bar = 20% / (10 thousand dollars 20%)**

  **= 2% per thousand dollars**

**Formula for height:**

height of bar = % in interval/width of interval

= % in interval/ (right endpoint – left endpoint)

**The distribution table, along with the heights of the bars**

| **income (thousands of dollars)** | **height (% per thousand dollars)** | **percent** |
|---|---|---|
| 0 – 10 | 20 | 20/10 = 2:00 |
| 10 – 25 | 28 | 28/15 = 1:87 |
| 25 – 50 | 27 | 27/25 = 1:08 |
| 50 – 100 | 18 | 18/50 = 0:36 |
| 100 – 150 | 7 | 7/50 = 0:14 |

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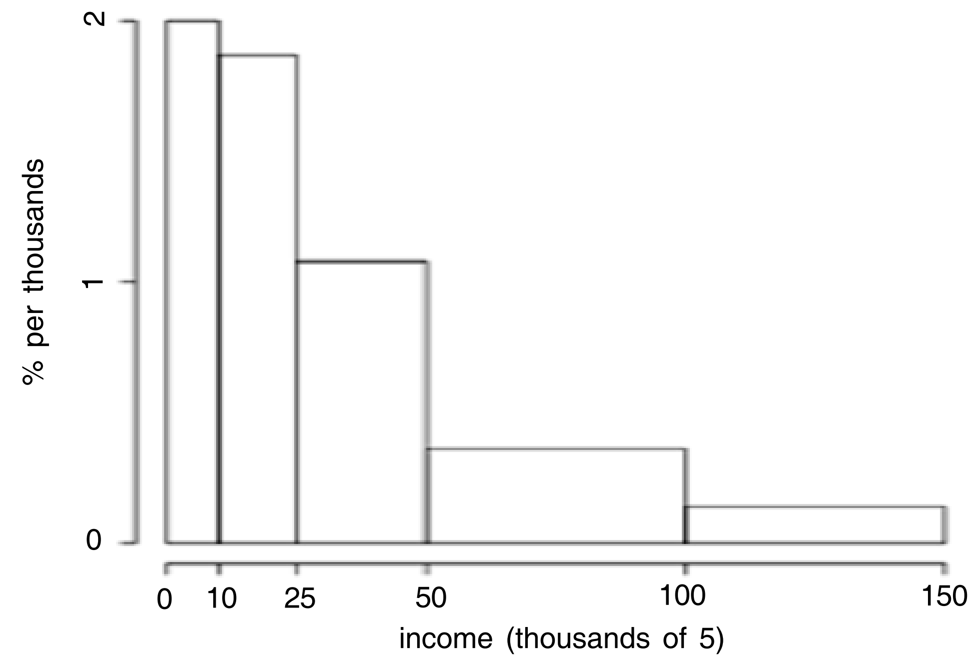
**A histogram**




**What do the heights measure?**

• The 10-25 bar has more people than the 0-10 bar (28% versus 20%). Its area is greater.

• But it is shorter than the 0-10 bar. So, heights do not measure \percent of people." Areas measure that.

• Heights measure \percent of people per unit on the horizontal axis". That's density, or crowdedness in the interval.

The 10-25 bar has more people than the 0-10 bar, but it is less crowded.

## Height and crowdedness

units: percent per thousand dollars

| **Income (thousands of dollars)** | **percent** | **(% per thousand dollars)** |
|---|---|---|
| 0 – 10 | 20 | 20 = 10 = 2:00 |
| 10 – 25 | 28 | 28 = 15 = 1:87 |

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Assuming that the people are uniformly distributed within the bars,

- about 2% have incomes in the range \$5,000 to \$6,000
- about 4% have incomes in the range \$5,000 to \$7,000
- about 1.87% have incomes in the range \$14,000 to \$15,000

Under the assumption of uniformity within bars, % In a subinterval = height of bar × width of subinterval

**Histogram: summary**

A histogram shows how a quantitative variable is distributed over all its values.

- Allows for the variable to be \binned" into unequal intervals
- Horizontal axis must be drawn to scale
- Areas represent precents

  height = %/width
- Units of height: % per unit on the horizontal axis

**Time Plots: Displaying Data over Time**

For some variables, observations occur over time. Examples include the daily closing price of a stock and the population of a country measured every decade in a census. A data set collected over time is called a time series.

We can display time-series data graphically using a time plot. This charts each observation, on the vertical scale, against the time it was measured, on the horizontal scale. A common pattern to look for is a trend over time, indicating a tendency of the data to either rise or fall. To see a trend more clearly, it is beneficial to connect the data points in their time sequence.

**Example:** Is whooping cough close to being eradicated? In the first half of the 20th century, whooping cough was a frequently occurring bacterial infection that often resulted in death, especially among young children. A vaccination for whooping cough was developed in the 1940s. How effective has the vaccination been in eradicating whooping cough? One measure to consider is the incidence rate (number of infected individuals per 100,000 population) in the United States. The table shows incidence rates from 1925–1970.

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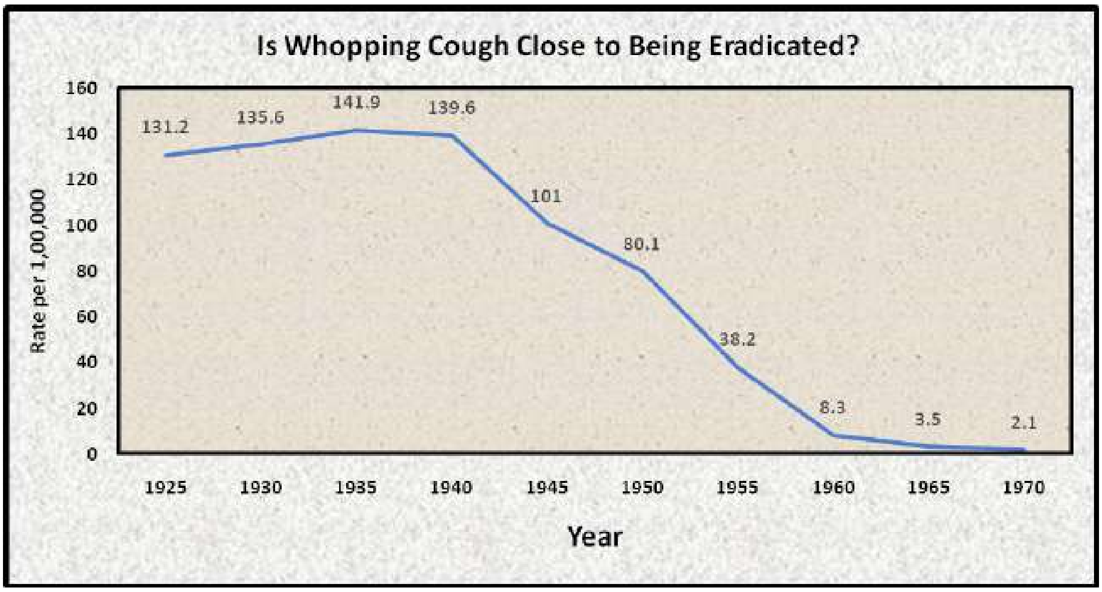
| Incidence Rates for Whopping Cough, 1925-1970 | |
|---|---|
| Year | Rate per 1,00,000 |
| 1925 | 131.2 |
| 1930 | 135.6 |
| 1935 | 141.9 |
| 1940 | 139.6 |
| 1945 | 101 |
| 1950 | 80.1 |
| 1955 | 38.2 |
| 1960 | 8.3 |
| 1965 | 3.5 |
| 1970 | 2.1 |

Sketch a time plot. What type of trend do you observe? Based on the trend from 1945–1970, was the whooping cough vaccination proving effective in reducing the incidence of whooping cough?

One can see in the time plot below that after an initial slight increase, there was a sharp and steady decrease in incidence of whopping cough starting around 1940. The decrease levelled off starting around 1960. These data suggest that the whopping cough vaccination was proving effective in reducing the incidence of whopping cough.



High Performance Bicycle Products Company in Chapel Hill, North Carolina, sampled its shipping records for a certain day with these results:

| Time from Receipt of Order to Delivery (in Days) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 12 | 8 | 14 | 11 | 6 | 7 | 13 | 13 | 11 |
| 11 | 20 | 5 | 19 | 10 | 15 | 24 | 7 | 19 | 6 |

Construct a frequency distribution for these data and a relative frequency distribution. Use intervals of 6 days.

(a) What statement can you make about the effectiveness of order processing from the frequency distribution?

(b) If the company wants to ensure that half of its deliveries are made in 10 or fewer days, can you determine from the frequency distribution whether they have reached this goal?

(c) What does have a relative frequency distribution permit you to do with the data that is difficult to do with only a frequency distribution?

| Class | 1–6 | 7–12 | 13–18 | 19–24 | 25–30 |
|---|---|---|---|---|---|
| Frequency | 4 | 8 | 4 | 3 | 1 |
| Relative Frequency | 0.2 | 0.4 | 0.2 | 0.15 | 0.05 |

(a) Assuming that the shop is open 6 days a week, we see that fully 80 percent of the orders are filled in 3 weeks or less.

(b) We can tell only that between 20 percent and 60 percent of the deliveries are made in 10 or fewer days, so the distribution does not generate enough information to determine whether the goal has been met.

(c) A relative frequency distribution lets us present frequencies as fractions or percentages.

A relative frequency distribution presents frequencies in terms of fractions or percentages.

## 6.6 Conclusion

This our learners got an idea about the various statistical representatives.

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## 6.8 Exercise

1. Outlet is Bar diagram.
2. What is Histograms.
3. What is Pie chart.

## 6.8 References

I. Statistics: David Freedman, Robert Pisani, Roger Purves, Fourth Edition, 2007, W • W • NORTON & COMPANY
II. Intro Stats: Richard D. De Veaux, Paul F. Velleman, David E. Bock
III. Introductory Statistics: Sheldon M. Ross,Elsevier,Fourth Edition, 2017
IV. Statistics: A Tool of Social Research, Joseph F. Healey, Wadsworth, Cengage Learning, Ninth Edition

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# Unit 7 ❑ Measures of central tendencies and dispersion

***Structure***

**7.0 Objective**

**7.1 Introduction**

**7.2 Measures of central tendencies and dispersion**

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## 7.0 Objective

In this unit will learn about measures of central tendencies and dispersion which will include knowledge about mean median mode

## 7.1 Introduction

In this module, we are going to discuss the centrality and spread of data. As you could imagine, very new set of data is filled with mystery. You have no idea what it contains. Will it tell us something odd, something interesting, or will it just confirm something we already knew? So when given a new set of data, where should we get started? How can we begin to feel comfortable with our new data set? Again, let's remember our data set is a collection of values. Some might be big, some might be small and individually these values are likely too much to handle, but we're hoping together all of these values will tell us a story. So what might be a good beginning to this story? Oddly enough for many, they like to start their story in the middle. With so many data points, wouldn't it be nice to know the center of the data? It makes sense. Knowing the center of the data would seem to give us some balance. The bigger question is what do we mean by the center of the data?

Again, let's take a look at these two small data sets. Both may have the same average, both have the same median values. Still, it might be that the data sets are vastly different. These data sets are small so we can quickly view all of the data and see the differences. What happens when the data sets are enormous? How can we measure the differences in data sets that might have very similar medians and means? Better yet, how can we get a better idea of what kind of data makes up this data set? When we measured mean and median, we were looking for the middle. Let's now measure how far out from the means and averages the farthest data points lie.

Summarizing data can help us understand them, especially when the number of data is large. This chapter presents several ways to summarize quantitative data by a typical value (a measure of location, such as the mean, median, or mode) and a measure of how well the typical value represents the list (a measure of spread, such as the range, inter-quartile range, or standard deviation).

## 7.2 Measures of Central Tendency :

The farthest one can reduce a set of data, and still retain any information at all, is to summarize the data with a single value. Measures of location do just that: They try to capture with a single number what is typical of the data. What single number is most representative of an entire list of numbers? We cannot say without defining "representative" more precisely. We will study three common measures of location: the mean, the median, and the mode. The mean, median and mode are all "most representative," but for different, related notions of representativeness.

**Mean**

**The best-known and most frequently used measure of the center of a distribution of a quantitative variable is the mean. It is found by averaging the observations.**

Another popular measure is the median. Half the observations are smaller than it, and half are larger.

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**Median**

**The median is the middle value of the observations when the observations are ordered from the smallest to the largest (or from the largest to the smallest).**

**Example1 :** The sodium levelin 20 breakfast cereals and saw various ways to graph the data. Let's returnto those data and learn how to describe their center. The observations(in mg) are :

0, 340, 70, 140, 200, 180, 210, 150, 100, 130

140, 180, 190, 160, 290, 50, 220, 180, 200, 210

a. Find the mean.

b. Find the median.

**Solution :**

a. we find the mean by adding all the observations and then dividing this sum by the number of observations, which is 20 :

Mean = (0 + 340 + 70 + . . . + 210)/20 =3340/20 =167.

b. To find the median, we arrange the data from the smallest to the largest observation.

0, 50, 70, 100, 130, 140, 140, 150, 160, 180

180, 180, 190, 200, 200, 210, 210, 220, 290, 340

For the 20 observations, the smaller 10 (on the first line) range from 0 to 180, and the larger 10 (on the second line) range from 180 to 340. The median is 180, which is the average of the two middle values, the tenth and eleventh observations, (180 + 180)/2.

**Note :** The mean and median take different values. Why? The median measures the center by dividing the data into two equal parts, regardless of the actual numerical values above that point or below that point. The mean takes into account the actual numerical values of all the observations.

**Problem 1:** The Energy Information Agencyreported the CO2 emissions from fossil fuel combustionfor the seven countries in 2008 with the highest emissions.These values, reported as million metric tons of carbonequivalent, are 6534 (China), 5833 (United States), 1729(Russia), 1495 (India), 1214 (Japan), 829 (Germany), and574 (Canada).

a. Find the mean and median.

b. The totals reported here do not take into account anation's population size. Explain why it may be moresensible to analyze per capita values.

**Problem 2 :** A list has 10 entries. Each entry is either 1 or 2 or 3. What must the list be if theaverage is 1? If the average is 3? Can the average be 4?

**Problem 3 :** Ten people in a room have an average height of 5 feet 6 inches. An 11th person, who is 6 feet 5 inches tall, enters the room. Find the average height of all 11 people.

**Problem 4 :** Twenty-one people in a room have an average height of 5 feet 6 inches. A 22nd person, who is 6 feet 5 inches tall, enters the room. Find the average height of all 22 people. Compare with exercise 3.

**Problem 5 :**Twenty-one people in a room have an average height of 5 feet 6 inches. A $22^{nd}$ person enters the room. How tall would he have to be to raise the average heightby 1 inch?

| ONE STEP AT A TIME | Finding the Median | | |
|---|---|---|---|
| ***Step*** | ***Operation*** | | |
| 1. | Array the scores in order from high score to low score. | | |
| 2. | Count the number of scores to determine whether *N* is odd or even. | | |
| | **IF *N* is ODD** ⇓ | | **IF *N* is EVEN** ⇓ |
| 3. | The median will be the score of the middle case. | 3. | The median is halfway between the scores of the two middle cases. |
| 4. | To find the middle case, add 1 to *N* and divide by 2. | 4. | To find the first middle case, divide *N* by 2. |
| 5. | The value you calculated in step 4 is the number of the middle case. the median is the score of this case. For example, if *N* = 13, the median will be the score of the (13 + 1)/2, or seventh, case. | 5. | To find the second middle case, increse the value you computed in step 4 by 1. |
| | | 6. | Add the scores of the two middle cases together and divide by 2. The result is the median. For example, If *N* = 14, the median is the score halfway between the scores of the seventh and eighth cases. If the middle cases have the same score, that score is defined as the median. |

- **Mathematical formulation of Average :**

Variables are symbolized by letters near the end of the alphabet, most commonly x and y. The sample size is denoted by n. For a sample of n observations on a variable x, the mean is denoted by $\overline{x}$. Using the mathematical symbol Σ for "sum," the mean has the formula :

$$\overline{x} = \Sigma x / n$$

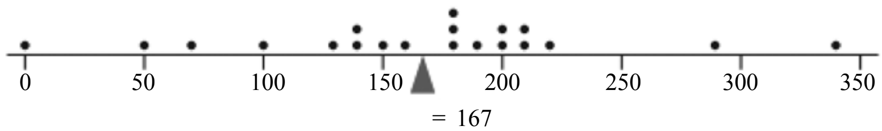
For instance, the cereal data set (in example 1) hasn = 20 observations.

$$x = \Sigma x/n = (0 + 340 + 70 + . . . + 210)/20 = 3340/20 = 167.$$

Some basic properties of the mean :

- The mean is the balance point of the data: If we were to place identical weights on a line representing where the observations occur, then the line would balance by placing afulcrum at the mean.
- For a skewed distribution, the mean is pulled in the direction of the longer tail, relative to the median.
- The mean can be highly influenced by anoutlier, which is an unusually small

**The Fulcrum Shows the Mean of the Central Sodium Data**




**Note :** An **outlier** is an observation that falls well above or well below the overall bulk of the data. Outliers typically call for further investigation to see, for example, whetherthey resulted from an error in data entry or from some surprising or unusual occurrence.

**Example 2 :** Consider the following threesets of observations :

Set 1 : 8, 9, 10, 11, 12

Set 2 : 8, 9, 10, 11, 100

Set 3 : 8, 9, 10, 11, 1000

a. Find the median for each data set.

b. Find the mean for each data set.

c. What do these data sets illustrate about the resistanceof the median and mean?

**Solution :**

a. The median for all three data sets is ten. The values for all three sets of observation are already arranged in numerical order, and the middle number for each is 10.

b. WE know, $\bar{x}$ x / n.

Thus, set 1 : $\bar{x}$ = (8+9+10+11+12)/5 = 10.

set 2 : $\bar{x}$ = (8+9+10+11+100)/5 = 27.6

set 3 : $\bar{x}$ = (8+9+10+11+1000)/5 = 207.6

c. As the highest values become more and more of an extreme outlier, the median is unaffected, whereas the mean gets higher and higher as the data become more skewed.

**Problem 6 :** The International Energy Agency5 reported the per capita CO2 emissions by country (that is, the total CO2 emissions for the country divided by the population size of that country) for 2007. For the eight largest countries in population size (which make up more than half the world's population), the values were, in metric tons per person :

China 4.9

Brazil 1.9

India 1.4

Pakistan 0.9

United States 18.9

Russia 10.8

Indonesia 1.8

Bangladesh 0.3

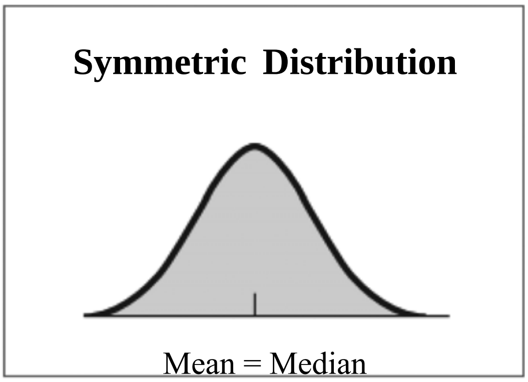
a. For these eight values, the mean is 5.1. What is the median?
b. Is any observation a potential outlier? Discuss its impact on how themean compares to the median.
c. Using this data set, explain the effect an outlier can have on the mean.

**Comparing mean and median**

The shape of a distribution influences whether the mean is larger or smallerthan the median. For instance, an extremely large value out in the right-hand tailpulls the mean to the right. The mean then usually falls above the median.

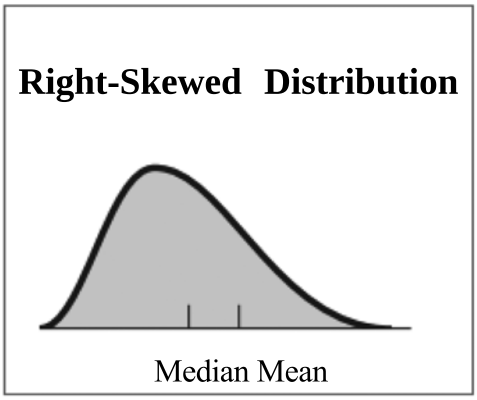
Generally, if the shape is

- Perfectly symmetric, the mean equals the median.



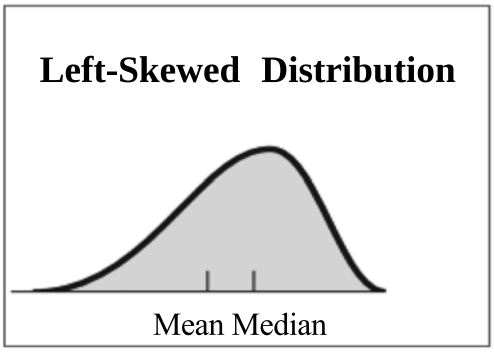

When a distribution is close to symmetric, the tails will be of similar length, and therefore the median and mean are similar.

- Skewed to the right, the mean is larger than the median.




In a Positively Skewed Distribution, the mean is greater in value than the median.

- Skewed to the left, the mean is smaller than the median.




In a Negatively Skewed Distribution, the mean is less than the median.

**Note :**

- For skewed distributions, the mean lies toward the direction of skew (the longer tail) relative to the median. This is because extreme observations in a tail affect the balance point for the distribution, which is the mean.
- The more highly skewed the distribution, the more the mean and median tend to differ.
- Median is not affected by an outlier. How far an outlier falls from themiddle of the distribution does not influence the median. The median is determined solely by having an equal number of observations above itand below it.
- Unlike the median, mean depends on how far observations fall from the middle. Because the mean is the balance point, an extreme value on the right side pulls the mean toward the right tail. Because the median is not affected, it is said to be **resistant** to the effect of extreme observations.
- **Resistant-**A numerical summary of the observations is called **resistant** if extreme observations have little, if any, influence on its value.The median is resistant. The mean is not.

You might think that it would always be advisable to use median (and not mean) in order to know the centrality of a typical distribution. However, that is not the case. Mean has some very useful properties and the use of it become more apparent in the modules to follow. Moreover, there are certain advantages of having a measure that involve all the numerical values in a dataset. Forinstance, for discrete data that take only a few values, quite different patterns ofdata can give the same result for the median. It is then too resistant.

**Example 3 :** The table summarizes responses of 4383 subjects in a recent General Social Survey to the question, "Within the past month, how many people have you known personally that were victims of homicide?"

Number of People You Have Known
Who Were Victims of Homicide

| No. of Victims | Frequency |
|---|---|
| 0 | 3944 |
| 1 | 279 |
| 2 | 97 |
| 3 | 40 |
| 4 or more | 23 |
| Total | 4383 |

a. To find the mean, it is necessary to give a score tothe “4 or more” category. Find it, using the score 4.5.(In practice, you might try a few different scores, suchas 4, 4.5, 5, 6, to make sure the resulting mean is nothighly sensitive to that choice.)

b. Find the median. Note that the “4 or more” category isnot problematic for it.

c. If 1744 observations shift from 0 to 4 or more, how dothe mean and median change?

d. Why is the median the same for parts b and c, eventhough the data are so different?

**Solution :**

a. The mean is 0.16.

(0*3944+1*279+2*97+3*40+4.5*23)/4383 = 0.16. [The mean is not necessarily a possible valuefor a discrete variable.]

b. The median is the middle score. With 4383 scores, the median is the score in the $2192^{nd}$ position. Thus the median is zero.

c. The median would still be zero, because there are still 2200 people who gave zero as a response. The mean would now be 1.95.

(0*2200 + 1*279 + 2*40 + 3*40 + 4.5*1767)/4383 = 1.95

d. The median is same for the both because median ignores much of the data. The data are highly discrete; hence, a high proportion of the data falls at only one or two values. The mean is better in this case because it uses the numerical values of all of the observations, not just the ordering.

**Note :** The median ignores too much information when the data are highly discrete—that is, when the data take only a few values. An extreme case occurs for **binary data**, which take only two values, 0 and 1. The median equals the more common outcome but gives no information about the relative number of observations at the two levels.

**Illustration :** For instance, consider a sample of size 5 for the variable, number of times married. The observations (1, 1, 1, 1, 1) and the observations (0, 0, 1, 1, 1) both have a median of 1. The mean is 1 for (1, 1, 1, 1, 1) and 3/5 for (0, 0, 1, 1, 1). When observations take values of only 0 or 1, the mean equals the proportion of observations that equal 1. It is much more informative than the median. When the data are highly discrete but have more than two categories, it is more informative to report the proportions (or percentages) for the possible outcomes than to report the median or the mean.

**Problem 7 :** One variable in a study measures how many serious motor vehicle accidents a subject has had in the past year. Explain why the mean would likely be more useful than the median for summarizing the responses of the 60 subjects.

**A Rough Rule of Using Mean and Median :**

- If a distribution is highly skewed, the median is usually preferred over the mean because it better represents what is typical.
- If the distribution is close to symmetric or only mildly skewed, or if it is discrete with few distinct values, the mean is usually preferred because it uses the numerical values of all the observations.

**The Mode :** In statistical language the mode in an ungrouped data is defined as the value corresponding to a peak when the observations are arranged according to their order of magnitudes and in a grouped data it is defined as the value corresponding to a maximum frequency.Thus,the mode of any distribution of scores is the value that occurs most frequently. For example, in the set of scores 58, 82, 82, 90, 98, the mode is 82 because it occurs twice and the other scores occur only once.The concept of themode is most often used to describe the category of a categorical variable thathas the highest frequency (the modal category). With quantitative variables, themode is most useful with discrete variables taking a small number of possiblevalues.The mode is a simple statistic, most useful when you are interested in themost common score and when you are working with nominal-level variables. Infact, the mode is the only measure of central tendency for nominal-level variables.The mode need not be near the center ofthe distribution. It may be the largest or thesmallest value.

Here are some properties of the mode :

- The mode is appropriate for all types of data. For example, we might measure the mode for religion in Australia (nominal scale), for the grade given by a teacher (ordinal scale), or for the number of years of education completed by Hispanic Americans (interval scale).
- A frequency distribution is called bimodal if two distinct mounds occur in the distribution. Bimodal distributions often occur with attitudinal variables when

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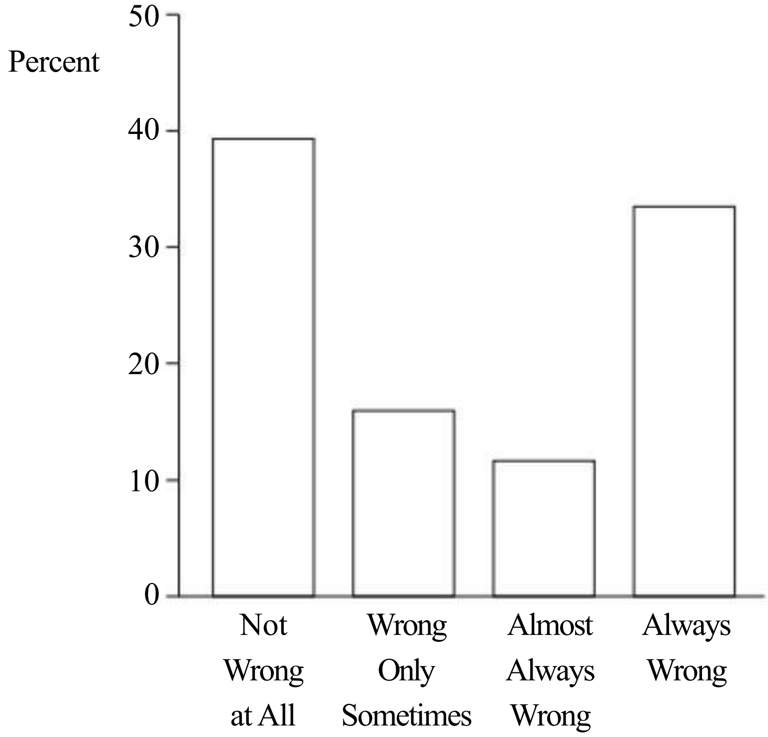
populations are polarized, with responses tending to be strongly in one direction or another. For instance, figure below shows the relative frequency distribution of responses in a General Social Survey to the question "Do you personally think it is wrong or not wrong for a woman to have an abortion if the family has a very low income and cannot afford any more children?" The frequencies in the two extreme categories are much higher than those in the middle categories.




- The mean, median, and mode are identical for a unimodal, symmetric distribution, such as a bell-shaped distribution.

The mean, median, and mode are complementary measures. They describe different aspects of the data. In any particular example, some or all their values maybe useful. Be on the lookout for misleading statistical analyses, such as using onestatistic when another would be more informative. People who present statisticalconclusions often choose the statistic giving the impression they wish to convey.

**Example 4.** Obtain the mode, if it exists, for the followingdata (a) l, 2, 2, 7; (b) 4, 5, 6; (c) -1, 0, 0, 2, 4, 5, 6, 8; (d) 2, 7, 7,8, 9, 10, 10, 10, 11, 12.

**Solution :**

(a) Since 2 is the most frequently occurring item themode is 2.

(b) Since 4, 5, and 6 occur with frequency one eachthere is no mode.

(c) Here 0 occurs with frequency 2 and hencethe mode is zero.

(d) Here 7 occurs with frequency 2 and 10 occurswith frequency 3 and others occur with frequency one. If these arerepresented by a histogram then there will be two peak pointscorresponding to the frequencies 2 and 3. Hence there are twomodes, namely, 7 and 10. This can be called a bimodal data.

You should note that the mode has several limitations.

**First,** distributionscan have no mode at all (when all scores have the same frequency) or so manymodes that the statistic becomes meaningless.

**Second,** the modal score of ordinal or interval-ratio variables may not becentral to the distribution as a whole. That is, most common does not necessarily identify the center of the distribution.

## Choosing a Measure of Central Tendencey

| | | |
|---|---|---|
| Use the mode when : | **1** | The variable is measured at the nominal level. |
| | **2** | You want a quick and easy measure for ordinal and interval-ratio variables. |
| | **3** | You want to report the most common score. |
| Use the median when : | **1** | The variable is measured at the ordinal level. |
| | **2** | An interval-ratio variable is badly skewed. |
| | **3** | You want to report the central score. The median always lies at the exact center of the distribution. |
| Use the mean when : | **1** | The variable is measured at the interval-ratio level (except when the variable is badly skewed). |
| | **2** | You want to report the typical score. The mean is the "fulcrum that exactly balances all of the scores." |
| | **3** | You anticipate additional statistical analysis. |

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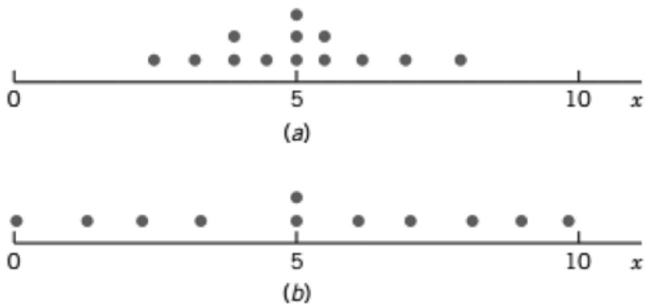
## 7.3 Measures of Dispersions :

A measure of the center is not enough to adequately describe a distribution for aquantitative variable. Besides locating the center of the data, any descriptive study of data must numerically measure the extent of variation around the center. Two data sets mayexhibit similar positions of center but may be remarkably different with respectto variability. For example, the dots in Figure 1b are more scattered than thosein Figure 1a.




**The Range :**

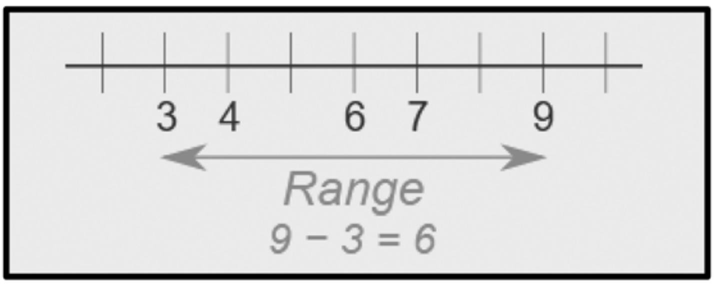
The difference between the largest and smallest observations is the simplest way todescribe variability.

**Range : The range is the difference between the largest and smallest observations.**

The range gives the length of the interval spanned by the observations.

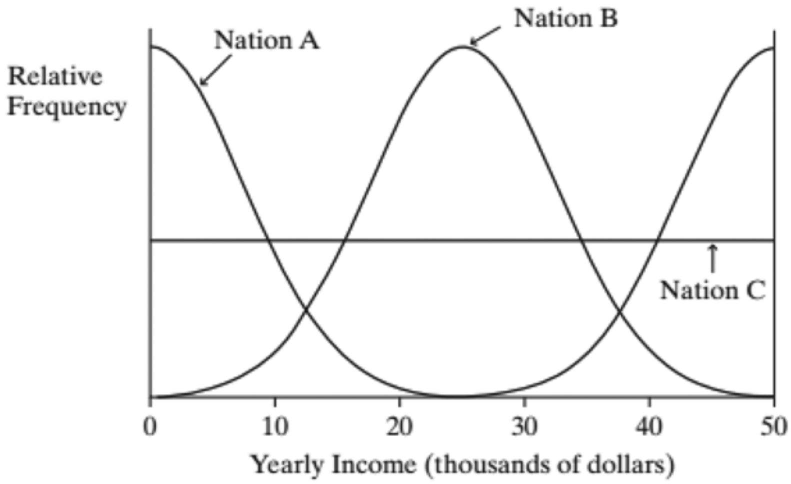
**Example 5 :** In {4, 6, 9, 3, 7} the lowest value is 3, and the highest is 9. So, the range is 9 – 3 = 6.

The range is not, however, sensitive to other characteristics of data variability.The threedistributions in the Figure below.All have the same mean ($25,000) and range($50,000), but they differ in variability about the center. In terms of distances ofobservations from the



mean, nation A has the most variability, and nation B theleast. The incomes in nation A tend to be farthest from the mean, and the incomesin nation B tend to be closest.

Distributions with the Same Mean and Range, but Different Variability about the Mean.




**Standard Deviation :**

$(x - \bar{x})$

Because the sample mean, x, is a measure of center, the variation of the individual data points about this center is reflected in their deviation from the mean

Deviation = Observation – sample mean

$= x - \bar{x}$

For instance, the data set 3, 5, 7, 7, 8 has mean,x = (3 + 5 +7 + 7 +8)/5 = 30/5 = 6, so the deviations are calculated by subtracting 6 from eachobservation.

**Calculation of Deviations**

| Observation (x) | Deviation |
|---|---|
| 3 | –3 |
| 5 | –1 |
| 7 | 1 |
| 7 | 1 |
| 8 | 2 |

One might feel that the average of the deviations would provide a numerical measure ofspread. However, some deviations are positive and some negative, and the total of the

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positive deviations exactly cancels the total of the negative ones. In the foregoing example, we see that the positive deviations add to 4and the negative ones add to –4, so the total deviation is 0. With a little reflection on the definition of the sample mean, the reader will realize that this wasnot just an accident. For any data set, the total deviation is 0.

$$\Sigma \text{ (Deviation)} = \Sigma(x_i - x) = 0$$

To obtain a measure of spread, we must eliminate the signs of the deviations before averaging. One way of removing the interference of signs is to square the numbers. A measure of spread, called the sample variance, is constructed by adding the squared deviations and dividing the total by the number of observations minus one.

Sample variance of *n* observations :

$$s^2 = \frac{\text{sum of squared deviations}}{n - 1}$$

$$= \frac{\sum_{i=1}^{n} (x_i - \overline{x})^2}{n-1}$$

**Example 6 : Calculating Sample Variance**

Calculate the sample variance of the data 3, 5, 7, 7, 8.For this data set, n = 5. To find the variance, we first calculate the mean,then the deviations and the squared deviations.

**Calculation of Variance**

| **Observation** $x$ | **Deviation** $x - \overline{x}$ | **(Deviation)$^2$** $(x - \overline{x})^2$ |
|---|---|---|
| **3** | **–3** | **9** |
| **5** | **–1** | **1** |
| **7** | **1** | **1** |
| **7** | **1** | **1** |
| **8** | **2** | **4** |
| **Total : 30** | **0** | **16** |

$\sum x \sum(x-\bar{x}) \qquad \sum(x-\bar{x})^2$

$\bar{x}$ = (30/5) = 6, Sample Variance ($s^2$) = 16/(5-1) = 4.

**Note :** Although the sample variance is conceptualized as the average squared deviation, notice that the divisor, (n – 1) is rather than n. The divisor is called the degrees of freedom associated with $s^2$.

**A Technical Point :** You may wonder why the denominators of the variance and the standard deviation use n – 1 instead of n. We said that the variance was an average of the n squared deviations, so should we not divide by n? Basically, it is because the deviations have only n – 1 pieces of information about variability : That is, n – 1 of the deviations determine the last one, because the deviations sum to 0. For example, suppose we have n = 2 observations and the first observation has deviation ($x - \bar{x}$) = 5. Then the second observation musthave deviation ($x - \bar{x}$) = –5 because the deviations must add to 0. With n = 2, there's only n – 1 = 1 nonredundant piece of information about variability. Andwith n = 1, the standard deviation is undefined because with only one observation, it's impossible to get a sense of how much the data vary.

Because the variance involves a sum of squares, its unit is the square of theunit in which the measurements are expressed. For example, if the data pertainto measurements of weight in pounds, the variance is expressed in $(\text{pounds})^2$. Toobtain a measure of variability in the same unit as the data, we take the positivesquare root of the variance, called the sample standard deviation. The standard deviation rather than the variance serves as a basic measure of variability.

Sample Standard Deviation

$$s = \sqrt{\text{Variance}} = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

**Example 6 :** Calculating the Sample Standard Deviation

Calculate the standard deviation for the data of the previous Example.

**Solution :** We already calculated the variance, so the standard deviation is S = $\sqrt{4}$ = 2.

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**Example 7 :** Calculate the standard deviation for the data 1, 4, 5, 9, 11.

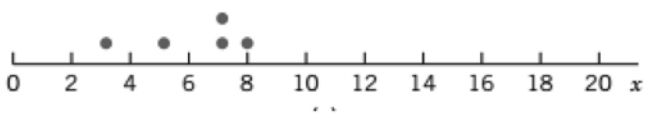
**Solution :** The standard deviation is calculated in the table below :

| **x** | **x–** $\bar{x}$ | (**x–** $\bar{x}$ )$^2$ |
|---|---|---|
| **1** | **–5** | **25** |
| **4** | **–2** | **4** |
| **5** | **–1** | **1** |
| **9** | **3** | **9** |
| **11** | **5** | **25** |
| **Total 30** | **0** | **64** |

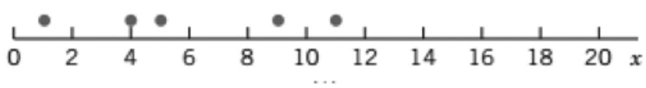
$\bar{x}$ **= 6** $\qquad$ $\mathbf{s^2 = (64/4) = 16}$

$\mathbf{s = \sqrt{16} = 4}$

- **Compare Variation in Two Data Sets, viz, data sets in problems 6 and 7 :**




**Dot Diagram of Data Set in Example 6**




**Dot Diagram of Data Set in Example 7**

- An alternative formula for the sample variance is :

$$s^2 = \frac{1}{n-1}\left[\sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n}\right]$$

It does not require the calculation of the individual deviations. In hand calculation, the use ofthis alternative formula often reduces the arithmetic work,especially when turns out to be a number with many decimal places.

**Problem 8 :** In a psychological experiment a stimulating signal of fixed intensity was usedon six experimental subjects. Their reaction times, recorded in seconds, were 4, 2, 3, 3, 6, 3. Calculate the standard deviation for the data by using the alternative formula.

**Problem 9 :** For the data set 8, 6, 14, 4 :

(a) Calculate the deviations andcheck to see that they add up to 0.

(b) Calculate the variance and the standarddeviation.

**Problem 10 :** The monthly rents for 7 one-bedroom apartments located in one area of the city, are 625, 740, 805, 670, 705, 740, 870.

(a) The sample variance.

(b) The sample standard deviation.

**Problem 11 :** (a) For each list below, work out the average, the deviations from average, and the SD.

(i) 1, 3, 4, 5, 7

(ii) 6, 8, 9, 10, 12

(b) How is list (ii) related to list (i)? How does this relationship carry over to theaverage? the deviations from the average? the SD?

**Problem 12 :** Can the SD ever be negative?

**Problem 13 :** Can the SD ever be positive?

**Problem 14 :** For a list of positive numbers, can the SD ever be larger than the average?

**Problem 15 :** What is the reason behind the use of (n – 1), rather than n, in the denominator of standard deviation?

**Problem 16 :** The first exam in your statistics course is graded on a scale of 0 to 100.Suppose that the mean score in your class is 80. Which value is most plausible for the standard deviation s : 0, 10, or 50?

**Problem 17 :** For an exam given to a class,the students' scores ranged from 35 to 98, with a meanof 74. Which of the following is the most realistic valuefor the standard deviation : –10, 0, 3, 12, 63? Clearlyexplain what's unrealistic about each of the othervalues.

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**Problem 18 :** A company decides to investigate the amountof sick leave taken by its employees. A sample of eightemployees yields the following numbers of days of sickleave taken in the past year :

0, 0, 4, 0, 0, 0, 6, 0

a. Find and interpret the range.

b. Find and interpret the standard deviation s.

c. Suppose the 6 was incorrectly recorded and is supposed to be 60. Redo parts a and b with the correctdata and describe the effect of this outlier

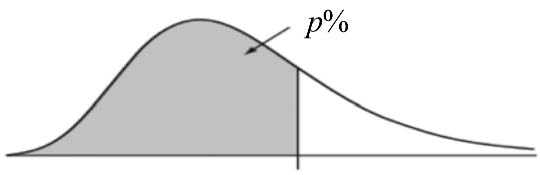
## Quartiles and other percentiles :

The mean and median describe the center of a distribution. The range and the standard deviation describe the variability of the distribution. We'll now learn about some other ways of describing a distribution using measures of position.

One type of measure of position tells us the point where a certain percentage of the data fall above or fall below that point. The median is an example. Itspecifies a location such that half the data fall below it and half fall above it. Therange uses two other measures of position, the maximum value and the minimumvalue. Another type of measure of position tells us how far an observation fallsfrom a particular point, such as the number of standard deviations an observation falls from the mean.

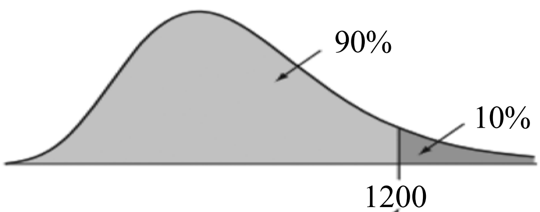
The median is a special case of a set of measures of position called**percentiles.**

| |
|---|
| **Percentile : The pth percentile is a value such that p percent of the observations fall below or at that value.** |




*p*th Percentile

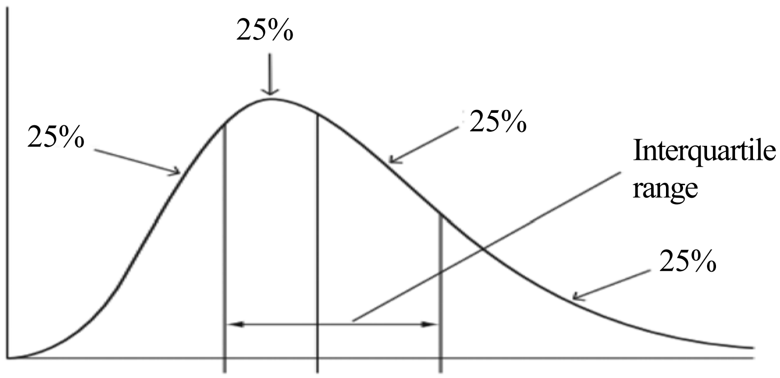
Suppose you're informed that your score of 1200 (out of 1600) on the college entrance exam falls at the 90th percentile. Set p = 90 in this definition.Then, 90% of those who took the exam scored between the minimum score and1200. Only 10% of the scores were higher than yours.




Substituting p = 50 in this definition gives the 50th percentile. For it, 50%of the observations fall below or at it and 50% above it. But this is simply themedian. The 50th percentile is usually referred to as the median.

Three useful percentiles are the quartiles. The first quartile has p = 25, so it isthe 25th percentile. The lowest 25% of the data fall below it. The second quartilehas p = 50, so it is the 50th percentile, which is the median. The third quartile hasp = 75, so it is the 75th percentile. The highest 25% of the data fall above it. Thequartiles split the distribution into four parts, each containing one quarter (25%) ofthe observations.

The Quartiles and the MedianSplit a Distribution intoFour Equal Parts. Theinterquartile




rangedescribes the spread of themiddle half of thedistribution.

**Note :** The median, the quartiles, and the maximum and minimum are five positionsoften used as a set to describe center and spread.

| **Sample interquartile range = Third quartile – First quartile** |
|---|

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**Example 8 :** An administrator wanted to study the utilization of long-distance telephoneservice by a department. One variable of interest is the length, in minutes, oflong-distance calls madeduring one month. There were 38 calls that resultedin a connection. The lengths of calls,already ordered from smallest to largest,are presented in Table below. Also calculate the sample interquartile range for the length of long-distance phonecalls data given in Table

**The Lengths of Long-Distance Phone Calls in Minutes**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1.6 | 1.7 | 1.8 | 1.8 | 1.9 | 2.1 | 2.5 | 3.0 | 3.0 | 4.4 |
| 4.5 | 4.5 | 5.9 | 7.1 | 7.4 | 7.5 | 7.7 | 8.6 | 9.3 | 9.5 |
| 12.7 | 15.3 | 15.5 | 15.9 | 15.9 | 16.1 | 16.5 | 17.3 | 17.5 | 19.0 |
| 19.4 | 22.5 | 23.5 | 24.0 | 31.7 | 32.8 | 43.5 | 53.3 | | |

**Solution :** To determine the first quartile, we take p = .25 and calculate the product 38 * .25 = 9.5. Because 9.5 is not an integer, we take the next largest integer, 10. In Table above, we see that the 10th ordered observation is 4.4 so the firstquartile is $Q_1$ = 4.4 minutes.

We confirm that this observation has 10 values at or below it and 29 values at or above so that it does satisfy the conceptual definition of the firstquartile.

For the median, we take p = .5 and calculate 38 * .5 = 19. Becausethis is an integer, we average the 19th and 20th smallest observations to obtain the median, (9.3 + 9.5)/ 2 = 9.4 minutes.

Next, to determine the third quartile, we take p = .75 and calculate38 * .75 = 28.5. The next largest integer is 29, so the 29th ordered observation is the third quartile $Q_3$ = 17.5 minutes. More simply, we couldmimic the calculation of the first quartile but now count down 10 observations starting with the largest value.

For the 90th percentile, we determine 38 * .90 = 34.2, which we increase to 35. The 90th percentile is 31.7 minutes. Only 10% of calls last 31.7minutes or longer.

**Sample interquartile range** = $Q_3 - Q_1$ = 17.4 - 4.4 = 13.1 minutes.

The following operating rule will simplify the calculation of the sample percentile.

**Calculating the Sample 100*p*-th Percentile**

1. Order the data from smallest to largest
2. Determine the product (*sample size*) × (*proportion*) = *np.*

If *np* is not an integer, round it up to the next integer and find the corresponding ordered value.

If *np* is an integer, say *k*, calculate the average of the *k*th and (*k* + 1)st ordered values.

The quartiles are simply the 25th, 50th, and 75th percentiles.

**Sample Quartiles**

| | |
|---|---|
| Lower (first) quartile | $Q_1$ = 25th percentile |
| Second quartile (or median) | $Q_2$ = 50th percentile |
| Upper (third) quartile | $Q_3$ = 75th percentile |

As with the range and standard deviation s, the more varied the data, the larger the IQR tends to be. But unlike those measures, the IQR is not affected by any observations below the first quartile or above the third quartile. In other words, it is not affected by outliers. In contrast, the range depends solely on the minimum and the maximum values, the most extreme values, so the range changes as either extreme value changes.

**Detecting Potential Outliers**

Examining the data for unusual observations, such as outliers, is important in anystatistical analysis. Is there a formula for flagging an observation as potentiallybeing an outlier? One way uses the interquartile range.

**The 1.5 × IQR Criterion for Identifying Potential Outliers**

**An observation is a potential outlier if it falls more than 1.5 × IQR below the first quartile or more than 1.5 × IQR above the third quartile.**

**Example 9 :** The sodium level in 20 breakfast cereals(in mg) are :

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 340 | 70 | 140 | 200 | 180 | 210 | 150 | 100 | 310 |
| 140 | 180 | 190 | 160 | 290 | 50 | 220 | 180 | 200 | 210 |

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the breakfast cereal sodium data has Q1 = 135 and Q3 = 205. So, IQR = Q3 – Q1 = 205 – 135 = 70. For those data

$$1.5 * IQR = 1.5 * 70 = 105.$$

Q1 – 1.5 * IQR = 135 – 105 = 30 (lower boundary, potential outliers below)

and

Q3 + 1.5 * IQR = 205 + 105 = 310 (upper boundary, potential outliers above).

By the 1.5 * IQR criterion, observations below 30 or above 310 are potential outliers.

The only observations below 30 or above 310 are the sodium values of 0 mg and 340 mg for. These are the only potential outliers.

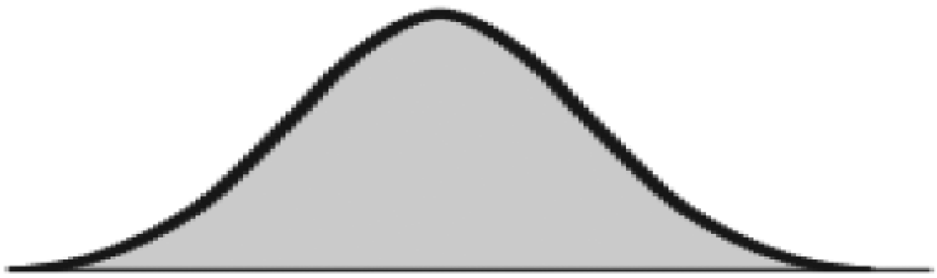
## Interpreting the magnitude of s: the empirical rule

A distribution with s = 5.1 has greater variability than one with s = 3.3, but how do we interpret how large s = 5.1 is? We've seen that a rough answer is that s is a typical distance of an observation from the mean. To illustrate, suppose the first exam in your course, graded on a scale of 0 to 100, has a sample mean of 77. A value of s = 0 in unlikely, since every student must then score 77. A value such as s = 50 seems implausibly large for a typical distance from the mean. Values of s such as 8 or 12 seem much more realistic.

Suppose that a distribution is unimodal and approximately symmetric with a bellshape. The value of s then has a more precise interpretation. Using the mean and standard deviation, we can form intervals that containcertain percentages (approximately) of the data.

**Empirical Rule**

**Bell-shaped Distribution**



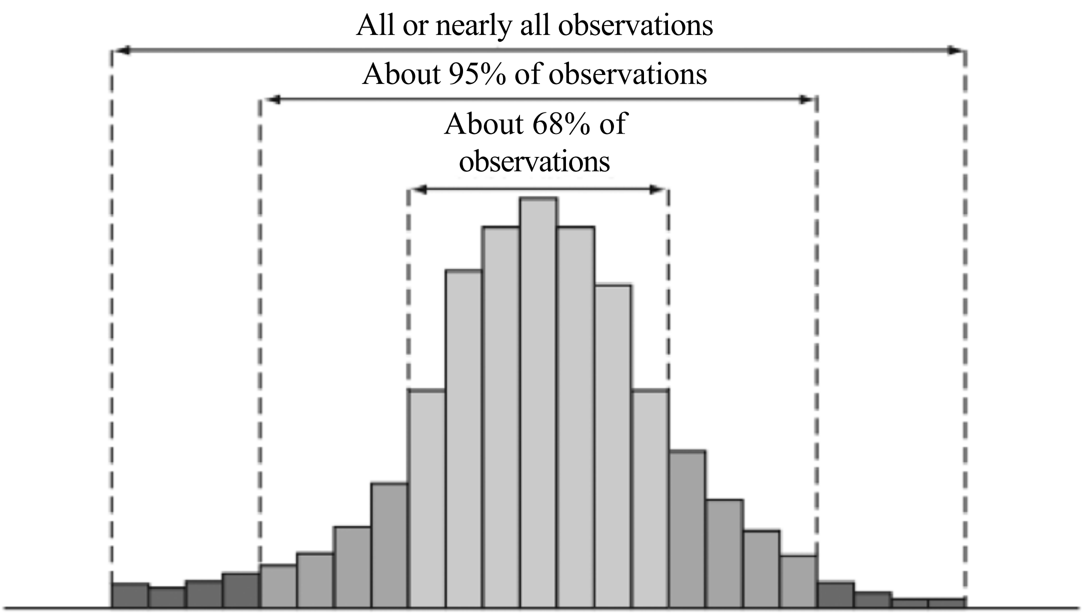
**If a distribution of data is bell shaped, then approximately**

- **68% of the observations fall within1 standard deviationof the mean, that is, betwen the values of $\bar{x}$ – *s* and $\bar{x}$ + *s* (denoted $\bar{x}$ ± *s*).**
- **95% of the observations fall within 2 standard deviations of the mean ($\bar{x}$ ± 2*s*).**
- **All or nearly all observations fall within 3 standard deviations of the mean ($\bar{x}$ ± 3*s*).**

The empirical rule has this name becausemany distributions of data observed inpractice (empirically) are approximately bellshaped.

**Example 10 :** Students require different amounts of sleep. A sample of 59 students at a college reported the following hours of sleep the previous night.

$\bar{x}$ 3*s*




*A graphical portrayal of the empirical rule*

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**Hours of Sleep for Fifty-nine Students**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4.5 | 4.7 | 5.0 | 5.0 | 5.3 | 5.5 | 5.5 | 5.7 | 5.7 | 5.7 |
| 6.0 | 6.0 | 6.0 | 6.0 | 6.3 | 6.3 | 6.3 | 6.5 | 6.5 | 6.5 |
| 6.7 | 6.7 | 6.7 | 6.7 | 7.0 | 7.0 | 7.0 | 7.0 | 7.3 | 7.3 |
| 7.3 | 7.3 | .7.5 | 7.5 | 7.5 | 7.5 | 7.7 | 7.7 | 7.7 | 7.7 |
| 8.0 | 8.0 | 8.0 | 8.0 | 8.3 | 8.3 | 8.3 | 8.5 | 8.5 | 8.5 |
| 8.5 | 8.7 | 8.7 | 9.0 | 9.0 | 9.0 | 9.3 | 9.3 | 10.0 | |

Examine the 59 hours of sleep in the above table in the context of the empirical guideline.

**Solution :** We can calculate the following values as follows (Try!) :

$\bar{x} = 7.18$

$s = 1.28$ $\quad\quad$ $2*s = 2(1.28) = 2.56$

Going two standard deviations either side of $\bar{x}$ results in the interval :

$7.18 - 2.56 = 4.62$ $\quad$ to $\quad$ $9.74 = 7.18 + 2.56$

By actual count, all the observations except 4.5 and 10.0 fall in thisinterval. We find that 57/59 = .966, or 96.6% of the observations liewithin two standard deviations of $\bar{x}$. The empirical guidelines suggest 95%so they are close.

**Problem 19 :** The following data represent the scores of 40 students on a college qualification test :

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 162 | 171 | 138 | 145 | 144 | 126 | 125 | 162 | 174 | 178 |
| 167 | 98 | 161 | 152 | 182 | 136 | 165 | 137 | 133 | 143 |
| 184 | 166 | 115 | 115 | 95 | 190 | 119 | 144 | 176 | 135 |
| 194 | 147 | 160 | 158 | 178 | 162 | 131 | 106 | 157 | 154 |

Calculations with the test scores data of the above table give $\bar{x} = 150.125$ and s = 24.677.

a) Find the proportion of the observations in the intervals $\bar{x} + 2s$ & $\bar{x} - 2s$ and $\bar{x} + 3s$ & $\bar{x} - 3s$.

b) Compare your findings in part (a) with those suggested by the empirical guidelines for bell-shaped distributions.

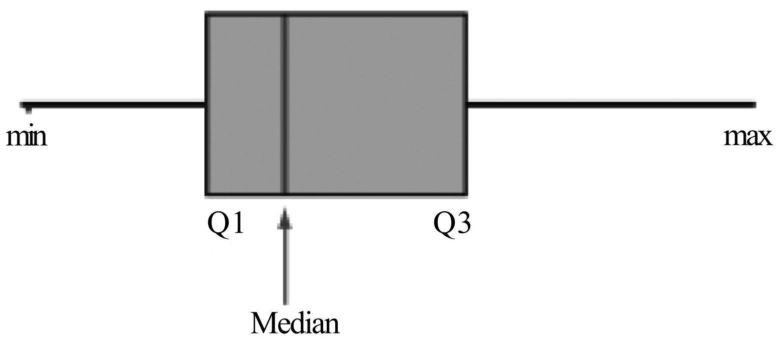
c) Calculate the interquartile range.

## The Box Plot : Graphing a Five-Number Summary of Positions

The quartiles and the maximum and minimum values are five numbers often used as a set to summarize positions that help to describe center and variability of a distribution.

The five-number summary is the basis of a graphical display called the boxplot. The box of a box plot contains the central 50% of the distribution, from thefirst quartile to the third quartile (see the margin figure). A line inside the boxmarks the median. The lines extending from the box are called whiskers. Theseextend to encompass the rest of the data, except for potential outliers, which areshown separately.

## SUMMARY : Constructing a Box Plot




- **A box goes from the lower quartile Q1 to the upper quartile Q3.**
- **A line is drawn inside the box at the median.**
- **A line goes from the lower end of the box to the smallest observation that is not a potential outlier. A separate line goes from the upper end of the box to the largest observation that is not a potential outlier. These lines are called whiskers. The potential outliers (more than 1.5 IQR below the first quartile or above the third quartile) are shown separately.**

**Example 11 :** The sodium level in 20 breakfast cereals (in mg) are :

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 340 | 70 | 140 | 200 | 180 | 210 | 150 | 100 | 130 |
| 140 | 180 | 190 | 160 | 290 | 50 | 220 | 180 | 200 | 210 |

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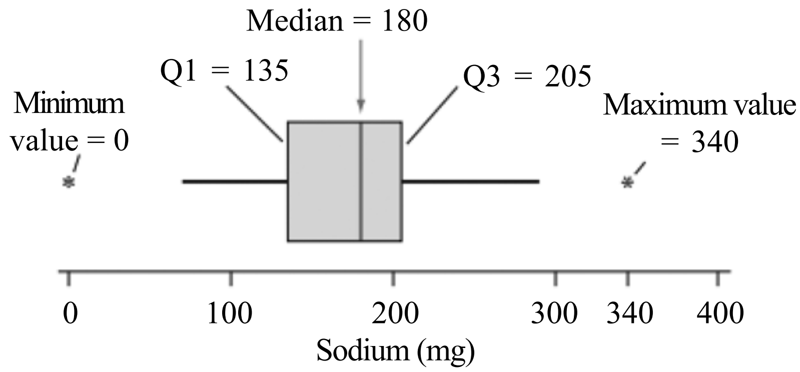
Figure below shows a box plot for the sodiumvalues. Labels are also given for the five-number summary of positions.




Box Plot and Five-Number Summary for 20 Breakfast Cereal Sodium Values. The central box contains the middle 50% of the data. The line in the box marks themedian. Whiskers extend from the box to the smallest and largest observations, which arenot identified as potential outliers. Potential outliers are marked separately.

The five-number summary of sodium values shown on the boxplot is minimum = 0, Q1 = 135, median = 180, Q3 = 205, andmaximum = 340. The middle 50% of the distribution of sodium values range from Q1 = 135 mg to Q3 = 205 mg, which are the twoouter lines of the box. The median of 180 mg is indicated by the center line through the box. As we saw in part a, the 1.5 * IQR criterionflags the sodium values of 0 mg for and 340 mgfor as outliers. These values are represented on the boxplot as asterisks. The whisker extending from Q1 is drawn down to 50,which is the smallest observation that is not below the lower boundaryof 30. The whisker extending from Q3 is drawn up to 290, which is thelargest observation that is not above the upper boundary of 310.

**Problem 20 :** The scores on an exam havemean = 88, standard deviation = 10, minimum = 65,Q1 = 77, median = 85, Q3 = 91, maximum = 100.Sketch a box plot, labeling which of these values are usedin the plot.

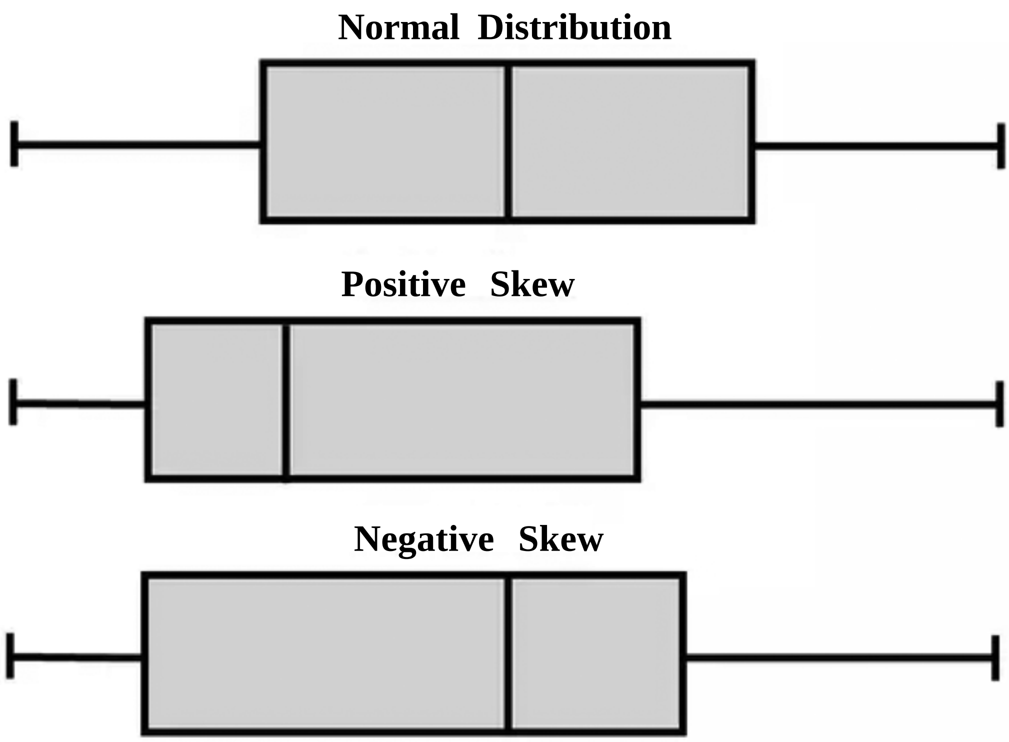
## Usefulness of Boxplot Diagram :

- **Box plots are useful as they show the average score of a data set.**

  The median is the average value from a set of data and is shown by the line that divides the box into two parts. Half the scores are greater than or equal to this value and half are less.

- **Box plots are useful as they show the skewness of a data set**

  The box plot shape will show if a statistical data set is normally distributed or skewed.




When the median is in the middle of the box, and the whiskers are about the same on both sides of the box, then the distribution is symmetric.

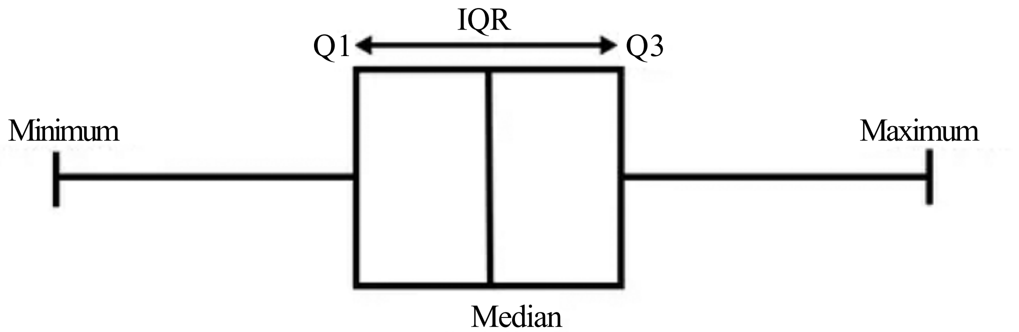
When the median is closer to the bottom of the box, and if the whisker is shorter on the lower end of the box, then the distribution is positively skewed (skewed right).

When the median is closer to the top of the box, and if the whisker is shorter on the upper end of the box, then the distribution is negatively skewed (skewed left).

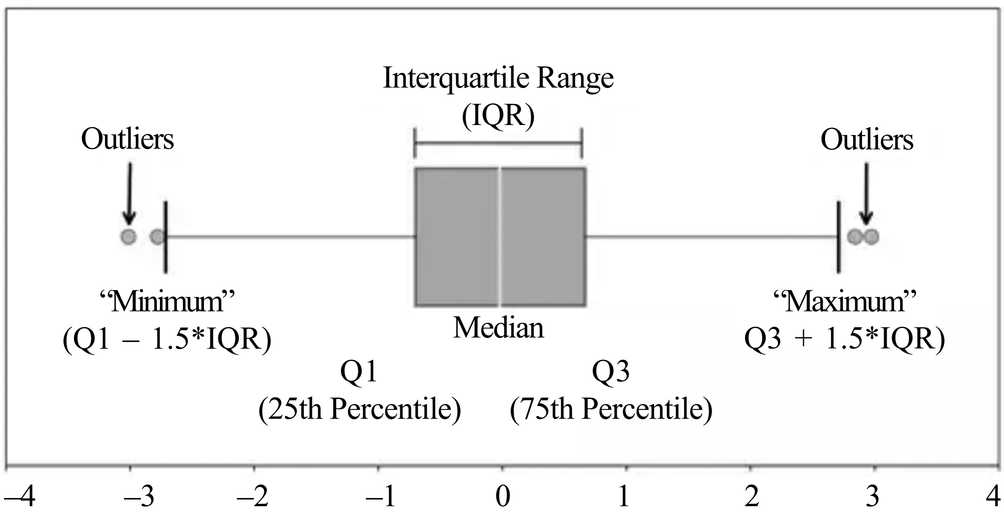
- **Box plots are useful as they show the dispersion of a data set.**

  The smallest value and largest value are found at the end of the 'whiskers' and are useful for providing a visual indicator regarding the spread of scores (e.g. the range).

The interquartile range (IQR) is the box plot showing the middle 50% of scores and can be calculated by subtracting the lower quartile from the upper quartile (e.g. Q3"Q1).




- **Box plots are useful as they show outliers within a data set.**




For example, outside 1.5 times the interquartile range above the upper quartile and below the lower quartile (Q1 - 1.5 * IQR or Q3 + 1.5 * IQR).

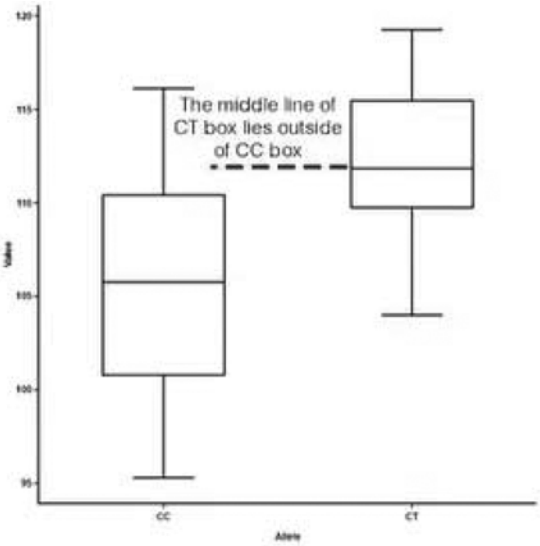
Box plots are useful as they show the skewness of a data set

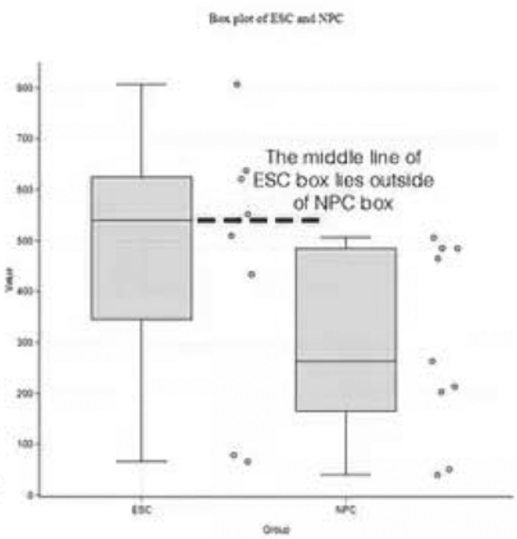
## How to compare box plots :

Box plots are a useful way to visualize differences among different samples or groups. They manage to provide a lot of statistical information, including—medians, ranges, and outliers.

**Step 1 :** Compare the medians of box plots :

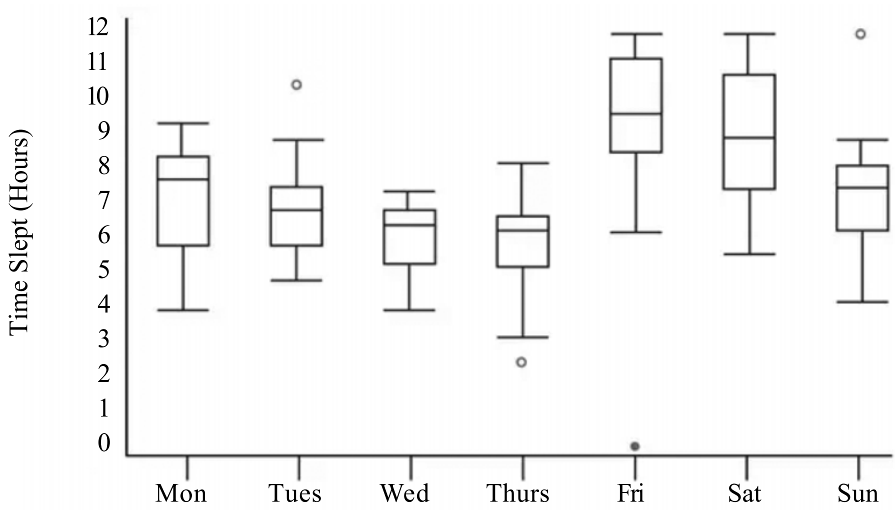
Compare the respective medians of each box plot. If the median line of a box plot lies outside of the box of a comparison box plot, then there is likely to be a difference between the two groups.




**Step 2 :** Compare the interquartile ranges and whiskers of box plots :

Compare the interquartile ranges (that is, the box lengths), to examine how the data is dispersed between each sample. The longer the box the more dispersed the data. The smaller the less dispersed the data.

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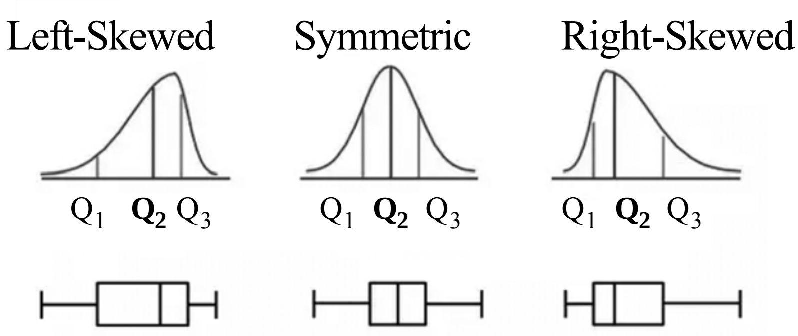
Next, look at the overall spread as shown by the extreme values at the end of two whiskers. This shows the range of scores (another type of dispersion). Larger ranges indicate widerdistribution, that is, more scattered data.

**Step 3 :** Look for potential outliers :

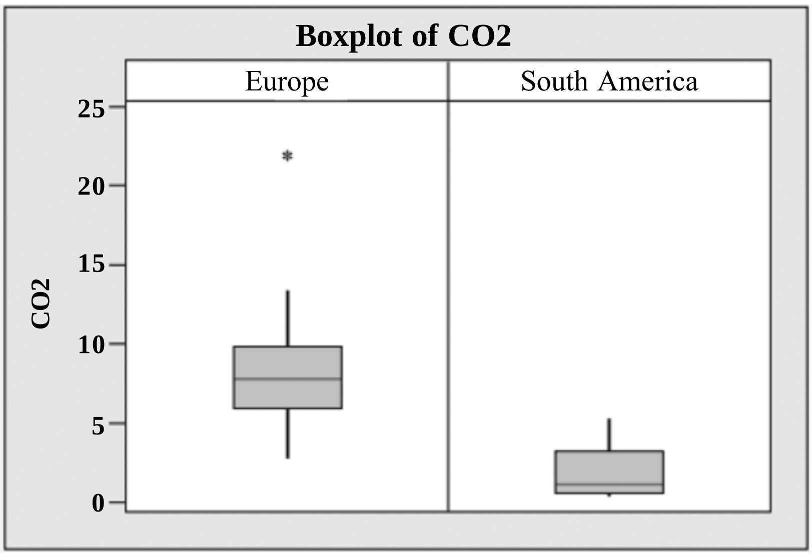
When reviewing a box plot, an outlier is defined as a data point that is located outside the whiskers of the box plot.

**Step 4 :** Look for signs of skewness :

If the data do not appear to be symmetric, does each sample show the same kind of asymmetry?




**Problem 21 :** Vertical side-by-side box plots shown below compare the values reported by the UN of per capita carbon dioxide emissions for nations in the European Union and in South America.



a. Give the approximate value of carbon dioxide emissions for the outlier shown.

b. What shape would you predict for the distribution inSouth America? Why?

c. Summarize how the carbon dioxide emissions comparein Europe and South America.

## The z-Score Also Identifies Position and Potential Outliers

The empirical rule tells us that for a bell-shaped distribution, it is unusual for an observation to fall more than 3 standard deviations from the mean. An alternative criterion for identifying potential outliers uses the standard deviation.

An observation in a bell-shaped distribution is regarded as a potential outlierif it falls more than 3 standard deviations from the mean.

How do we know the number of standard deviations that an observation fallsfrom the mean? When $\bar{x}$ = 84 and s = 16, a value of 100 is 1 standard deviationabove the mean, since (100 – 84) = 16. Alternatively, (100 – 84)/16 = 1.

Taking the difference between an observation and the mean and dividing bythe standard deviation tells us the number of standard deviations that the observation falls from the mean. This number is called the **z-score**.

### Z-SCORE

The **z-score** for an observation is the number of standard deviations that it falls from the mean. A positive *z*-score indicates the observation is above the mean. A negative *z*-score indicates the observation is below the mean. For sample data, the *z*-score is calculated as

$$z = \frac{\text{observation} - \text{mean}}{\text{standard deviation}}.$$

The z-score allows us to quickly tell how surprising or extreme an observationis. The z-score converts an observation (regardless of the observation's unit ofmeasurement) to a common scale of measurement, which allows comparisons.

**Example 12 :** Suppose astudent scored 65 in a math course and 72 in a history course. These (raw) scores tell littleabout the student's performance. If the classaverages and standard deviations werex = 60 and s = 20 in mathematics and $\bar{x}$ = 78 and s = 10 in history, this student's

Z-score in mathematics = (65 – 60)/20 = .25

Z-score in history = (72 – 78)/10 = –.60

Thus, the student was .25 standard deviationsabove the average in math and .6 standard deviations below the average in history.

**Problem 22 :** (a) If $\bar{x}$ = 490 and s = 120, find the z scores of 350 and 620.

(b) For a z score of 2.4, what is the raw score if $\bar{x}$ = 210 and s = 50?

**Problem 23 :** Two cities provided the following informationon public school teachers' salaries.

| | Minimum | $Q_1$ | Median | $Q_3$ | Maximum |
|---|---|---|---|---|---|
| City *A* | 38,400 | 44,000 | 48,300 | 50,400 | 56,300 |
| City *B* | 39,600 | 46,500 | 51,200 | 55,700 | 61,800 |

(a) Construct a boxplot for the salaries inCity A.

(b) Construct a boxplot, on the same graph,for the salaries in City B.

(c) Are there larger differences at the loweror the higher salary levels? Explain.

## 7.5 Coefficient of Variation :

To compare variation in different data sets, you can use standard deviation whenthe data sets use the same units of measure and have means that are about thesame. For data sets with different units of measure or different means, use thecoefficient of variation.

The coefficient of variation (CV) of a data set describes the standard deviationas a percent of the mean.

Population : CV = $(\sigma/\mu)$ *100% Sample : CV = $(s/\bar{x})$ *100%

Note that the coefficient of variation measures the variation of a data setrelative to the mean of the data.

**Example 13 :** The table at the left shows the population heights (in inches) and weights (inpounds) of the members of a football team. Find the coefficient of variationfor the heights and the weights. Then compare the results.

| Heights | Weights |
|---|---|
| 72 | 180 |
| 74 | 168 |
| 68 | 225 |
| 76 | 201 |
| 74 | 189 |
| 69 | 192 |
| 72 | 197 |
| 79 | 162 |
| 70 | 174 |
| 69 | 171 |
| 77 | 185 |
| 73 | 210 |

**Solution :** The mean height is $\mu \approx 72.8$ inches with a standard deviation of $\sigma \approx 3.3$ inches.

The coefficient of variation for the heights is

$CV_{height} = (\sigma/\mu) * 100\%$

$= (3.3/72.8)*100\%$

$= 4.5\%$

The mean weight is $\mu \approx 187.8$ pounds with a standard deviation of $\sigma \approx 17.7$ pounds. The coefficient of variation for the weights is

$CV_{weight} = (\sigma/\mu) * 100\%$

$= (17.7/187.8) * 100\%$

$= 9.4\%$

**Interpretation :** The weights (9.4%) are more variable than the heights (4.5%).

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**Problem 24 :** Find the coefficient ofvariation for each of the two data sets. Then compare the results.Sample annual salaries (in thousands of dollars) forentry level accountants in Dallas and New York City are listed.

| | | | | | |
|---|---|---|---|---|---|
| **Dallas** | 41.6 | 50.0 | 49.5 | 38.7 | 39.9 |
| | 45.8 | 44.7 | 47.8 | 40.5 | 44.3 |
| **New York City** | 45.6 | 41.5 | 57.6 | 55.1 | 59.3 |
| | 59.0 | 50.6 | 47.2 | 42.3 | 51.0 |

## 7.6 Probability Distributions

A prescription for the probability model of an experiment contains two basic ingredients: the sample space and the assignment of probability to each elementary outcome.we encountered several examples where the elementary outcomes had only qualitative descriptions rather than numerical values. For instance, with two tosses of a coin, the outcomes HH, HT, TH, and TTare pairs of letters that identify the occurrences of heads or tails. If a new vaccine is studied for the possible side effects of nausea, the response of each subject may be severe, moderate, or no feeling of nausea. These are qualitative outcomes rather than measurements on a numerical scale.Often, the outcomes of an experiment are numerical values: for example,the daily number of burglaries in a city, the hourly wages of students on summerjobs, and scores on a college placement examination. Even in the former situation where the elementary outcomes are only qualitatively described, interestfrequently centres on some related numerical aspects.

**Random Variables :** A random variable X associates a numerical value with each outcome of an experiment.

In mathematical language, we say that a random variable X is a real-valued function defined on a sample space. The word “random”serves as a reminder of the fact that, beforehand, we do not know the outcomeof an experiment or its associated value of X.

**Example 1 :** Consider X to be the number of heads obtained in three tosses of a coin. Listthe numerical values of X and the corresponding elementary outcomes.

**Solution :** First, X is a variable since the number of heads in three tosses of a coin canhave any of the values 0, 1, 2, or 3. Second, this variable is random in thesense that the value that would occur in a given instance cannot be predictedwith certainty. We can, though, make a list of the elementary outcomes andthe associated values of X.

| Outcome | Value of X |
|---|---|
| HHH | 3 |
| HHT | 2 |
| HTH | 2 |
| HTT | 1 |
| THH | 2 |
| THT | 1 |
| TTH | 1 |
| TTT | 0 |

Note that, for each elementary outcome there is only one value of X.However, several elementary outcomes may yield the same value. Scanningour list, we now identify the events (i.e., the collections of the elementaryoutcomes) that correspond to the distinct values of X.

Guided by this example, we observe the following general facts.

- The events corresponding to the distinct values of X are incompatible.
- The union of these events is the entire sample space.

Typically, the possible values of a random variable X can be determined directly from the description of the random variable without listing the sample space. However, to assign probabilities to these values, treated as events, it issometimes helpful to refer to the sample space.

**Problem 1 :** Identify each of the following as a discrete orcontinuous random variable.

(a) Number of empty seats on a flight fromAtlanta to London.

(b) Yearly low temperature in your city.

(c) Yearly maximum daily amount of ozonein Los Angeles.

(d) Time it takes for a plumber to fix a bathroom faucet.

(e) Number of cars ticketed for illegal parking on campus today.

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**Problem 2 :** A child psychologist interested in how friendsare selected studies groups of three children.

For one group, Ann, Barb, and Carol, each isasked which of the other two she likes best.

(a) Make a list of the outcomes. (Use A, B,and C to denote the three children.)

(b) Let X be the number of times Carol ischosen. List the values of X.

## Probability distribution of a discrete random variable :

The probability distribution or, simply the distribution, of a discrete random variable X is a list of the distinct numerical values of X along with their associated probabilities.

Often, a formula can be used in place of a detailed list.

**Example 2 :** If X represents the number of heads obtained in three tosses of a fair coin, find the probability distribution of X.

**Solution :** We know the eight elementary outcomes and theassociated values of X. The distinct values of X are 0, 1, 2, and 3. We now calculate their probabilities.

The model of a fair coin entails that the eight elementary outcomes areequally likely, so each is assigned the probability The event [X = 0] has thesingle outcome TTT, so its probability is Similarly, the probabilities of [X = 1], [X = 2], and [X = 3] are found to be and respectively. Collecting these results, we obtain the probability distribution of X displayed in Table :

| Value of X | Probability |
|---|---|
| 0 | $\frac{1}{8}$ |
| 1 | $\frac{3}{8}$ |
| 2 | $\frac{3}{8}$ |
| 3 | $\frac{1}{8}$ |
| Total | 1 |

For general discussion, we will use the notation $x_1$, $x_2$, and so on, to designate the distinct values of a random variable X. The probability that a particularvalue occurs will be denoted by f ($x_i$). If X can take k possible values, ..., with the corresponding probabilities f ($x_1$), ..., f ($x_k$), the probability distribution of X can be displayed in the format of the above Table. Sincethe quantities f ($x_i$) represent probabilities, they must all be numbers between 0 and 1. Furthermore, when summed over all possible values of X, these probabilities must add up to 1.

TABLE 2 Form of a Discrete Probability Distribution

| Value of X | Probability $f(x)$ |
|---|---|
| $x_1$ | $f(x_1)$ |
| $x_2$ | $f(x_2)$ |
| . | . |
| . | . |
| . | . |
| $x_k$ | $f(x_k)$ |
| Total | 1 |

The probability distribution of a discrete random variable X is described as the function

$$f(x_i) = P[X = x_i]$$

which gives the probability for each value and satisfies :

1. $0 \leq f(x_i) \leq 1$ for each value $x_i$ of $X$
2. $\sum_{i=1}^{k} f(x_i) = 1$

A probability distribution or the probability function describes the mannerin which the total probability 1 gets apportioned to the individual values of therandom variable.

**Note :** You should recognize an important distinction between a relativefrequency distribution and the probability distribution. The former is a sample-based entity and is therefore susceptible to variation on different occasions ofsampling. By contrast, the probability distribution is a stable entity that refers tothe entire population. It is a theoretical construct that serves as a model for describing the variation in the population.

The probability distribution of X can be used to calculate the probabilitiesof events defined in terms of X.

**Problem 3 :** Faced with a tight deadline on two major projects, you decide to hire two of the five availablepersons to help complete the work. They have1, 2, 4, 2- and 1- years' experience, respectively.Since their references are very similar, you decide to select two of these workers at random.Let X denote the sum of their years' experience.Obtain the probability distribution of X.

## Expectation (mean) and standard deviation of a probability distribution :

The mean of X or population mean

$$E(X) = \mu$$

$$= \sum (\text{Value} \times \text{Probability}) = \sum x_i f(x_i)$$

Here the sum extends over all the distinct values $x_i$ of $X$.

The mean of a probability distribution is also called the population mean for the variable X and is denoted by theGreek letterμ.The mean of a random variable X is also called its expected value and, alternatively, denoted by E (X). That is, the mean μ and expected value E (X) arethe same quantity and will be used interchangeably.

**Example 3 :** Calculate o the mean of the following data set. Suppose a die is tossed 20 times and the following data obtained.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4, | 3, | 4, | 2, | 5, | 1, | 6, | 6, | 5, | 2 |
| 2, | 6, | 5, | 4, | 6, | 2, | 1, | 6, | 2, | 4 |

**Solution :** We know, sample mean $\overline{x} = \Sigma$ (Value * Relative Frequency)

Rather than stopping with 20 tosses, if we imagine a very large number of tosses of a die, the relative frequencies will approach the probabilities, each of which is for a fair die. The mean of the (infinite) collection of tosses of a fair die should then be calculated as

We can first count the frequency of each point and use the relative frequencies to calculate the mean as :

$\overline{x}$ = 1*(2/20) + 2*(5/20) + 3*(1/20) + 4*(4/20) + 5*(3/20) + 6*(5/20) = 3.8

**Note :** Like many concepts of probability, the idea of the mean or expectation originated from studies of gambling. When X refers to the financial gain in a gameof chance, such as playing poker or participating in a state lottery, the name “expected gain” is more appealing than “mean gain.” In the realm of statistics, boththe names “mean” and “expected value” are widely used.

The concept of expected value also leads to a numerical measure for the spread of a probability distribution—namely, the standard deviation.

Because the mean μ is the center of the distribution of X, we express variation of X in terms of the deviation X – μ. We define the variance of X as the expected value of the squared deviation $(X-\mu)^2$. To calculate this expected value, we note that

| $(X-\mu)^2$ Takes Value | With Probability |
|---|---|
| $(x_1-\mu)^2$ | $f(x_1)$ |
| $(x_2-\mu)^2$ | $f(x_2)$ |
| . | . |
| . | . |
| . | . |
| $(x_k-\mu)^2$ | $f(x_k)$ |

The expected value of $(X-\mu)^2$ is obtained by multiplying each value $(x_i-\mu)^2$ by the probability $f(x_i)$ and then summing these products. This motivates the definition :

$$\text{Variance of X} = \Sigma\,(\text{Deviation})^2 * (\text{Probability})$$
$$= \Sigma\,(x_i-\mu)^2 * f(x_i)$$

The variance of X is abbreviated as Var(X) and is also denoted by $\sigma^2$. The standard deviation of X is the positive square root of the variance and is denoted by sd (X) or σ (a Greek lower-case sigma.).

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The variance of X is also called the population variance and ó denotes the population standard deviation.

**Variance and Standard Deviation of *X***

$$s^2 = \text{Var(X)} = \sum (x_i - m)^2 f(x_i)$$

$$s^2 = \text{sd(X)} = +\sqrt{\text{Var(X)}}$$

**Example 4 :** Calculate the variance and the standard deviation of the distribution of X that appears in the Table below :

| $x$ | $f(x)$ |
|---|---|
| 0 | .1 |
| 1 | .2 |
| 2 | .4 |
| 3 | .2 |
| 4 | .1 |

**Solution :** We calculate the mean μ, the deviations x – μ, $(x - \mu)^2$ and finally, $(x - \mu)^2$ * f(x).

| $x$ | $f(x)$ | $x f(x)$ | $(x - \mu)$ | $(x - \mu)^2$ | $(x - \mu)^2 f(x)$ |
|---|---|---|---|---|---|
| 0 | .1 | 0 | –2 | 4 | .4 |
| 1 | .2 | .2 | –1 | 1 | .2 |
| 2 | .4 | .8 | 0 | 0 | 0 |
| 3 | .2 | .6 | 1 | 1 | .2 |
| 4 | .1 | .4 | 2 | 4 | .4 |
| Total | 1.0 | 2.0 = μ | | | $1.2 = \sigma^2$ |

$$\text{Var (X)} = \sigma^2 = 1.2$$

$$\text{Sd(X)} = \sigma = \sqrt{1.2} = 1.095$$

**Problem 4 :** Given the following probability distribution concerning Web sites visited almost every day: Find E(X), $\sigma^2$, and $\sigma$.

| $x$ | $f(x)$ |
|---|---|
| 1 | .1 |
| 2 | .2 |
| 3 | .3 |
| 4 | .4 |

## Bernoulli trials :

Often, an experiment can have only two possible outcomes.In all these circumstances, a simple probability model can be developed forthe chance variation in the outcomes.Moreover, the population proportion neednot be known. Instead, the probabilitydistributionwill involve this unknown population proportion as a parameter.Sampling situations where the elements of a population have a dichotomyabound in virtually all walks of life. A few examples are :

- Survey a sample of voters and observe how many favours an increase of public spending on welfare.
- Examine the case histories of a number of births and count how many involved deliveries by Cesarean section.
- Inspect a specified number of items coming off a production line and count the number of defectives.

Selecting a single element of the population is envisioned as a trial of the (sampling) experiment, so that each trial can result in one of two possible outcomes. Our ultimate goal is to develop a probability model for the number of outcomes inone category when repeated trials are performed. We call each repetition by the simpler name—a trial. Furthermore, the two possible outcomes of a trial are now assigned the technical names success (S) and failure (F) just to emphasize the point that they are the only two possible results. These names bear no connotation of success or failure in real life. Customarily, the outcome of primary interest in a study is labeled success (even if it is a disastrous event). Further conditions on the repeated trials are necessary in order to arrive atour intended probability distribution. Repeated trials that obey these conditionsare called Bernoulli trials after the Swiss mathematician Jacob Bernoulli.

Perhaps the simplest example of Bernoulli trials is the prototype model oftossing a coin, where the occurrences head and tail can be labelled S and F, respectively. For a fair coin, we assign probability to success andto failure.p = 1/ 2 to success and q=½ to failure.

**Bernoulli Trials**

1. Each trial yields one of two outcomes, technically called success (S) and failure (F).
2. For each trial, the probability of success $P(\mathrm{S})$ is the same and is denoted by $p = P(\mathrm{S})$. The probability of failure is then $P(\mathrm{F}) = 1 - p$ for each trial and is denoted by $q$, so that $p + q = 1$.
3. Trials are independent. The probability of success in a trial remains unchanged given the outcomes of all the other trials.

**Example 5 :** Consider a lot (population) of items in which each item can be classified aseither defective or non-defective. Suppose that a lot consists of 15 items, ofwhich 5 are defective and 10 are non-defective.Do the conditions for Bernoulli trials apply when sampling (1) with replacement and (2) without replacement?

**Solution :**

1. Sampling with replacement. An item is drawn at random (i.e., ina manner that all items in the lot are equally likely to be selected).The quality of the item is recorded, and it is returned to the lot before the next drawing. The conditions for Bernoulli trials are satisfied. If the occurrence of a defective is labelled S, we have P(S) = 5/15.
2. Sampling without replacement. In situation (2), suppose that 3items are drawn one at a time but without replacement. Then thecondition concerning the independence of trials is violated. Forthe first drawing, P(S) = 5/15. If the first draw produces S, the lotthen consists of 14 items, 4 of which are defective. Given this information about the result of the first draw, the conditional probability of obtaining an S on the second draw is then 4/14 which is not certainly equal to 5/15 and thatestablishes the lack of independence.

This violation of the condition of independence loses its thrust when thepopulation is vast and only a small fraction of it is sampled. Consider sampling 3 items without replacement from a lot of 1500 of items, 500 of whichare defective. With $S_1$ denoting the occurrence of an S in the first draw and $S_2$that in the second, we haveand

$$P(S_1) = 500/1500 = 5/15$$

and

$$P(S_2) = 499/1499$$

For most practical purposes, the latter fraction can be approximated by 5/15. Strictly speaking, there has been a violation of the independence of trials, butit is to such a negligible extent that the model of Bernoulli trials can be assumed as a good approximation.

**Note :** If elements are sampled from a dichotomous population at random and with replacement, the conditions for Bernoulli trials are satisfied. When the sampling is made without replacement, the condition of the independence of trials is violated. However, if the population is large and only a small fraction of it (less than 10%, as a rule of thumb) is sampled, the effect of this violation is negligible and the model of the Bernoulli trials can be taken as a good approximation.

**Problem 5 :** Is the model of Bernoulli trials plausible ineach of the following situations? Discuss inwhat manner (if any) a serious violation of theassumptions can occur.

(a) Seven friends go to a blockbuster movieand each is asked whether the movie wasexcellent.

(b) A musical aptitude test is given to 10 students and the times to complete the testare recorded.

(c) Items coming off an assembly line are inspected and classified as defective or non-defective.

(d) Going house by house down the blockand recording if the newspaper was delivered on time.

## The Binomial Distribution :

With a sample, we summarize such variables by counting the number or the proportion of cases with an outcome of interest. For instance, with a sample of size n = 5, let the random variable X denote the number of people who vote yes about some issue in a referendum. The possible values for X are 0, 1, 2, 3,4, and 5. Under certain conditions, a random variable X that counts the number of observations of a particular type has a probability distribution called the binomial.

Consider n cases, called trials, in which we observe a binary random variable.This is a fixed number, such as n = 5 for a sample of five voters. The number X(trials in which the outcome of interest occurs) can take any one of the integervalues 0, 1, 2,c, n. The binomial distribution gives probabilities for these possible values of X when the following three conditions hold :

**Conditions for Binomial Distribution**

- Each of *n* trials has two possible outcomes. The outcome of interest is called a success and the other outcome is called a failure.
- Each trial has the same probability of a success. This is denoted by *p*, so the probability of a failure is denoted by $1 - p$.
- The *n* trials are independent. That is, the result for one trial does not depend on the results of other trials.

The binomial random variable *X* is the number of successes in the *n* trials.

Flipping a coin n times, where n is determined in advance, is a prototype for the binomial distribution :

- Each trial is a flip of the coin. There are two possible outcomes for each flip, head or tail. Let's identify (arbitrarily) head as success.
- The probability p of a head equals 0.50 for each flip if head and tail are equally likely.
- The flips are independent, since the result for any specific flip does not depend on the outcomes of previous flips.

The binomial random variable X counts the number of heads (the outcome of interest) in the n flips. With n = 3-coin flips, X = number of heads could equal 0, 1, 2, or 3.

**Example 6 :** An experiment is conducted in which a person in one room picks one of the integers 1, 2, 3, 4, 5 at random and concentrates on it for one minute. In another room, Robin identifies the number he believes was picked. The experiment is done withthree trials. After the third trial, the random numbers are compared withRobin's predictions. Robin got the correct result twice. If Robin does not actually have extrasensory perception and is merely guessing the number, what is the probability that he'd make a correct guess on two of the threetrials?

**Solution :** Let X = number of correct guesses in n = 3 trials. Then X = 0, 1, 2, or 3. Let p denote the probability of a correct guess for a given trial. If Robin is guessing, p = 0.2 Robin's prediction of one of the five possible integers. Then, 1 – p = 0.8 is the probability of an incorrect prediction on a given trial. Denote the outcome on a given trial by S or F, representing success or failure for whether Robin's guess was correct or not. Table below shows the eight outcomes in the sample space for this experiment. For instance, FSS represents a correct guess on the second and third trials. It also shows their probabilities by using the multiplication rule for independent events.

| **Outcome** | **Probability** |
|---|---|
| SSS | $0.2 * 0.2 * 0.2 = (0.2)^3$ |
| SSF | $0.2 * 0.2 * 0.8 = (0.2)^3(0.8)^1$ |
| SFS | $0.2 * 0.8 * 0.2 = (0.2)^2(0.8)^1$ |
| FSS | $0.8 * 0.2 * 0.2 = (0.2)^2(0.8)^1$ |
| SFF | $0.2 * 0.8 * 0.8 = (0.2)^1(0.8)^2$ |
| FSF | $0.8 * 0.2 * 0.8 = (0.2)^1(0.8)^2$ |
| FFS | $0.8 * 0.8 * 0.2 = (0.2)^1(0.8)^2$ |
| FFF | $0.8 * 0.8 * 0.8 = (0.8)^3$ |

The three ways John Doe could make two correct guesses in threetrials are SSF, SFS, and FSS. Each of these has probability equal to$(0.2)^2(0.8) = 0.032$. The total probability of two correct guesses is

$$3(0.2)^2(0.8) = 3(0.032) = 0.096.$$

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In terms of the probability p = 0.2 of a correct guess on a particulartrial, the solution $3(0.2)^2(0.8)$ for x = 2 correct in n = 3 trials equals $3p^2(1 - p)^1 = 3p^2(1 - p)^{n-x}$. The multiple of 3 represents the number ofways that two successes can occur in three trials (SSF or SFS or FSS). Youcan use similar logic to evaluate the probability that x = 0, or 1, or 3. Tryx = 1, for which you should get P (1) = 0.384.

**Note :** For independentevents, P (A and B) = P(A)P(B).

Thus, P(FSS) = P(F)P(S)P(S) =0.8 * 0.2 * 0.2.

**Problem 6 :** Jane Doe claims to possess extrasensoryperception (ESP). She says she can guess more oftenthan not the outcome of a flip of a balanced coin inanother room. In an experiment, a coin is flippedthree times. If she does not actually have ESP, findthe probability distribution of the number of hercorrect guesses.a. Do this by constructing a sample space, finding theprobability for each point, and using them to constructthe probability distribution.

## The formula for binomial probabilities (Optional) :

When the number of trials n is large,it's tedious to write out all the possible outcomes in the sample space. But there'sa formula you can use to find binomial probabilities for any n.

### Probabilities for a Binomial Distribution

Denote the probability of success on a trial by *p*. For *n* independent trials, the probability of *x* successes equals

$$P(x) = \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x}, \; x = 0, 1, 2, ..., n.$$

## Did You Know?

The term wih factorials at the start of the binomial formula is

$$\binom{n}{x} = \frac{n!}{x!(n-x)!}$$

which is also called the **binomial coefficient.** It is the number of outcomes that have *x* successes in *n* trials, such as the

$$\binom{n}{x} = \binom{3}{2}\frac{3!}{2!1!} = 3$$

outcomes (SSF, SFS, and FSS) that have $x = 2$ successes in $x = 3$ trials

The symbol n! is called n factorial. It represents n! = 1 * 2 * 3 * c * n, the product of all integers from 1 to n. That is, 1! = 1, 2! = 1 * 2 = 2,3! = 1 * 2 * 3 = 6, 4! = 1 * 2 * 3 * 4 = 24, and so forth. Also, 0! is definedto be 1. For given values for p and n, you can find the probabilities of the possibleoutcomes by substituting values for x into the binomial formula.

Let's use this formula to find the answer for the above Example:

- The random variable X represents the number of correct guesses (successes)in n = 3 trials
- The probability of a correct guess in a particular trial is p = 0.2.
- The probability of exactly two correct guesses is the binomial probability with n = 3 trials, x = 2 correct guesses, and p = 0.2 probability of a correct guess for a given trial,

$P(2) = (n! / (x! * (n - x)!))\ p^{x}\ (1 - p)^{n-x} = (3! / (2! * 1!)) * (0.2)^{2*}(0.8)^{1} = 3(0.04)(0.8) = 0.096$

**Problem 7 :** Let us introduce a case involving possible discrimination against female employees. A group of women employees has claimed that female employees are less likely than male employees of similar qualifications to bepromoted. Suppose the large employee pool that can be tapped for management training is half female and half male. In a group recently selected for promotion, none of the 10 individuals chosen were female. What would be the probability of 0 females in 10 selections, if there truly were no gender bias?

Suppose the population of individuals to choose for promotion contained only four people, twomen and two women (instead of the very large pool of employees), and thenumber chosen was n = 2. Do the binomial conditions apply for calculating the probability, under random sampling, of selecting 0 women in the two choices for promotion?

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**Mean and Standard Deviation of the Binomial Distribution :**

As with any discrete probability distribution, we can use the formula $\mu = \Sigma xP(x)$ to find the mean. However, finding the mean $\mu$ and standard deviation $\sigma$ is actually simpler for the binomial distribution. There are special formulas based on thenumber of trials n and the probability p of success on each trial.

## Binomial Mean and Standard Deviation

The binomial probability distribution for *n* trials with probability *p* of success on each trial has mean $\mu$ and standard deviation $\sigma$ given by

$$m = np, \quad s = \sqrt{np(1-p)}.$$

The formula for the mean makes sense. If the probability of success is p for agiven trial, then we expect about a proportion p of the n trials to be successes, orabout np total. If we sample n = 10 people from a population in which half arefemale, then we expect that about np = 10(0.50) = 5 in the sample will be female.

When the number of trials n is large, it can be tedious to calculate binomialprobabilities of all the possible outcomes. Often, it's adequate merely to use themean and standard deviation to describe where most of the probability falls.The binomial distribution has a bell shape when n is large (as explained in aguideline at the end of this section), so in that case, we can use the normal distribution to approximate the binomial distribution and conclude that nearly all theprobability falls between $\mu - 3\sigma$ and $\mu + 3\sigma$.

**Example 7 :** For the binomial distribution with n = 3 and p = .5, calculate the meanand the standard deviation.

**Solution :** Employing the formulas, we obtainMean = np = 3 * .5 = 1.5

$$\text{Sd} = \sqrt{npq} = \sqrt{3 * .5 * .5} = \sqrt{.75} = 0.866$$

**Problem 8 :** An exit poll is taken of 3000 voters in a statewide election. Let X denote the number who voted infavor of a special proposition designed to lower propertytaxes and raise the sales tax. Suppose that in the population, exactly 50% voted for it.

a. Explain why this scenario would seem to satisfy thethree conditions needed to use the binomial distribution. Identify n and p for the binomial.

b. Find the mean and standard deviation of the probability distribution of X.

c. Using the normal distribution approximation, give aninterval in which you would expect X almost certainlyto fall, if truly p = 0.50.

d. Now, suppose that the exit poll had x = 1706. Whatwould this suggest to you about the actual value of p?

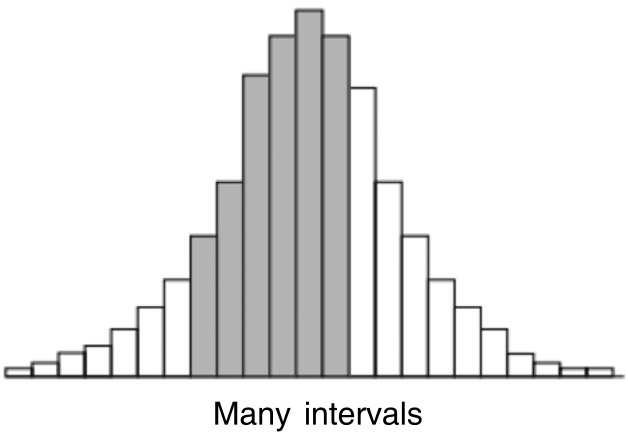
## Normal distribution :

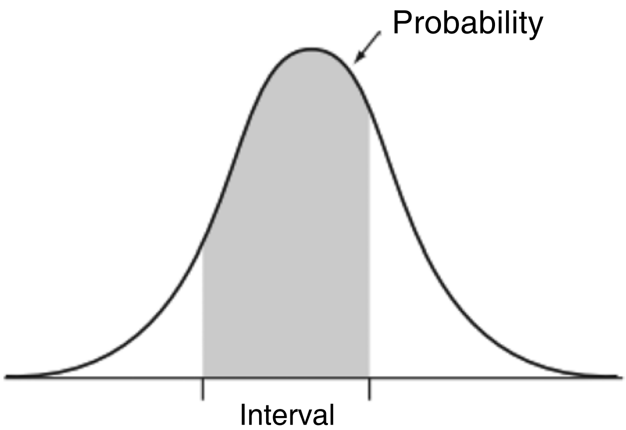
A random variable is called continuous when its possible values form an interval.For instance, a recent study analyzed the time thatpeople take to commute to work. Commuting time can be measured with realnumber values, such as between 0 and 150 minutes.

Probability distributions of continuous random variables assign probabilitiesto any interval of the possible values. For instance, a probability distribution forcommuting time provides the probability that the travel time is less than 15 minutes or that the travel time is between 30 and 60 minutes. The probability that arandom variable falls in any particular interval is between 0 and 1, and the probability of the interval that contains all the possible values equals 1.

When a random variable is continuous, the intervals of values for the bars ofa histogram can be chosen as desired. For instance, one possibility for commuting time is {0 to 30, 30 to 60, 60 to 90, 90 to 120, 120 to 150}, quite wide intervals.By contrast, using {0 to 1, 1 to 2, 2 to 3, c, 149 to 150} gives lots of very narrow intervals. As the number of intervals increases, with their width narrowing,the shape of the histogram gradually approaches a smooth curve. We'll use suchcurves to portray probability distributions of continuous random variables.

### Probability Distribution of a Continuous Random Variable






Smooth curve approximation

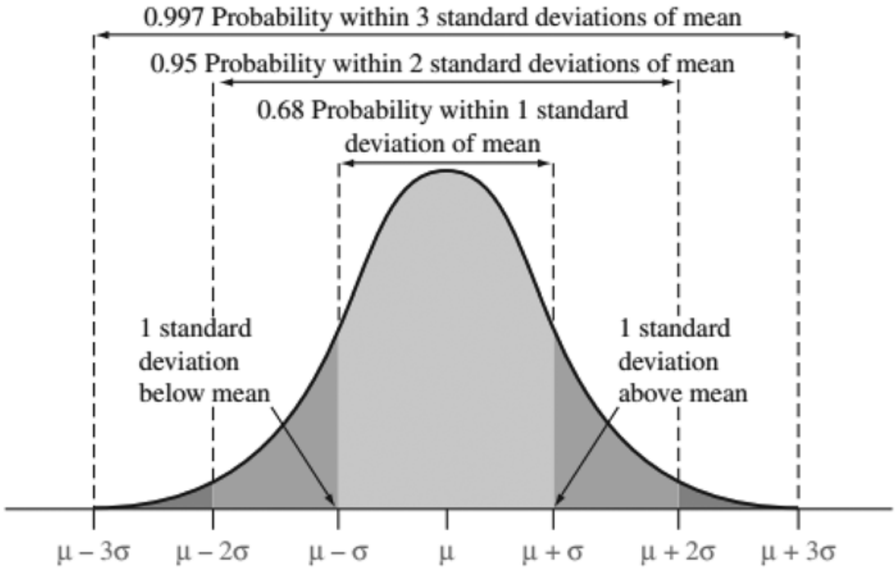
A **continuous** random variable hasd possible values that form an interval. Its **probability distribution** is specified by a curve that determines the probability that the random variable falls in any particular interval of values.

- Each interval has probability between 0 and 1. This is the area under the curve, above that interval.
- The interval containing all possible values has probability equal to 1, so the total area under the curve equals 1.

Some probability distributions merit special attention because they are useful for many applications. They have formulas or tables that provide probabilities of the possible outcomes. We next learn about a probability distribution, called the normal distribution, that is commonly used for continuous random variables. It is characterized by a particular symmetric, bell-shaped curve with two parameters—the mean ì and the standard deviation σ.

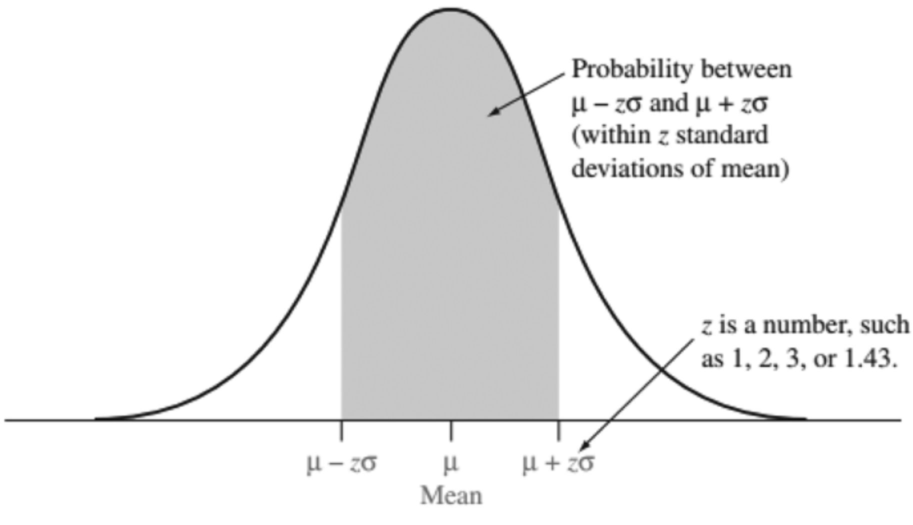
## Normal Distribution

The **normal distribution** is symmetric, bell-shaped, and characterized by its mean μ and standard deviation σ. The probability within any particular number of standard deviations of μ is the same for all normal distributions. This probability equals 0.68 within 1 standard deviation, 0.95 within 2 standard deviations, and 0.997 within 3 standard deviations. See Figure 6.5.




*The Normal Distribution. The probability equals 0.68 within 1 standard deviation of the mean, 0.95 within 2 standard deviations, and 0.997 within 3 standard deviations.*

The property of the normal distribution in the definition tells us probabilitieswithin 1, 2, and 3 standard deviations of the mean. The multiples 1, 2, and 3 ofthe number of standard deviations from the mean are denoted by the symbol zin general. For instance,




*The Probability between $\mu - z\sigma$ and $\mu + z\sigma$. This is the area highlighted under the curve. It is the same for every normal distribution and depends only on the value of z. Figure 6.5 showed this for z = 1,2, and 3, but z does not have to be an integer—it can be any number.*

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z = 2 for 2 standard deviations. For each fixed number z, the probability within z standard deviations of the mean is the area underthe normal curve between $\mu - z\sigma$ and $\mu + z\sigma$.

For everynormal distribution, this probability is 0.68 for z = 1, so 68% of the area (probability) of anormal distribution falls between $\mu - \sigma$ and $\mu + \sigma$. Similarly, this probability is 0.95 for z = 2, and nearly 1.0 for z = 3 (that is, between $\mu - 3\sigma$ and $\mu + 3\sigma$). The total probability for any normal distribution equals 1.0.

The normal distribution is the most important distribution in statistics,partly because many variables have approximately normal distributions. Thenormal distribution is also important because it approximates many discretedistributions well when there are a large number of possible outcomes. Themain reason for the prominence of the normal distribution is that many statistical methods use it even when the data are not bell shaped.

**Note :** the z-score for anobservation is the number of standarddeviations that it falls from the mean. Thez-score can be used with any distribution fora quantitative variable. This includes bothnormal and non-normal distributions.

## Finding Probabilities for the Normal Distribution :

As we'll discuss, the probabilities 0.68, 0.95, and 0.997 within 1, 2, and 3 standarddeviations of the mean are no surprise, because of the empirical rule. But what if we wanted to find the probability within, say, 1.43 standard deviations?

We have a table that enables us to find normal probabilities. It tabulates the normal cumulative probability, the probability of falling below the point $\mu + z\sigma$.

The leftmost column of the above-mentioned table lists the valuesfor z to one decimal point, with the second decimal place listed above the columns.

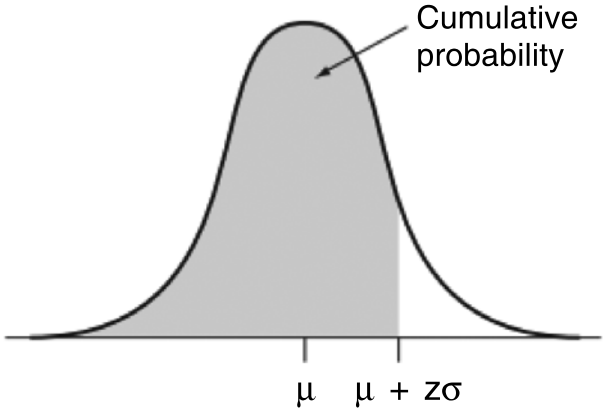


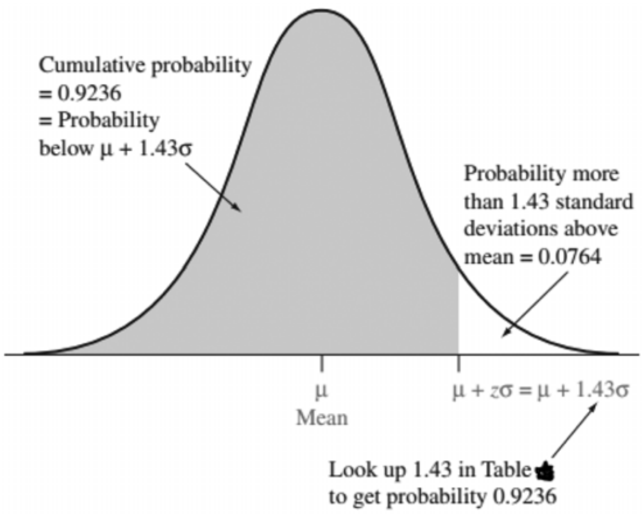
Table below shows a small excerpt from the original table. The tabulated probability for z = 1.43 falls in the row labeled 1.4 and in the column labeled 0.03. It equals 0.9236. For every normal distribution, the probability that falls below $\mu + 1.43\sigma$ equals 0.9236.

**Second Decimal Place of *z***

| *z* | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | .5000 | .5040 | .5080 | .5120 | .5160 | .5199 | .5239 | .5279 | .5319 | .5359 |
| ... | | | | | | | | | | |
| 1.3 | .9032 | .9049 | .9066 | .9082 | .9099 | .9115 | .9139 | .9147 | .9162 | .9177 |
| 1.4 | .9192 | .9207 | .9222 | .9236 | .9251 | .9265 | .9278 | .9292 | .9306 | .9319 |
| 1.5 | .9332 | .9345 | .9357 | .9370 | .9382 | .9394 | .9406 | .9418 | .9429 | .9441 |

*Part of the original Table for Normal Cumulative (Left-Tail) Probabilities. The top of the table gives the second digit for z. The table entry is the probability falling below $\mu + z\sigma$, for instance, 0.9236 below ì + 1.43σ for z = 1.43.*

Since an entry in Table A is a probability below $\mu + z\sigma$, one minus that probability is theprobability above $\mu + z\sigma$. For example, the right-tail probabilityabove $\mu + 1.43\sigma$ equals 1 – 0.9236 = 0.0764. By the symmetry of the normalcurve, this probability also refers to




*The Normal Cumulative Probability, Less than z Standard Deviations above the Mean. Table A lists a cumulative probability of 0.9236 for z = 1.43, so 0.9236 is the probability less than 1.43 standard deviations above the mean of any normal distribution (that is, below $\mu + 1.43\sigma$). The complement probability of 0.0764 is the probability above $\mu + 1.43\sigma$ in the right tail.*

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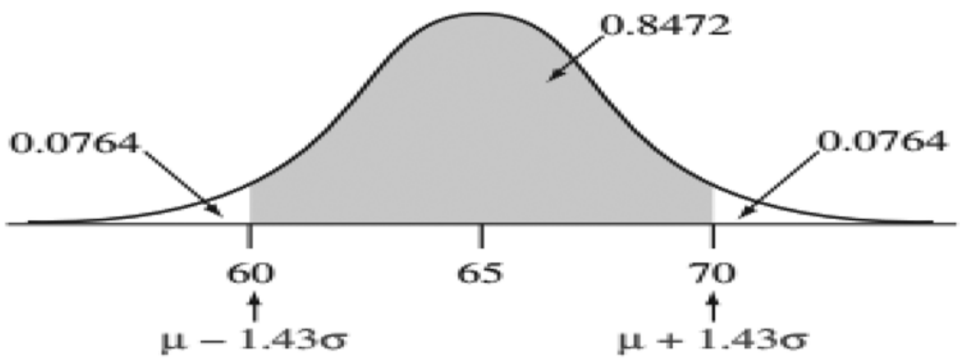
the left tail below $\mu - 1.43\sigma$, which you'llfind in the original table by looking up $z = -1.43$. The negative z-scores in the tablerefer to cumulative probabilities for random variable values below the mean.

Since the probability is 0.0764 in each tail, the total probability more than 1.43 standard deviations from the mean equals 2(0.0764) = 0.1528. The total probability equals 1, so the probability falling within 1.43 standard deviations of themean equals 1 – 0.1528 = 0.8472, about 85%. For instance, 85% of women in North America have height between $\mu - 1.43\sigma = 65.0 - 1.43(3.5) = 60$ inchesand $\mu + 1.43\sigma = 65 + 1.43(3.5) = 70$ inches (that is, between 5 feet and 5 feet, 10 inches).

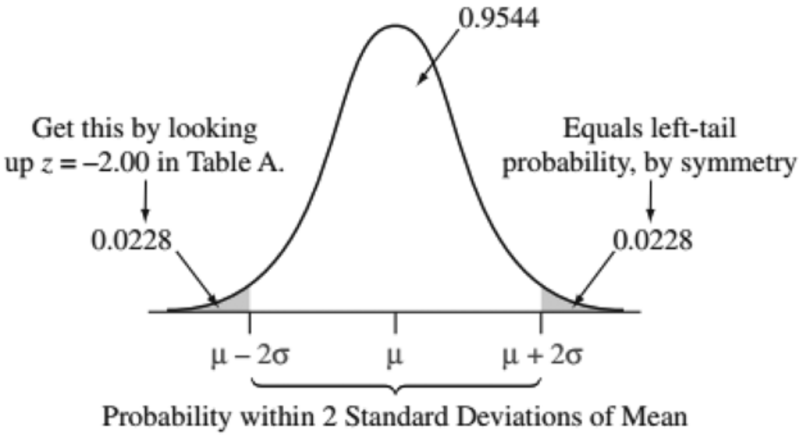



## Normal Probabilities and the Empirical Rule :

The empirical rule states that for an approximately bell-shaped distribution,about 68% of observations fall within 1 standard deviation of the mean, 95%within 2 standard deviations, and all or nearly all within 3. In fact, those percentages came from probabilities calculated for the normal distribution.

For instance, a value that is 2 standard deviations below the mean has$z = -2.00$. The cumulative probability below $\mu - 2\sigma$ listed in the table opposite$z = -2.00$. is 0.0228. The right-tail probability above $\mu + 2\sigma$ also equals 0.0228, by symmetry. See the figure drawn below. The probability falling more than 2 standard deviations from the mean in either tail is 2(0.0228) = 0.0456. Thus, the probabilitythat falls within 2 standard deviations of the mean equals 1 – 0.0456 = 0.9544.When a variable has a normal distribution, 95.44% of the distribution (95%, rounded) falls within 2 standard deviations of the mean.

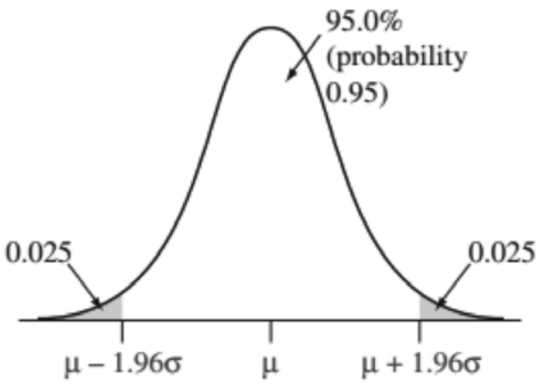
**Note :** Theempirical rule stated the probabilities as being approximate rather than exact because that rule referred to all approximately bell-shaped distributions, notjust the normal.




***Normal Probability within 2 Standard Deviations of the Mean.*** *Probabilities in one tail determine probabilities in the other tail by symmetry. Subtracting the total two-tail probability from 1.0 gives probabilities within a certain distance of the mean.*

## To Find the Value of z for a CertainCumulative Probability :

In practice, we'll sometimes need to find the value of z that corresponds to a certain normal cumulative probability. How can we do this? To illustrate, let's findthe value of z for a cumulative probability of 0.025. We look up the cumulative probability of 0.025 in the body of the table. It corresponds to z = –1.96, since it is in the row labelled –1.9 and in the column labelled 0.06. So, a probability of 0.025 lies below $\mu - 1.96\sigma$. Likewise, a probability of 0.025 lies above $\mu + 1.96\sigma$. A total probability of 0.050 lies more than $1.96\sigma$ from $\mu$. Precisely 95.0% of anormal distribution falls within 1.96 standard deviations



of the mean. We've seen previously that 95.44% falls within 2.00 standard deviations, and we now see that precisely 95.0% falls within 1.96 standard deviations.

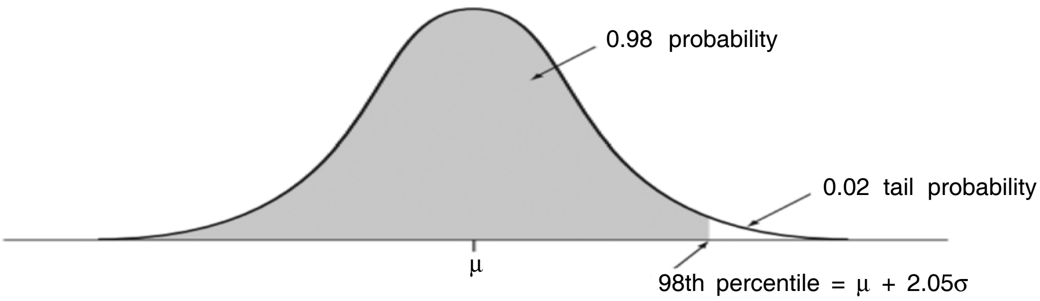
**Example 8 :** ABC is a society of high-IQ people whose members have IQ scores at the 98th percentile or higher. The XYZ IQ scores that are used as thebasis for admission into ABC are approximately normally distributed witha mean of 100 and a standard deviation of 16.

a. How many standard deviations above the mean is the 98th percentile?

b. What is the IQ score for that percentile?

**Solution :**

**a.** For a value to represent the 98th percentile, its cumulative probability must equal 0.98, by the definition of a percentile.




*The cumulative probability of 0.980 in the body of the table correspondsto z = 2.05. The 98th percentile is 2.05 standard deviations above themean, at $\mu + 2.05\sigma$.*

**b.** Since $\mu = 100$ and $\sigma = 16$, the 98th percentile of IQ scores equalsì + 2.05σ = 100 + 2.05(16) = 133.

In summary, 98% of the IQ scores fall below 133, and an IQ score of atleast 133 is required to join ABC.

About 2% of IQ scores are higher than 133. By symmetry, about 2% of IQ scores are lower than $\mu - 2.05\sigma = 100 - 2.05(16) = 67$. This is the secondpercentile. The remaining 96% of the IQ scores fall between 67 and 133, which is the region within 2.05 standard deviations of the mean.

**Problem 9 :** z-score for given probability in tails For a normaldistribution,

a. Find the z-score for which a total probability of0.02 falls more than z standard deviations (in eitherdirection) from the mean, that is, below $\mu - z\sigma$ orabove $\mu + z\sigma$.

b. For this z, explain why the probability more thanz standard deviations above the mean equals 0.01.

c. Explain why $\mu + 2.33\sigma$ is the 99th percentile.

**To find probabilities using Z :** We've used the symbol z to represent the number of standard deviations a valuefalls from the mean. If we have a value x of a random variable, how can we figureout the number of standard deviations it falls from the mean μ of its probability distribution? The difference between x and μ equals $x - \mu$. The z-score expressesthis difference as a number of standard deviations, using $z = (x - \mu)/\sigma$.

### *z*-Score for a Value of a Random Variable

the **z-score** for a value *x* of a random variable is the number of standard deviations that *x* falls from the mean μ. It is calculated as

$$z = \frac{x - m}{s}.$$

The formula for the z-score is useful when we are given the value of x for somenormal random variable and need to find a probability relating to that value. Weconvert x to a z-score and then use a normal table to find the appropriate probability.

**Example 9 :** The Scholastic Aptitude Test (SAT), a college entrance examination, hasthree components: critical reading, mathematics, and writing. The scores oneach component are approximately normally distributed with mean $\mu = 500$ and standard deviation $\sigma = 100$. The scores range from 200 to 800 on each component.

a. If your SAT score from one of the three components was $x = 650$,how many standard deviations from the mean was it?

b. What percentage of SAT scores was higher than yours?

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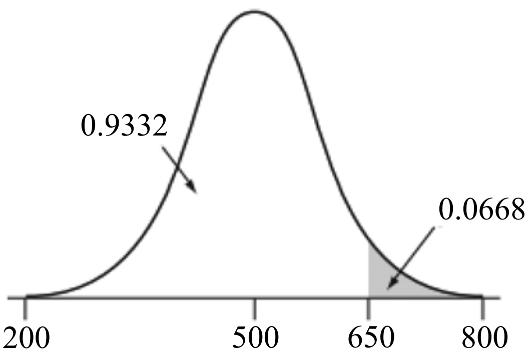
**Solution :**

**a.** The SAT score of 650 has a z-score of z = 1.50 because 650 is 1.50 standard deviations above the mean. In other words, x = 650 = μ + zσ = 500 + z (100), where z = 1.50. We can find thisdirectly using the formula

$$z = (x - \mu)/\sigma = 650 - 500 = 100 = 1.50.$$

**b.** The percentage of SAT scores higher than 650 is the right-tail probability above 650, for a normal random variable with mean μ = 500 and standard deviation σ = 100. From Table A, the z-score of 1.50 hascumulative probability 0.9332. That's the probability below 650, so theright-tail probability above it is 1 – 0.9332 = 0.0668. Only about 7% of SAT test scores fall above 650. In summary,a score of 650 was well above average, in the sense that relativelyfewstudents scored higher.



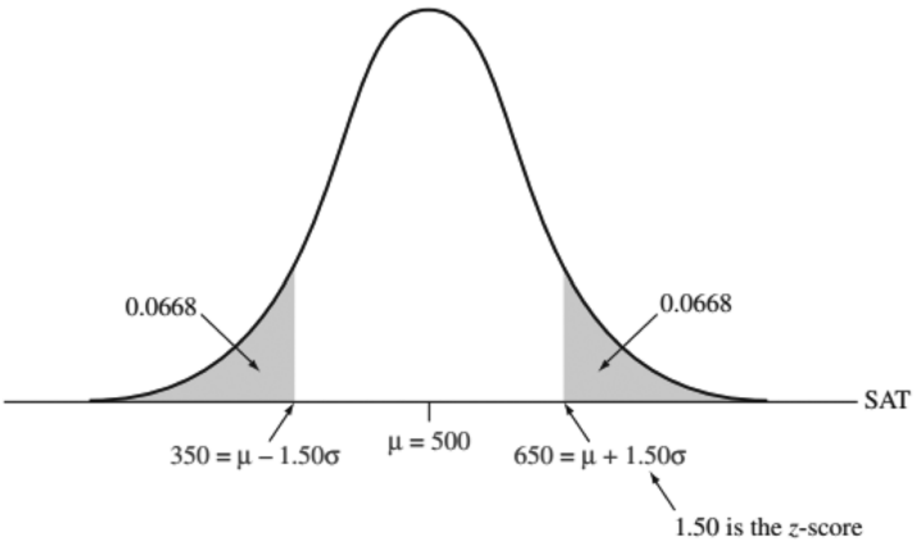

Positive z-scores occur when the value x falls above the mean μ. Negativez-scores occur when x falls below the mean. For instance, an SAT score = 350 has a z-score of

$$z = (x - \mu)/\sigma = (350 - 500) /100 = -1.50.$$

The SAT score of 350 is 1.50 standard deviations below the mean. Theprobability that an SAT score falls below 350 is also 0.0668.

**Problem 10 :** A World Health Organization study (the MONICA project) of health in various countriesreported that in Canada, systolic blood pressure readingshave a mean of 121 and a standard deviation of 16. Areading above 140 is considered to be high blood pressure.

a. What is the z-score for a blood pressure reading of 140?




b. If systolic blood pressure in Canada has a normaldistribution, what proportion of Canadians suffersfrom high blood pressure?

c. What proportion of Canadians has systolic bloodpressures in the range from 100 to 140?

d. Find the 90th percentile of blood pressure readings.

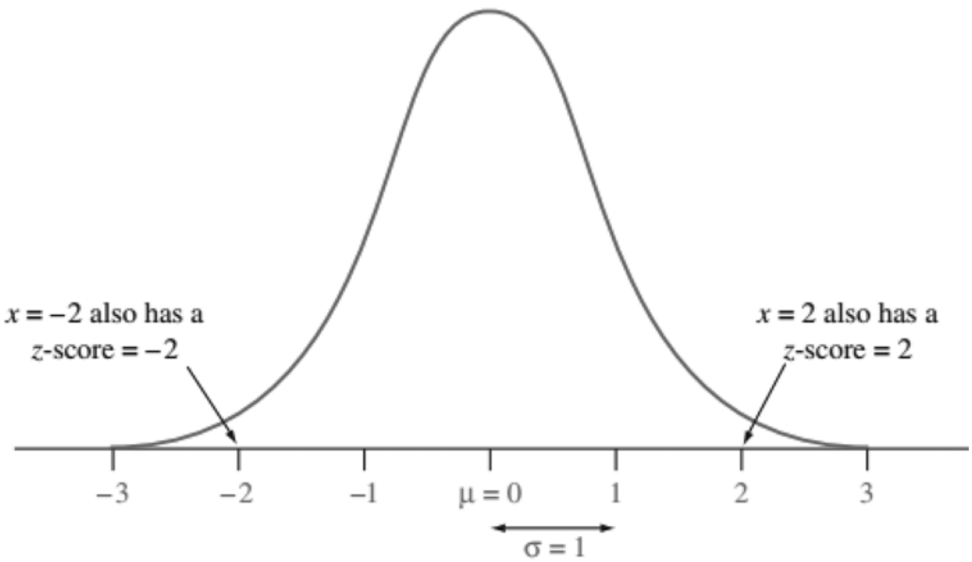
**The Standard Normal Distribution has Mean = 0 and Standard Deviation = 1**

Many statistical methods refer to a particular normal distribution called thestandard normal distribution.

> **Standard Normal Distribution**
>
> The **standard normal distribution** is the normal distribution with mean $\mu = 0$ and standard deviation $\sigma = 1$. It is the distribution of normal *z*-scores.

For the standard normal distribution, the number falling z standard deviations above themean is $\mu + z\sigma = 0 + z(1) = z$, simply the z-score itself. Forinstance, the value of 2.0 is two standard deviations above the mean, and thevalue of –1.3 is 1.3 standard deviations below the mean. As Figure drawn below shows, the original values are the same as the z-scores, since

$$z = (x - \mu)/\sigma = (x - 0)/1 = x.$$




***The Standard Normal Distribution.*** *This has mean = 0 and standard deviation = 1. The random variable value x is the same as its z-score.*

The previous example (example 6) dealt with SAT scores, having $\mu = 500$ and $\sigma = 100$. Suppose we convert each SAT score x to a z-score by using $z = (x - \mu)/\sigma = (x - 500)/100$. Then x = 650 converts to z = 1.50, and x = 350 converts toz = –1.50. When the values for a normal distribution are converted to z-scores, those z-scores have a mean of 0 and have a standard deviation of 1. That is, theentire set of z-scores has the standard normal distribution.

> ### *z*-Scores and the Standard Normal Distribution
> When a random variable has a normal distribution and its values are converted to *z*-scores by subtracting the mean and dividing by the standard deviation, the *z*-scores have the **standard normal** distribution (mean = 0, standard deviation = 1).

## A Quick Look at the Theory of Probability

People talk loosely about chance all the time, without doing any harm. What are the chances of getting a job? of meeting someone? of rain tomorrow? But for scientific purposes, it is necessary to give the word chance a definite, clear interpretation. This turns out to be hard, and mathematicians have struggled with the job for centuries. They have developed some careful and rigorous theories, but these theories cover just a small range of the cases where people ordinarily speak of chance. This section of the module will present the frequency theory, which works best for processes which can be repeated over and over again, independently and under the same conditions. Many games fall into this category, and the frequency theory was originally developed to solve gambling problems.

One simple game of chance involves betting on the toss of a coin. The process of tossing the coin can be repeated over and over again, independently and under the same conditions. The chance of getting heads is 50%: in the long run, heads will turn up **about** 50% of the time.

Take another example. A die (plural, "dice") is a cube with six faces, labelled 1,2,3,4,5,6. When the die is rolled, the faces are equally likely to turn up. The chance of getting an ace— is 1 in 6, or sixteen and two-third percentages. The interpretation: if the die is rolled over and over again, repeating the basic chance process under the same conditions, in the long run an ace will show **about** sixteen and two-third percentages of the time.

> The chance of something gives the percentage of time it is expected to happen, when the basic process is done over and over again, independently and under the same conditions.

If something is impossible, it happens 0% of the time. At the other extreme, if something is sure to happen, then it happens 100% of the time. All chances are between these two extremes.

> Chances are between 0% and 100%.

Here is another basic fact. Suppose you are playing a game and have a 45%chance to win. In other words, you expect to win about 45% of the time. So, youmust expect to lose the other 55% of the time.

> The chance of something equals 100% minus the chance of the opposite being

**Example 1 :** A box contains red marbles and blue marbles. One marble is drawn at random from the box (each marble has an equal chance to be drawn). If it is red, you win \$1. If it is blue, you win nothing. You can choose between two boxes :

- box A contains 3 red marbles and 2 blue ones.
- box B contains 30 red marbles and 20 blue ones.

Which box offers a better chance of winning, or are they the same?

**Solution :** Some people prefer box A, because it has fewer blue marbles. Others prefer B, because it has more red marbles. Both views are wrong. The two boxes offer the same chance of winning, 3 in 5. To see why, imagine drawing many times at random from box A (replacing the marble after each draw, so as not to change the conditions of the experiment). In the long run each of the 5 marbles will appear about 1 time in 5. So, the red marbles will turn up about 3/5 of the time. With box A, your chance of drawing a red marble is 3/5, that is, 60%.

Now imagine drawing many times at random with replacement from box B.Each of the 50 marbles will turn up about 1 time in 50. But now there are 30 redmarbles. With box B, your chance of winning is 30/50 = 3/5 = 60%, just as forbox A. What counts is the ratio number of red marbles/total number of marbles.

The ratio is the same in both boxes.

**Problem 1 :** A coin will be tossed 1,000 times. About how many heads are expected?

**Problem 2 :** A die will be rolled 6,000 times. About how many aces are expected?

**Problem 3 :** Match the numerical answers with the verbal descriptions (which may be used more than once).

| *Numerical answer* | | *Verbal description* | |
|---|---|---|---|
| (a) | –50% | (i) | This is as likely to happen as not. |
| (b) | 0% | (ii) | This is very likely to happen, but it's not certain. |
| (c) | 10% | (iii) | This won't happen. |
| (d) | 50% | (iv) | This may happen, but it's not likely. |
| (e) | 90% | (v) | This will happen, for sure. |
| (f) | 100% | (vi) | There's bug in the program. |
| (g) | 200% | | |

**Some Definitions :**

A **probability experiment** is an action, or trial, through which specific results(counts, measurements, or responses) are obtained. The result of a single trialin a probability experiment is an **outcome**. The set of all possible outcomesof a probability experiment is the **sample space**. An **event** is a subset of thesample space. It may consist of one or more outcomes.The probability that event E will occur iswritten as P(E) and is read as "the probability of event E." Probabilities can be written asfractions, decimals, or percent.

Here is a simple example ofthe use of the terms**probability experiment, sample space, event,** and **outcome.**

**Probability Experiment :** Roll a six-sided die.

**Sample Space :** {1, 2, 3, 4, 5, 6}

**Event :** Roll an even number, {2, 4, 6}.

**Outcome :** Roll a 2, {2}.

**Conditional probabilities :** A conditional probability is the probability of an event occurring, given that another event has already occurred. The conditional probability of event B occurring, given that event A has occurred, is denoted by P(B|A) and is read as "probability of B, given A.

**Example 2 :** Two cards are selected in sequence from a standard deck of 52 playing cards. Find the probability that the second card is a queen, given that the first card is a king. (Assume that the king is not replaced.)

**Solution :** Because the first card is a king and is not replaced, the remaining deck has 51 cards, 4 of which are queens. So,

$$P(B|A) = 4/51 = 0.078$$

**Note :** A deck of cards has 4 suits: clubs, diamonds, hearts, spades. There are 13 cardsin each suit: 2 through 10, jack, queen, king, ace. So, there are 4 × 13 = 52 cardsin the deck.

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**Standard Deck of Playing Cards**

| Hearts | Diamonds | Spades | Clubs |
|---|---|---|---|
| A ♠ | A ♦ | A ♠ | A ♣ |
| K ♠ | K ♦ | K ♠ | K ♣ |
| Q ♠ | Q ♦ | Q ♠ | Q ♣ |
| J ♠ | J ♦ | J ♠ | J ♣ |
| 10 ♠ | 10 ♦ | 10 ♠ | 10 ♣ |
| 9 ♠ | 9 ♦ | 9 ♠ | 9 ♣ |
| 8 ♠ | 8 ♦ | 8 ♠ | 8 ♣ |
| 7 ♠ | 7 ♦ | 7 ♠ | 7 ♣ |
| 6 ♠ | 6 ♦ | 6 ♠ | 6 ♣ |
| 5 ♠ | 5 ♦ | 5 ♠ | 5 ♣ |
| 4 ♠ | 4 ♦ | 4 ♠ | 4 ♣ |
| 3 ♠ | 3 ♦ | 3 ♠ | 3 ♣ |
| 2 ♠ | 2 ♦ | 2 ♠ | 2 ♣ |

**Example 3 :** The table below shows the results of a study in which researchersexamined a child's IQ and the presence of a specific gene in the child. Findthe probability that a child has a high IQ, given that the child has the gene.

| | **Gene present** | **Gene not present** | **Total** |
|---|---|---|---|
| **High IQ** | 33 | 19 | 52 |
| **Normal IQ** | 39 | 11 | 50 |
| **Total** | 72 | 30 | 102 |

**Solution :** There are 72 children who have the gene. So, the sample space consists of these 72 children, as shown at the left. Of these, 33 have a high IQ. So,

$$P(B|A) = 33/72 = 0.458$$

The probability that a child has a high IQ, given that the child has the gene, is about 0.458.

**Sample Space**

| | **Gene present** |
|---|---|
| **High IQ** | 33 |
| **Normal IQ** | 39 |
| **Total** | 72 |

**Example 4 :** A deck of cards is shuffled, and the top two cards are put on atable, face down. You win $1 if the second card is the queen of hearts.

(a) What is your chance of winning the dollar?

(b) You turn over the first card. It is the seven of clubs. Now what is yourchance of winning?

**Solution :**

**(a)** The bet is about the second card, not the first. Initially, this will seem a little strange. Some illustrations may help.

- If the first card is the two of spades and the second is the queen of hearts,you win.
- If the first card is the jack of clubs and the second is the queen of hearts,you win.
- If the first card is the seven of clubs and the second is the king of hearts, you lose.

The bet can be settled without even looking at the first card. The second card isall you need to know.

The chance of winning is 1/52. To see why, think about shuffling the deck.That brings the cards into random order. The queen of hearts has to wind upsomewhere. There are 52 possible positions, and they are all equally likely. So,there is 1 chance in 52 for her to wind up as the second card in the deck—andbring you the dollar.

**(b)** There are 51 cards left. They are in random order, and the queenof hearts is one of them. She has 1 chance in 51 to be on the table. Your chancegoes up a little, to 1/51. That is the answer.

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The 1/51 in part (b) is a conditional chance. The problem puts a conditionon the first card: it has to be the seven of clubs. A mathematician might talk aboutthe conditional probability that the second card is the queen of hearts given thefirst card is the seven of clubs. To emphasize the contrast, the 1/52 in part (a) iscalled an unconditional chance: the problem puts no conditions on the first card.

**Problem 4 :** A penny is tossed 5 times.

(a) Find the chance that the 5th toss is a head.

(b) Find the chance that the 5th toss is a head, given the first 4 are tails.

**Problem 5 :** Five cards are dealt off the top of a well-shuffled deck.

(a) Find the chance that the 5th card is the queen of spades.

(b) Find the chance that the 5th card is the queen of spades, given that the first 4 cards are hearts.

## The multiplication rule :

To find the probability of two events occurring in sequence, you can use theMultiplication Rule.

The probability that two events A and B will occur in sequence is :

$$P\ (A \text{ and } B) = P(A).\ P(B|A).$$

If events A and B are independent, then the rule can be simplified to P (A and B) = P(A). P(B). This simplified rule can be extended to anynumber of independent events.

**Example 5 :** Two cards are selected, without replacing the first card, from a standarddeck of 52 playing cards. Find the probability of selecting a king and thenselecting a queen.

**Solution :** P (K and Q) = P(K). P(Q|K) = (4/52). (4/51) = (16/2652) = 0.006

So, the probability of selecting a king and then a queen without replacementis about 0.006.

**Example 6 :** A coin is tossed, and a die is rolled. Find the probability of tossing a headand then rolling a 6.

**Solution :** The events are independent.

P(H and 6) = P(H).P6)

= (1/2).(1/6)

= (1/12)

= 0.083

So, the probability of tossing a head and then rolling a 6 is about 0.083.

**Problem 6 :** A deck of cards is shuffled, and two cards are dealt. What isthe chance that both are aces?

**Problem 7 :** A coin is tossed twice. What is the chance of a head followedby a tail?

**Problem 8 :** A coin is tossed 3 times.

(a) What is the chance of getting 3 heads?

(b) What is the chance of not getting 3 heads?

(c) What is the chance of getting at least 1 tail?

(d) What is the chance of getting at least 1 head?

## Independence :

Two things are independent if the chances for the second given thefirst are the same, no matter how the first one turns out. Otherwise,the two things are dependent.

**Example 7 :** Someone is going to toss a coin twice. If the coin lands heads on the second toss, you win a dollar.

(a) If the first toss is heads, what is your chance of winning the dollar?

(b) If the first toss is tails, what is your chance of winning the dollar?

(c) Are the tosses independent?

**Solution :** If the first toss is heads, there is a 50% chance to get heads thesecond time. If the first toss is tails, the chance is still 50%. The chances for thesecond toss stay the same, however the first toss turns out. That is independence.

**Note :** If two things are independent, the chance that both will happenequals the product of their unconditional probabilities. This is aspecial case of the multiplication rule.

**Problem 9 :** Every week you buy a ticket in a lottery that offers one chance in a million ofwinning. What is the chance that you never win, even if you keep this up for tenyears?

## The Addition Rule :

This section is about the chance that at least one of two specified things willhappen: either the first happens, or the second, or both. The possibility of bothhappening turns out to be a complication, which can sometimes be ruled out.

Two things are mutually exclusive when the occurrence of one prevents the occurrence of the other: one excludes the other.

**Example 8 :** A card is dealt off the top of a well-shuffled deck. The cardmight be a heart. Or, it might be a spade. Are these two possibilities mutuallyexclusive?

**Solution :** If the card is a heart, it can't be a spade. These two possibilitiesare mutually exclusive.

We can now state a general principle for figuring chances. It is called the**addition rule**.

**Addition Rule :** To find the chance that at least one of two thingswill happen, check to see if they are mutually exclusive. If theyare, add the chances.

**Example 9 :** A card is dealt off the top of a well-shuffled deck. There is 1chance in 4 for it to be a heart. There is 1 chance in 4 for it to be a spade. What isthe chance for it to be in a major suit (hearts or spades)?

**Solution :** The question asks for the chance that one of the following twothings will happen :

- the card is a heart.
- the card is a spade.

If the card is a heart then it can't be a spade: these are mutuallyexclusive events. So it is legitimate to add the chances. The chance of getting acard in a major suit is 1/4 + 1/4 = 1/2. (A check on the reasoning: there are 13hearts and 13 spades, so 26/52 = 1/2 of the cards in the deck are in a major suit.)

**Note :** If you want to find the chance that at least one event occurs, andthe events are not mutually exclusive, do not add the chances: thesum will be too big.

Blindly adding chances can give the wrong answer, by double counting the chancethat two things happen. With mutually exclusive events, there is no double counting: that is why the addition rule works.

Technically, The probability that events A or B will occur, P (A or B), is given by

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

If events A and B are mutually exclusive, then the rule can be simplified toP(A or B) = P(A) + P(B). This simplified rule can be extended to anynumber of mutually exclusive events.

In words, to find the probability that one event or the other will occur, addthe individual probabilities of each event and subtract the probability that theyboth occur. As shown in the Venn diagram at the left, subtracting P(A and B) avoids double counting the probability of outcomes that occur in both A and B.

**Problem 10 :** You select a card from a standard deck of 52 playing cards. Find theprobability that the card is a 4 or an ace.

**Problem 11 :** You roll a die. Find the probability of rolling a number less than 3 or rollingan odd number.

**Note :** What's the difference between mutually exclusive and independent?

"Mutually exclusive" is one idea; independence is another. Both ideas applyto pairs of events and say something about how the events are related. However,the relationships are quite different.

- Two events are mutually exclusive if the occurrence of one prevents theother from happening.
- Two events are independent if the occurrence of one does not change thechances for the other.

**Note :** When do I add and when do I multiply?

The addition rule, like the multiplication rule, is a way of combining chances.However, the two rules solve different problems.

- The addition rule finds the chance that at least one of two things happens.
- The multiplication rule finds the chance that two things both happen.

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So, the first step in deciding whether to add or to multiply is to read the question : Do you want to know P (A or B), P (A and B), or something else entirely? Butthere is also a second step—because the rules apply only if the events are relatedin the right way.

- Adding the probabilities of two events requires them to be mutually exclusive.
- Multiplying the unconditional probabilities of two events requires them tobe independent. (For dependent events, the multiplication rule uses conditional probabilities.)

## 7.7 Conclusion

We developed a knowledge about measures of central tendencies and dispension. The solved examples helped us to understand the concept in a better manner.

## 7.8 Exercise

1. Define measures of central tendencies.
2. What is Range.
3. What is Mean.
4. What is Mode

## 7.9 References

I. Statistical Methods For The Social Sciences: Alan Agresti, Fifth Edition, 2018, Pearson.

II. Statistics for Social Workers: Essential Concepts: David Royse, Denise Montcalm, Austin Griffiths, Second Edition,2021, Cognella.

III. Introductory Statistics:NeilA. Weis, 10th Edition, Pearson, 2017.

# Unit 8 ❑ The Statistics of Relationship

*Structure*



## 8.0 Objectives

By the end of this chapter, you should understand the following concepts:

1.1 What correlation is (and is not)



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1.2 How to determine the strength and direction of a correlation based on Pearson's r

1.3 How to use the coefficient of determination

1.4 How to read scatter grams and correlation tables

## 8.1 Introduction

**Introduction:** Analyzing relationships between variables that affect people is as important as analyzing relationships between people. Correlational methods help you better understand people, communities, and policy. If you are interested in what protective factors might help develop resilience in your client, correlations help with that. If you have ever wondered whether a person's income can help predict school outcomes for their children, correlations help with that too. Or if you have ever wondered whether older adults who are lonely are more likely to experience poor health outcomes, correlations can provide useful context there too. The relationships between these variables affect the people you work with, and correlations help you analyze variables more effectively.

## 8.2 What are Independent and Dependent Variables?

A variable is an entity that is being measured. There are two kinds of variables: independent and dependent.

- An independent variable (x) is the input, the one that is manipulated in a scientific experiment, or one that is stable and unaffected by the other variables you are trying to measure.
- A dependent variable (y) is the output, the one that has a consequent role in relation to the independent variable; changes made to the independent variable affect the dependent variable.

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For example, in a comparison of income and poverty, income is the independent variable. Poverty is the dependent variable because a person's income level determines whether that person is above or below the poverty line.

In a clinical setting, the dose of an antianxiety medication is the independent variable, and level of reported anxiety is the dependent variable. Adjusting the dose of the medication should affect the level of anxiety. The level of anxiety is dependent on adjusting the dosage of medication to find the best fit.

## 8.3 How do I measure correlation?

Pearson's r, also known as the Pearson product-moment correlation coefficient, was named for British statistician Karl Pearson. Pearson's r is a common statistical tool you will come across in academic studies. As its name suggests is a measure of correlation. Specifically, Pearson's r creates a scale for understanding how correlated two variables are with each other. For your social work practice, understanding and interpreting Pearson's r is more important than being able to calculate it.

### 8.3.1 How Do I know how strong a relationship is?

Pearson's r measures both the strength of a relationship and its direction.

- Pearson's r can only have a value between “1 and 1.
- The strength of a relationship is determined by the distance of r from 0, or the absolute value of r.
- The direction of a relationship is determined by whether the value is positive or negative.

If a correlation is positive, one variable increases as the other increases.

If a correlation is negative, one variable increases as the other increases.

Variable X | Variable Y | Variable X | Variable Y

**Figure 1.1 :** Relationships and correlation

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When a correlation is positive, one variable follows the other. If one increases, the other increases. If one decreases, the other decreases. This is a direct relationship. When a correlation is negative, one variable behaves the opposite of the other. If one increases, the other decreases. If one decreases, the other decreases. This is an inverse relationship.

- If Pearson's r is equal to 1, then the relationship is a perfect (very strong) direct relationship.
- If Pearson's r is equal to "1, then the relationship is a perfect (very strong) inverse relationship.
- If Pearson's r is equal to 0, then there is no relationship.

Consider the values for the strength of a relationship as though they fall on a scale like the one depicted in figure 1.2.

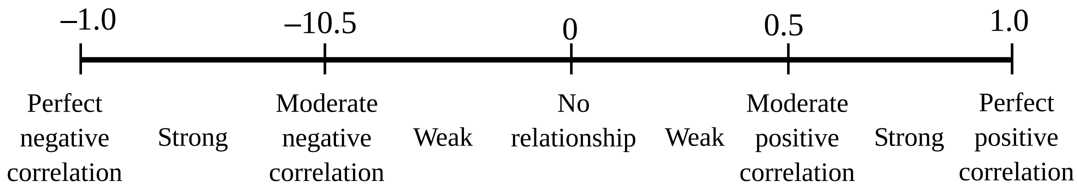


**Figure 1.2 :** Measuring magnitude of Pearson's r

A scale for measuring the magnitude of Pearson's r where one end begins with "1.0 and a perfect negative correlation and the other end is 1 with a perfect positive correlation. In the middle is a 0 where there is no relationship at all and between the ends and the middle there are strong, moderate, and weak levels of correlation.

## 8.4 Spurious Correlations

A relationship with either a perfect correlation (1 or "1) or no correlation at all (0) is rare. Some variables are correlated even though no causal relationship exists. These correlations are called spurious correlations. A spurious correlation is misleading because the r value indicates that a correlation exists between two variables but the correlation is produced through the operation of a third causal variable that is not examined by the analysis, or the correlation may be due to random chance.

For example, the number of marriages in West Bengal is correlated with the annual deaths caused by lightning strikes in the India at r = 0.89. You just learned

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that r = 0.89 is considered a strong positive correlation. As more people get married in West Bengal, it must be more likely people in India will be struck by lightning. Could the number of people who get married in West Bengal somehow cause more lightning strikes? Or could the fear of getting struck by lightning cause more people in West Bengal to propose? This relationship does not make sense. When a relationship does not make sense, you should look for other possible explanations.

Here are two possible explanations in this case:

- A third variable, population, is driving the relationship. The increase in population is leading both to more marriages in West Bengal and to more people who could potentially be struck by lightning.
- Random chance caused these two values to increase at the same time.

Another example of spurious correlation in the social work literature has to do with the relationship between family income and child development. Researchers have argued that income effects are driven by unmeasured factors that are correlated with both income and child outcomes but are not captured when simply looking at income and child development. They argue that rather than income driving the relationship, factors such as parental mental health or motivation drive earnings and also affect child development. The underlying relationship between these other factors leads to a spurious correlation between income and child development.

If family income has a spurious relationship with child development, the types of interventions you would consider to improve child outcomes are different. Instead of focusing on connecting families to cash assistance programs or helping parents find jobs, you would prioritize addressing any mental health challenges that may be driving both income insecurity and poor child development.

## 8.5 How can I understand relationships visually?

You can understand correlations visually using a scatterplot or scattergram—a diagram or graph that plots variables to show their relationship. The figure below shows examples of this type of graph.

Three graphs showing strong positive correlation, no correlation, and strong negative correlation. The positive correlation has fairly closely clustered data around an upward-sloping line with r = 0.96. No correlation has data points scattered in a way that appears random, with no clear clustering of points and an r of 0.04. The

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negative correlation has fairly closely clustered data around a downward-sloping line with r = “0.94.

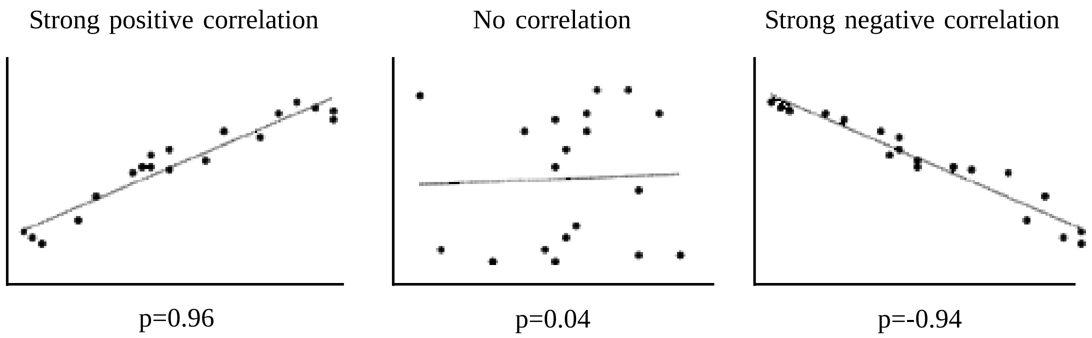


**Figure 1.3:** Understanding correlation using scatterplots

In figure 1.3, the left graph shows an example of a strong positive or direct correlation (r = 0.96, very close to 1). The values of one variable increase with the values of the other variable. For example, this could show the relationship between years of education and income. As the number of years people spend in school increases, so does their eventual annual income, with individuals who have advanced degrees earning the highest incomes. One variable increases (education level measured by number of years) as the other increases (annual salary measured in dollars).

The second graph shows an example of no correlation. While r is not quite zero, this is a very weak correlation (r = 0.04). No relationship exists between the two variables plotted here. Even though a trend line is included, you see no clear pattern in the points. This could show the relationship between the amount of coffee people drink and the number of pets they own. One variable (coffee consumed measured in ounces) does not increase or decrease in the same way the other variable (pets measured as the number of cats, dogs, birds, etc.) does. We would expect no relationship to exist between these two variables.

The final graph in figure 5.3 shows an example of a strong negative or inverse correlation (r = “0.94, very close to “1). The values of one variable decrease as the values of the other variable increase. This could show the relationship between college GPA and alcohol use. As the amount of alcohol regularly consumed by college students increases, the value of their GPA decreases. One variable increases (alcohol consumption measured in number of drinks), but the other decreases (GPA).

Not all relationships are so clear, with either a strong or weak correlation. In figure 1.4, the relationships are much weaker than those shown in figure 1.3. In

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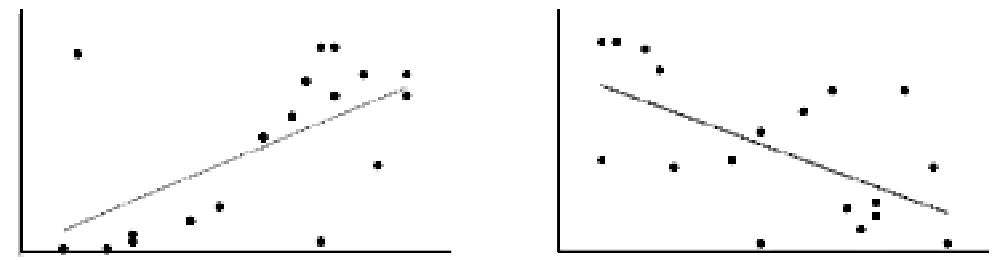
figure 1.4, despite some outliers and no tightly clustered points, the r value is still 0.6 or “0.6, a moderate correlation.

Positive correlation Nagative correlation



r=0.60 r=-0.60

**Figure 1.4:** Scatterplots for moderate correlations

Two graphs showing moderate positive and negative correlations. The positive correlation has some data points that are closely clustered around an upward-sloping line but others that are further from those clusters; r = 0.6. The negative correlation has some data points that are closely clustered around a downward-sloping line but others that are further from those clusters; r = “0.6.

When you analyze correlation data, you must understand the relationship between the strength or magnitude of a correlation and the direction of the correlation. Of the following r values, which has the stronger correlation?

0.34 Or -0.45

The value of r = “0.45 is a stronger correlation than r = 0.34.

You first use the absolute value of r to determine the magnitude of a correlation and then take into account the direction of the relationship between the variables. The absolute values here are 0.34 and 0.45, and 0.45 is stronger than 0.34. A negative sign before the value for r does not affect the strength of the relationship, only the direction. If there is a negative sign, then you know the relationship is inverse. Without a negative sign, the relationship is direct or positive.

**Correlations, Risk, and Resilience**

Much of what we know about mental illness, particularly about the risk and resilience factors, is based on studies of correlations between diagnoses and genetic and environmental factors. As a social worker, you will use the results of correlational research to inform your work with clients and to shape your practice. Consider the following statements from an article in the journal Social Work

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Research: Risk factors are markers, correlates, and—in a best-case scenario—causes. For example, although other factors are related to serious mental illnesses such as schizophrenia, parental psychopathology is thought to influence the likelihood of developing the disorder. How it does that—whether through genetic or environmental influences—is not yet fully understood. But the word “risk” denotes the fact that a group of people with a similar characteristic is more likely than others in the population at large to develop a problem (in this case, schizophrenia).

The article is describing correlational research. There is a relationship between mental illnesses such as schizophrenia and whether parents have also experienced a mental illness, but setting up experiments to find a causal relationship is impossible. You cannot control who a person’s parents are, nor whether they have a mental illness. Instead, once an individual has been diagnosed later in life, researchers can look back at factors from the person’s childhood, or at the person’s lifestyle for environmental factors, but cannot limit or control factors in the person’s life to set up a more rigorous experiment. Correlation does not guarantee there is a causal relationship, but when you cannot achieve causal results, correlations can create a body of useful literature for practitioners to draw from.

The article goes on to describe some risk factors that are correlated with mental health disorders:

Some individual, familial, and extra-familial factors appear to affect many disorders concomitantly and, in that sense, they are “nonspecific” risks. They elevate risk for a variety of conditions. These risk factors include child abuse; chronic family conflict; unskilled parenting; academic failure; peer rejection; poverty; racism, sexism, and other types of discrimination; and neighborhood disorganization.

Imagine you are working in a high school. You know from this article that parental psychopathology is correlated with mental illness and that experiences of child abuse, academic failure, and poverty are also correlated with higher risks. This knowledge could help you prioritize students for mental health screenings and early intervention. It could lead you to include questions on your intake form about students’ family history with different conditions. If you work in a school where poverty and racism are common experiences, this correlational research may motivate you to develop resilience tools and training for students to mediate some of these risk factors.

Fraser, Mark W., Maeda J. Galinsky, and Jack M. Richman. 1999. “Risk, Protection, and Resilience: Toward a Conceptual Framework for Social Work Practice.” Social Work Research 23(3): 131–143.

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## 8.6 How do I read a correlation table?

Scholarly articles that discuss correlation often include a correlation table or correlation matrix. Table 1.1 is an example of a correlation table. You may have never seen a table like this, but it can provide a lot of information.

Table 1.1 Correlations Among Variables

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| 1. Poverty | 1 | 0.24 | 0.20 | 0.70 |
| 2. Population | 0.24 | 1 | 0.53 | 0.15 |
| 3. Violent crime rate | 0.20 | 0.53 | 1 | 0.26 |
| 4. Unemployment rate | 0.70 | 0.15 | 0.26 | 1 |

First, notice that there are numbers beside each variable name and along the top of the table. This is a common shorthand used in correlation tables instead of including the variable names in the table twice. When there is a 1 at the top of the table, it is in place of "Poverty." This method allows the author to save space, but the numbers could be replaced with the name of the variable without changing the results in the table.

Notice that the number 1 is repeated along the diagonal; in other tables, these 1s may be replaced with dashes or blank spaces. The 1 occurs when a variable is compared to itself. For example, where "Violent crime rate" and column 3 meet in the table, there is a 1, indicating a perfect correlation between these two variables because they are the same variable. In figure 1.5 the 1s are highlighted for when a variable is compared to itselff.

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| 1. Poverty | 1 | 0.24 | 0.20 | 0.70 |
| 2. Population | 0.24 | 1 | 0.53 | 0.15 |
| 3. Violent crime rate | 0.20 | 0.53 | 1 | 0.26 |
| 4. Unemployment rate | 0.70 | 0.15 | 0.26 | 1 |

**Figure 1.5:** Perfect correlations in a correlation table

A correlation table highlighting the places where a variable intersects with itself in the table and therefore has a perfect correlation. Where this happens, a 1 is shown

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in the table, and those 1s create a diagonal line through the center of the correlation table.

To find the value of the Pearson's r for each set of variables, you find the intersection where the two variables meet. In figure 1.6, you can see that if you want to find the r value for the relationship between Poverty and Violent crime rate (indicated by the number 3 at the top of the table), you find the point where the row and column intersect. In this case, the intersection point is at r = 0.20.

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| 1. Poverty | 1 | 0.24 | 0.20 | 0.70 |
| 2. Population | 0.24 | 1 | 0.53 | 0.15 |
| 3. Violent crime rate | 0.20 | 0.53 | 1 | 0.26 |
| 4. Unemployment rate | 0.70 | 0.15 | 0.26 | 1 |

**Figure 1.6:** Finding correlations in a correlation table

A correlation table indicating the intersection between the variable Poverty and the variable Violent crime rate. The row for Poverty is highlighted, as is the third column, which corresponds to Violent crime rate. The Pearson's r for this relationship is found where the two highlighted areas cross.

You may also see data tables that looks like table 1.2.

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| 1. Poverty | – | | | |
| 2. Population | 0.24 | – | | |
| 3. Violent crime rate | 0.20 | 0.53 | – | – |
| 4. Unemployment rate | 0.70 | 0.15 | 0.26 | 1 |

In this table, half of the table is left blank because the values simply repeat those listed in the lower half of the table. All the information represented in table 1.1 is still present in table 1.2, but repeating values are only displayed once. If you look again at table 5.1, you will notice that if you find where Poverty intersects with column 3 for Violent crime rate, it is 0.20. If you follow Poverty in row 1 to column 3 for Violent crime rate in table 1.2, you will not find a value. Instead, follow row 3 for Violent crime rate to column 1 for Poverty to find the same 0.20.

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| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1. Poverty | 1 | 0.24 | 0.20 | 0.70 |
| 2. Population | 0.24 | 1 | 0.53 | 0.15 |
| 3. Violent crime rate | 0.20 | 0.53 | 1 | 0.26 |
| 4. Unemployment rate | 0.70 | 0.15 | 0.26 | 1 |

**Figure 1.7:** Mirrored data in correlation tables

In a correlation table, there are two places where the same variables intersect. When looking for the relationship between violent crime and poverty you can either go to the first row for Poverty and the third column for Violent crime rate to find the Pearson's r, or you can look at the third row and the first column. The values you find in these two locations will be the same.

## 8.7 How can I predict variance?

You may want to use correlations to predict what will happen in the future rather than examine what has already happened. Pearson's r cannot help with this, but the coefficient of determination, referred to as $r^2$, can.

Variance is simply a measure of how much a set of numbers differs from their average value. The coefficient of determination determines the proportion of the variance in the dependent variable that is predictable from the independent variable. For example, the coefficient of determination might indicate that an increase in the amount of exercise people do each day can predict 20 percent of the change in their weight over a given period of time.

The calculation for $r^2$ is relatively simple. Once you find the value of r, you square this value. Because all r values are between "1 and 1, the squaring operation results in a smaller value for $r^2$ than for r. Suppose, for example, that r = 0.65.

$r^2 = 0.65^2 = 0.65 \times 0.65 = 0.42$

When $r^2 = 0.42$, then 42 percent of the variation in one variable is predicted by the variance in the other variable, or one variable is 42 percent effective at predicting the other.

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**Setting Priorities Using the Coefficient of Determination**

Often social workers have to make choices about how to target services. Resources are limited, and they need to be used effectively. Understanding correlations and coefficients of determination can provide context for decisions about how to use scarce resources.

For example, if you work for an organization that addresses intimate-partner violence (IPV) and you want to start a prevention program, what population should you focus your resources on? You may not have the capacity to serve everyone. Is there a way to target your services to have the greatest effect?

Some studies have tried to find predictive variables for the incidence of IPV. These studies looked for relationships among variables such as education level, employment status, self-esteem, experience or viewing of domestic violence as a child, previous criminal justice system interactions, and many other factors. If you can only serve a limited number of people, what factors should you prioritize to increase the likelihood of achieving your goal of decreasing IPV in the future?

If the education level for your potential participants varies, you can look at the correlation between education level and incidences of IPV.

Suppose a study found r = 0.60 for incidence of IPV and partner education level.

$$r^2 = 0.60^2$$

$$r^2 = 0.60 \times 0.60$$

$$r^2 = 0.36$$

So, a partner's education level can account for 36 percent of the variation in incidence of IPV. A partner's education level may not be the best way to prioritize participation in the program, but in social science 36 percent is quite strong.

Another study found r = 0.77 for experiencing physical abuse in childhood and being abusive as an adult.

$$r^2 = 0.77^2 = 0.77 \times 0.77 = 0.59$$

Therefore, experiencing abuse in childhood can account for 59 percent of the variation in being abusive as an adult, a much higher percentage than education

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level. While 59 percent may not seem like a strong predictor, in social science this is considered a strong result.

Given this information, you might prioritize potential clients who report experiencing abuse in childhood over those who do not report experiencing abuse in order to better target your resources. You should consider the implications of using predictions like this, though. Many predictions use data about relationships that are based on behaviors of groups of people and not the individuals themselves. In this case, targeting people to receive additional services can be helpful. Using the same information in a punitive way, such as denying someone custody of her children, is unethical. While being abused as a child in general leads to a higher risk of perpetuating abuse as an adult, it does not predict any one's individual's likelihood of perpetuating abuse.

In summary, these are some of the characteristics of r2:

- The value or $r^2$ ranges from 0 to 1.
- If the value of $r^2$ is 0, then the dependent variable cannot be predicted using the independent variable.
- If the value of $r^2$ is 1, then the dependent variable can always be predicted without error using independent variable.
- Any value for $r^2$ indicates what percent of variance in the dependent variable can be predicted using the independent variable.
- If $r^2$ is 0.5, then 50 percent of the variation in the dependent variable can be predicted using the independent variable. An $r^2$ of 0.6 means that 60 percent can be predicted, and so on.

Again, correlation is not causation, but understanding these relationships and where the strong and weak relationships exist, can help you tailor more effective interventions, or at least better understand the individuals or populations you are working with.

There are limitations to using $r^2$. To use $r^{2,}$ the relationship must be linear. If the data are curvilinear, $r^2$ is no longer an appropriate tool. If you graph your data on a scatterplot and find that they resemble the curvilinear graph, in figure 1.8, you cannot use $r^2$ to assess your data.

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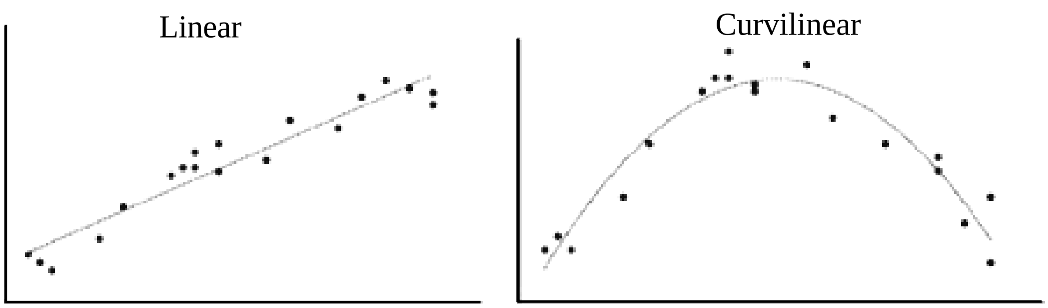


**Figure 1.8:** Linear and Curvilinear Distributions

On the left is a linear distribution, with data points on the scatterplot clustering along a straight upward-sloping line. On the right is a curvilinear distribution, with data values on the scatterplot beginning in the lower left-hand corner, increasing, and then decreasing, to cluster around a curve.

## 8.8 Computing the correlation coefficient

Here is the procedure for computing the correlation coefficient.

| Convert each variable to standard units. The average of the products gives the correlation coefficient. |
|---|

This procedure can be given as a formula, where x stands for the first variable, y for the second variable, and r for the correlation coefficient:

r = average of (x in standard units) × (y in standard units)

Compute r for the hypothetical data in table 1.

Table 1. Data.

| x | y |
|---|---|
| 1 | 5 |
| 3 | 9 |
| 4 | 7 |
| 5 | 1 |
| 7 | 13 |

Note. The first row of the above table represents two measurements on one subject in the study; the two numbers are the x- and y-coordinates of the corresponding point on the scatter diagram. Similarly for the other rows. The pairing matters:

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r is defined only when you have two variables, and both are measured for every subject in the study.

Solution. The work can be laid out as in table below.

**Computing r.**

| x | y | x in s tandard units | y in standard units | Product |
|---|---|---|---|---|
| 1 | 5 | “1 .5 | “0 .5 | 0.75 |
| 3 | 9 | “0 .5 | 0.5 | “0 .25 |
| 4 | 7 | 0.0 | 0.0 | 0.00 |
| 5 | 1 | 0.5 | “1 .5 | “0 .75 |
| 7 | 13 | 1.5 | 1.5 | 2.25 |

Step 1. Convert the x-values to standard units, as in chapter 5. This is quite a lot of work. First, you have to find the average and SD of the x-values:

average of x-values = 4, SD = 2.

Then, you have to subtract the average from each x-value, and divide by the SD:

(1 – 4)/2 = “1 .5, (3 – 4)/2 = “0 .5, (4 – 4)/2 = 0, (5 – 4)/2 = 0 .5, (7 – 4)/2 = 1 .5

The results go into the third column of the table above. The numbers tell you how far above or below average the x-values are, in terms of the SD. For instance, the value 1 is 1.5 SDs below average.

Step 2. Convert the y-values to standard units; the results go into the fourth column of the table. That finishes the worst of the arithmetic.

Step 3. For each row of the table, work out the product

(x in standard units) × (y in standard units)

The products go into the last column of the table.

Step 4. Take the average of the products:

r = average of (x in standard units) × (y in standard units)

= (0 .75 “ 0 .25 + 0 .00 “ 0 .75 + 2 .25)/5

= 0 .40

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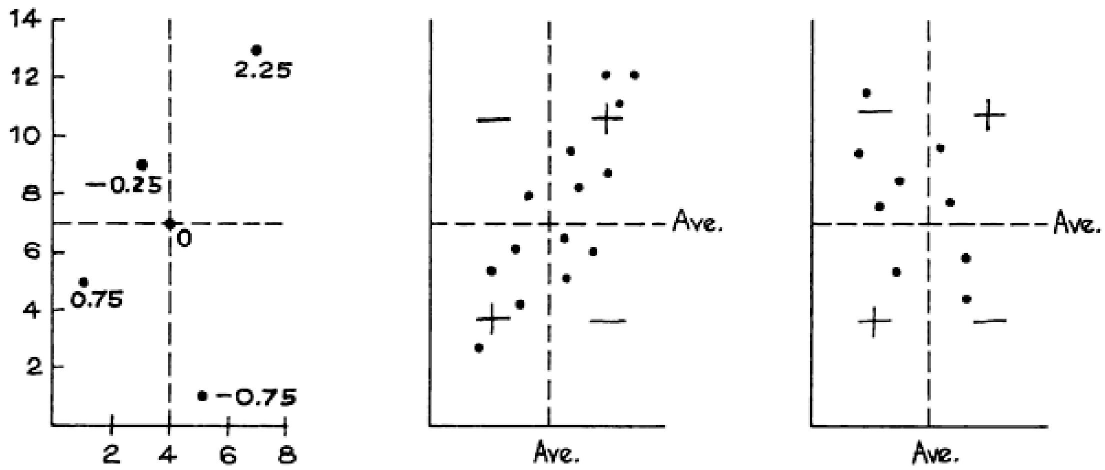
This completes the solution. If you plot a scatter diagram for the data, the points slope up but are only loosely clustered.

Why does r work as a measure of association? In figure below, the products are marked at the corresponding dots. Horizontal and vertical lines are drawn through the point of averages, dividing the scatter diagram into four quadrants. If a point is in the lower left quadrant, both variables are below average and are negative in standard units; the product of two negatives is positive. In the upper right quadrant, the product of two positives is positive. In the remaining two quadrants, the product of a positive and a negative is negative. The average of all these products is the correlation coefficient. If r is positive, then points in the two positive quadrants will predominate, as in figure b. If r is negative, points in the two negative quadrants will predominate, as in figure c.




(a) Scatter Diagram (b) Positive r (C) Negative r

**Figure. How the correlation coefficient works**

There is another way to compute r, which is sometimes useful:

r = cov(x, y)/ (SD of x) × (SD of y)

Where,

cov(x, y) = (average of products xy) “ (ave of x) × (ave of y).

**REGRESSION**

Regression is a tool that allows you to quantify a relationship between variables while also controlling for other factors. When you learned about correlations and saw scattergrams of data for two variables plotted, the line that best fit those data was

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created using regression analysis. This tool allows you to isolate the effect of one variable on another while holding other factors constant. If you wanted to know how participation in a religious community affects health outcomes like blood pressure or anxiety, then you would want to hold constant factors like income level, education level, age, and other health conditions to ensure that you were only seeing the effect of the variable of interest.

A common type of regression is linear regression. Linear regression fits a straight line to the data in a way that ensures that each point is as close as possible to the line, or the line is the "best fit." The line does not intersect every point, but it is the best description of all the points taken together to show a relationship.

In figure 9.1 , you can see that a line has been fit to the data points. This line is created using regression analysis and the equation $y = ax + b$ , where y is the dependent variable, x is the independent variable, b is the slope of the line or how much the dependent variable changes for each unit of the independent variable, and a is the y -intercept (the value of y when x is zero).

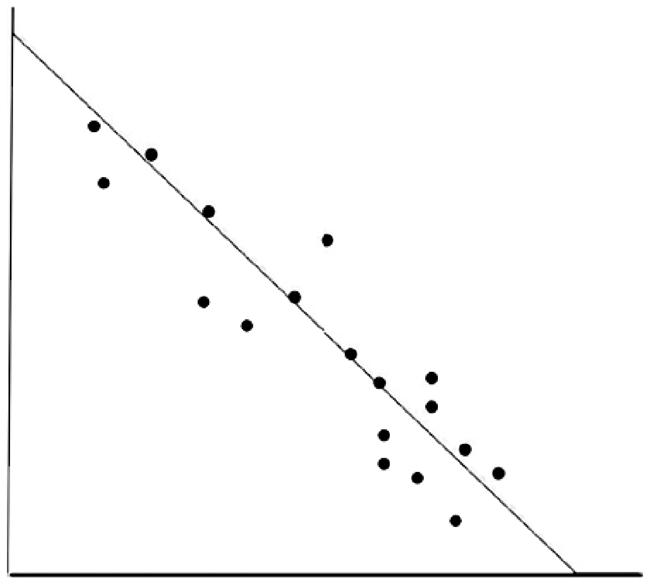

**Figure 9.1:** Linear regression

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To graphs of linear regressions modeling the relationship between two variables.

Many studies you see that discuss relationships but are not randomized control trials use regression analysis. The key to successful regression analysis is choosing which variables should be isolated and how best to do so. If you overlook a key variable and do not control for it, your results may reflect a relationship that is not the one you believe you are studying. When using regression analysis, you are limited in the same ways as you are for any type of inferential statistics. You have selected data relevant to the question you are trying to answer, but those data only represent a certain group of people at a certain time. You still have to determine if the results can be applied to other populations.

When you come across a regression analysis in the literature, you should check for a few things before deciding whether to use this information in your practice.

1. Is the relationship linear? If the pattern created by the data points does not generally follow a straight line, then linear regression is not appropriate.

2. Are all important variables controlled for? If age is likely to have a big effect on any health outcomes of interest, does the study control for age? What about income? Are there other factors that could contribute to this relationship that have not been addressed?

3. Is the sample used in the analysis similar to the people you work with? The results of these analyses are only applicable to samples that are similar. If you work with children, a sample made up of adults is unlikely to be useful to you. If you work with people who live in cities, a sample of rural farmers is unlikely to be useful to you.

4. Remember that correlation is not causation. Regression analysis cannot tell you that one variable caused an effect in the other. You may find a statistically significant relationship between two variables that have nothing to do with each other but happen to behave in similar ways. Beware of spurious correlations.

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## 8.9 Quick Look at the Theory of Probability

People talk loosely about chance all the time, without doing any harm. What are the chances of getting a job? of meeting someone? of rain tomorrow? But for scientific purposes, it is necessary to give the word chance a definite, clear interpretation. This turns out to be hard, and mathematicians have struggled with the job for centuries. They have developed some careful and rigorous theories, but these theories cover just a small range of the cases where people ordinarily speak of chance. This section of the module will present the frequency theory, which works best for processes which can be repeated over and over again, independently and under the same conditions. Many games fall into this category, and the frequency theory was originally developed to solve gambling problems.

One simple game of chance involves betting on the toss of a coin. The process of tossing the coin can be repeated over and over again, independently and under the same conditions. The chance of getting heads is 50%: in the long run, heads will turn up **about** 50% of the time.

Take another example. A die (plural, "dice") is a cube with six faces, labelled 1,2,3,4,5,6. When the die is rolled, the faces are equally likely to turn up. The chance of getting an ace— is 1 in 6, or sixteen and two-third percentages. The interpretation: if the die is rolled over and over again, repeating the basic chance process under the same conditions, in the long run an ace will show **about** sixteen and two-third percentages of the time.

> The chance of something gives the percentage of time it it expected to happen, when the basic process is done over and over again, independently and under and the same conditions.

If something is impossible, it happens 0% of the time. At the other extreme, if something is sure to happen, then it happens 100% of the time. All chances are between these two extremes.

> Chances are between 0% and 100%.

Here is another basic fact. Suppose you are playing a game and have a 45%chance to win. In other words, you expect to win about 45% of the time. So, you must expect to lose the other 55% of the time.

> The chance of something equals 100% minus the chance of the opposite thing.

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**Example 1:** A box contains red marbles and blue marbles. One marble is drawn at random from the box (each marble has an equal chance to be drawn). If it is red, you win $1. If it is blue, you win nothing. You can choose between two boxes:

- box A contains 3 red marbles and 2 blue ones.
- box B contains 30 red marbles and 20 blue ones.

Which box offers a better chance of winning, or are they the same?

**Solution:** Some people prefer box A, because it has fewer blue marbles. Others prefer B, because it has more red marbles. Both views are wrong. The two boxes offer the same chance of winning, 3 in 5. To see why, imagine drawing many times at random from box A (replacing the marble after each draw, so as not to change the conditions of the experiment). In the long run each of the 5 marbles will appear about 1 time in 5. So, the red marbles will turn up about 3/5 of the time. With box A, your chance of drawing a red marble is 3/5, that is, 60%.

Now imagine drawing many times at random with replacement from box B. Each of the 50 marbles will turn up about 1 time in 50. But now there are 30 red marbles. With box B, your chance of winning is 30/50 = 3/5 = 60%, just as for box A. What counts is the ratio number of red marbles/total number of marbles.

The ratio is the same in both boxes.

**Problem 1:** A coin will be tossed 1,000 times. About how many heads are expected?

**Problem 2:** A die will be rolled 6,000 times. About how many aces are expected?

**Problem 3:** Match the numerical answers with the verbal descriptions (which may be used more than once).

| *Numerical answer* | | *Verbal description* |
|---|---|---|
| (a) | –50% | (i) This is as likely to happen as not. |
| (b) | 0% | (ii) This is very likely to happen, but it’s not certain. |
| (c) | 10% | (iii) This won’t happen. |
| (d) | 50% | (iv) This may happen, but it’s not likely. |
| (e) | 90% | (v) This will happen, for sure. |
| (f) | 100% | (vi) There’s a bug in the program. |
| (g) | 200% | |

**Some Definitions**

A **probability experiment** is an action, or trial, through which specific results (counts, measurements, or responses) are obtained. The result of a single trial in a probability experiment is an **outcome**. The set of all possible outcomes of a probability experiment is the **sample space**. An **event** is a subset of the sample space.

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It may consist of one or more outcomes. The probability that event E will occur is written as P(E) and is read as "the probability of event E." Probabilities can be written as fractions, decimals, or percent.

Here is a simple example of the use of the terms **probability experiment, sample space, event,** and **outcome.**

**Probability Experiment**: Roll a six-sided die.

**Sample Space**: {1, 2, 3, 4, 5, 6}

**Event**: Roll an even number, {2, 4, 6}.

**Outcome**: Roll a 2, {2}.

**Conditional probabilities:** A conditional probability is the probability of an event occurring, given that another event has already occurred. The conditional probability of event B occurring, given that event A has occurred, is denoted by P(B|A) and is read as "probability of B, given A.

**Example 2:** Two cards are selected in sequence from a standard deck of 52 playing cards. Find the probability that the second card is a queen, given that the first card is a king. (Assume that the king is not replaced.)

**Solution:** Because the first card is a king and is not replaced, the remaining deck has 51 cards, 4 of which are queens. So,

$$P(B|A) = 4/51 = 0.078$$

Note: A deck of cards has 4 suits: clubs, diamonds, hearts, spades. There are 13 cards in each suit: 2 through 10, jack, queen, king, ace. So, there are 4 × 13 = 52 cards in the deck.

**Standard Deck of Playing Cards**

| Hearts | Diamonds | Spades | Clubs |
|---|---|---|---|
| A ♥ | A ♦ | A ♠ | A ♣ |
| K ♥ | K ♦ | K ♠ | K ♣ |
| Q ♥ | Q ♦ | Q ♠ | Q ♣ |
| J ♥ | J ♦ | J ♠ | J ♣ |
| 10♥ | 10♦ | 10♠ | 10♣ |
| 9 ♥ | 9 ♦ | 9 ♠ | 9 ♣ |
| 8 ♥ | 8 ♦ | 8 ♠ | 8 ♣ |
| 7 ♥ | 7 ♦ | 7 ♠ | 7 ♣ |
| 6 ♥ | 6 ♦ | 6 ♠ | 6 ♣ |
| 5 ♥ | 5 ♦ | 5 ♠ | 5 ♣ |
| 4 ♥ | 4 ♦ | 4 ♠ | 4 ♣ |
| 3 ♥ | 3 ♦ | 3 ♠ | 3 ♣ |
| 2 ♥ | 2 ♦ | 2 ♠ | 2 ♣ |

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**Example 3:**The table below shows the results of a study in which researchers examined a child's IQ and the presence of a specific gene in the child. Find the probability that a child has a high IQ, given that the child has the gene.

| | Gene present | Gene not present | Total |
|---|---|---|---|
| **High IQ** | 33 | 19 | 52 |
| **Normal IQ** | 39 | 11 | 50 |
| **Total** | 72 | 30 | 102 |

**Solution:** There are 72 children who have the gene. So, the sample space consists of these 72 children, as shown at the left. Of these, 33 have a high IQ. So,

$$P(B|A) = 33/72 = 0.458$$

The probability that a child has a high IQ, given that the child has the gene, is about 0.458.

**Sample Space**

| | Gene present |
|---|---|
| **High EQ** | 33 |
| **Normal IQ** | 39 |
| **Total** | 72 |

**Example 4:** A deck of cards is shuffled, and the top two cards are put on atable, face down. You win $1 if the second card is the queen of hearts.

(a) What is your chance of winning the dollar?

(b) You turn over the first card. It is the seven of clubs. Now what is your chance of winning?

**Solution. (a).** The bet is about the second card, not the first. Initially, this will seem a little strange. Some illustrations may help.

- If the first card is the two of spades and the second is the queen of hearts, you win.
- If the first card is the jack of clubs and the second is the queen of hearts, you win.
- If the first card is the seven of clubs and the second is the king of hearts, you lose.

The bet can be settled without even looking at the first card. The second card is all you need to know.

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The chance of winning is 1/52. To see why, think about shuffling the deck. That brings the cards into random order. The queen of hearts has to wind up somewhere. There are 52 possible positions, and they are all equally likely. So, there is 1 chance in 52 for her to wind up as the second card in the deck—and bring you the dollar.

**(b)**There are 51 cards left. They are in random order, and the queen of hearts is one of them. She has 1 chance in 51 to be on the table. Your chance goes up a little, to 1/51. That is the answer.

The 1/51 in part (b) is a conditional chance. The problem puts a condition on the first card: it has to be the seven of clubs. A mathematician might talk about the conditional probability that the second card is the queen of hearts given the first card is the seven of clubs. To emphasize the contrast, the 1/52 in part (a) is called an unconditional chance: the problem puts no conditions on the first card.

**Problem 4:** A penny is tossed 5 times.

(a) Find the chance that the 5th toss is a head.

(b) Find the chance that the 5th toss is a head, given the first 4 are tails.

**Problem 5:** Five cards are dealt off the top of a well-shuffled deck.

(a) Find the chance that the 5th card is the queen of spades.

(b) Find the chance that the 5th card is the queen of spades, given that the first 4 cards are hearts.

**The multiplication rule:**

To find the probability of two events occurring in sequence, you can use the Multiplication Rule.

The probability that two events A and B will occur in sequence is:

$$P\ (A \text{ and } B) = P(A).\ P(B|A).$$

If events A and B are independent, then the rule can be simplified to P (A and B) = P(A). P(B). This simplified rule can be extended to any number of independent events.

**Example 5:** Two cards are selected, without replacing the first card, from a standard deck of 52 playing cards. Find the probability of selecting a king and then selecting a queen.

**Solution:** P (K and Q) = P(K). P(Q|K) = (4/52). (4/51) = (16/2652) = 0.006

So, the probability of selecting a king and then a queen without replacement is about 0.006.

**Example 6:** A coin is tossed, and a die is rolled. Find the probability of tossing a head and then rolling a 6.

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**Solution:** The events are independent.

$$P\ (H \text{ and } 6) = P(H).\ P6)$$
$$= (1/2).\ (1/6)$$
$$= (1/12)$$
$$= 0.083$$

So, the probability of tossing a head and then rolling a 6 is about 0.083.

**Problem 6:** A deck of cards is shuffled, and two cards are dealt. What is the chance that both are aces?

**Problem 7:** A coin is tossed twice. What is the chance of a head followed by a tail?

**Problem 8:** A coin is tossed 3 times.

(a) What is the chance of getting 3 heads?

(b) What is the chance of not getting 3 heads?

(c) What is the chance of getting at least 1 tail?

(d) What is the chance of getting at least 1 head?

**Independence:**

Two things are independent if the chances for the second given the first are the same, no matter how the first one turns out. Otherwise, the two things are dependent.

**Example 7.** Someone is going to toss a coin twice. If the coin lands heads on the second toss, you win a dollar.

(a) If the first toss is heads, what is your chance of winning the dollar?

(b) If the first toss is tails, what is your chance of winning the dollar?

(c) Are the tosses independent?

**Solution.** If the first toss is heads, there is a 50% chance to get heads the second time. If the first toss is tails, the chance is still 50%. The chances for the second toss stay the same, however the first toss turns out. That is independence.

**Note:** If two things are independent, the chance that both will happen equals the product of their unconditional probabilities. This is a special case of the multiplication rule.

**Problem 9:** Every week you buy a ticket in a lottery that offers one chance in a million of winning. What is the chance that you never win, even if you keep this up for ten years?

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**The Addition Rule:**

This section is about the chance that at least one of two specified things will happen: either the first happens, or the second, or both. The possibility of both happening turns out to be a complication, which can sometimes be ruled out.

Two things are mutually exclusive when the occurrence of one prevents the occurrence of the other: one excludes the other.

**Example 8.** A card is dealt off the top of a well-shuffled deck. The card might be a heart. Or, it might be a spade. Are these two possibilities mutually exclusive?

**Solution.** If the card is a heart, it can't be a spade. These two possibilities are mutually exclusive.

We can now state a general principle for figuring chances. It is called the **addition rule**.

**Addition Rule.** To find the chance that at least one of two things will happen, check to see if they are mutually exclusive. If they are, add the chances.

**Example 9.** A card is dealt off the top of a well-shuffled deck. There is 1chance in 4 for it to be a heart. There is 1 chance in 4 for it to be a spade. What is the chance for it to be in a major suit (hearts or spades)?

**Solution:** The question asks for the chance that one of the following two things will happen:

- the card is a heart.
- the card is a spade.

If the card is a heart, then it can't be a spade: these are mutually exclusive events. So, it is legitimate to add the chances. The chance of getting a card in a major suit is 1/4 + 1/4 = 1/2. (A check on the reasoning: there are 13hearts and 13 spades, so 26/52 = 1/2 of the cards in the deck are in a major suit.)

**Note:** If you want to find the chance that at least one event occurs, and the events are not mutually exclusive, do not add the chances: the sum will be too big.

Blindly adding chances can give the wrong answer, by double counting the chance that two things happen. With mutually exclusive events, there is no double counting: that is why the addition rule works.

Technically, The probability that events A or B will occur, P (A or B), is given by

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P (A or B) = P(A) + P(B) – P (A and B)

If events A and B are mutually exclusive, then the rule can be simplified to P (A or B) = P(A) + P(B). This simplified rule can be extended to any number of mutually exclusive events.

In words, to find the probability that one event or the other will occur, add the individual probabilities of each event and subtract the probability that they both occur. As shown in the Venn diagram at the left, subtracting P (A and B) avoids double counting the probability of outcomes that occur in both A and B.

**Problem 10:** You select a card from a standard deck of 52 playing cards. Find the probability that the card is a 4 or an ace.

**Problem 11:** You roll a die. Find the probability of rolling a number less than 3 or rolling an odd number.

**Note:** What's the difference between mutually exclusive and independent?

"Mutually exclusive" is one idea; independence is another. Both ideas apply to pairs of events and say something about how the events are related. However, the relationships are quite different.

• Two events are mutually exclusive if the occurrence of one prevents the other from happening.

• Two events are independent if the occurrence of one does not change the chances for the other.

**Note:** When do I add and when do I multiply?

The addition rule, like the multiplication rule, is a way of combining chances. However, the two rules solve different problems.

• The addition rule finds the chance that at least one of two things happens.

• The multiplication rule finds the chance that two things both happen.

So, the first step in deciding whether to add or to multiply is to read the question: Do you want to know P (A or B), P (A and B), or something else entirely? But there is also a second step—because the rules apply only if the events are related in the right way.

• Adding the probabilities of two events requires them to be mutually exclusive.

• Multiplying the unconditional probabilities of two events requires them to be independent. (For dependent events, the multiplication rule uses conditional probabilities.)

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## 8.10 Data Processing and Analysis

### Coding Qualitative Data:

In quantitative research, data coding is a phase after you have collected all data. You code by arranging the measures of variables, already in the form of numbers, into a machine-readable format to facilitate statistical analysis. Coding data has a different meaning in qualitative research. You code by organizing the raw data into conceptual categories (i.e., concepts and themes). Instead of a simple clerical task to prepare for statistical analysis as in quantitative research, qualitative data coding is an integral part of data analysis. Coding encourages higher-level thinking about the data and research questions. It moves you toward theoretical generalizations.

In a qualitative study, you engage in two simultaneous activities as you code: mechanical data reduction and analytic data categorization. Coding data is the hard work of reducing mountains of raw data into a manageable size.

Beyond making a huge mass of data more manageable, coding is a way to impose order onto the data. In addition, coding allows you to retrieve relevant parts of the data. Coding huge amounts of qualitative data is no simple, easy task. Between the moments of thrill and inspiration, coding qualitative data, or "filework," is often wearisome and tedious.

The three forms of qualitative coding are open coding, axial coding, and selective coding. We examine each next.

**Open Coding**. You perform open coding as a first pass through the collected data. As you review the data, you are identifying concepts and themes and assigning initial codes or labels to them. This is your first attempt to condense the mass of raw data into analytic categories. To code, you slowly examine field notes, historical sources, or other data looking for critical terms, key events, or shared themes. If you have pages of written data notes, you write a preliminary code or label at the edge of a page and might highlight relevant text with brightly coloured ink. If your data is in electronic files, you can do something similar. In this process, you want to remain open to creating new themes and to changing initial codes in subsequent analysis. Having a general theoretical framework can help if you use it in a flexible manner.

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During open coding, you are bringing concepts and themes buried deep inside the data to the surface. The concepts and themes are at a low level of abstraction. They come from your initial research question, concepts in the literature, terms used by people in the social setting you are studying, or new thoughts you have stimulated by this immersion in the data.

You can see an example of how to open code based on LeMasters's (1975) field research study of a working-class tavern. He found that the topic of marriage came up in many conversations. If he reviewed his field notes, he could have open coded the field notes with the theme marriage. Following is an example of hypothetical field notes that could be open-coded with the theme marriage:

*I wore a tie to the bar on Thursday because I had been at a late meeting. Sam noticed it immediately and said. "Damn it, Doc. I wore one of them things once—when I got married—and look what happened to me! By God, the undertaker will have to put the next one on." I ordered a beer, then asked him, "Why did you get married?" He replied, "What the hell you goin' to do? You just can't go on shacking up with girls all your life—I did plenty of that when I was single" with a smile and wink. He paused to order another beer and light a cigarette, then continued, "A man, sooner or later, likes to have a home of his own, and some kids, and to have that, you have to get married. There's no way out of it—they got you hooked." I said, "Helen [his wife] seems like a nice person." He returned, "Oh, hell, she's not a bad kid, but she's a goddamn woman and they get under my skin. They piss me off. If you go to a party, just when you start having fun, the wife says 'let's go home.'"* [Based on *LeMasters, E. E. (1975). Blue collar aristocrats. Madison: University of Wisconsin Press.*]

When coding qualitative data, you have a choice. You can code every line of data or code entire paragraphs or code entire pages of notes. You will find that some raw data are not important to code. They become dross or left over and unused. The degree of detail when you code depends on your research question, the "richness" of the data, and your purposes.

**Axial Coding**. This type of coding is a "second pass" through the data. During open coding, you focused on the raw qualitative data (e.g., field notes, historical

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documents, photos, open interview transcripts). You assigned codes for the concepts, themes, relationships, and so forth that you saw in a review of the data. In open coding, your primary focus was on the data. You were little concerned about connecting themes or elaborating on the concepts. By contrast, in axial coding, your primary focus is on the collection of codes and the initial, preliminary concepts or themes from the open-coding process. In this second pass, you focus on the initial concepts and themes more than on the raw data. Nonetheless, you can continue to review the data and add new concepts and themes. In this sense, a milder kind of open coding continues as you axial-code.

During this second pass through the data, new codes, themes, or concepts may emerge, and you should add them. You elaborate on and identify connections among themes or concepts as you review the codes. As you review your initial set of codes, your primary focus is on organizing the concepts and themes of the codes. While doing this, you identify a few key analytic axes, or central principles, around which you can connect and organize the concepts and themes. This is the source of the name "axial coding."

During axial coding, you are constantly considering causes and consequences, conditions and interactions, strategies and processes. You are looking for categories of concepts and sets of concepts and themes that cluster together. You ask yourself questions, Can I divide this concept into subtypes? Should I combine these three closely related concepts into a general one? Does it make sense to organize these themes into a time sequence (i.e., A, then B, then C) or by their physical location?

For example, in a field research study on working-class life in a tavern you divide the general theme of marriage into sequential subparts (e.g., engagement, weddings, or parenting). You mark all notes involving the parts of marriage and then relate marriage to other themes of sexuality, division of labour in household tasks, views on children, and so on. When a theme reappears in different areas of the field notes, you compare it to elsewhere to see connections and develop new themes (e.g., men and women have different attitudes toward marriage).

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Axial coding both stimulates thinking about linkages among the open-coding concepts and themes and introduces new codes, concepts, and questions. During the coding, you may decide to drop some themes or explore others in greater depth. In addition, it reinforces the connections between evidence and concepts as you consolidate codes, re-evaluate themes, and return to the data for new evidence. The axial coding process helps you build a dense web of support in the data for increasingly interconnected themes and codes. This is analogous to the idea of multiple indicators in quantitative research. Multiple instances of concepts in the empirical evidence help to strengthen the connections between concepts and data.

**Selective Coding**. This is a last pass through the data. By this phase you probably have identified the major themes for your study. Selective coding involves scanning the data using the central themes and concepts. You add an empirical grounding to themes and concepts and elaborate on them. You are looking selectively in the data for several strong examples that offer clear support for each concept and theme. You also seek data to compare and elaborate on major concepts and themes.

Selective coding occurs after data collection ended, after you have well-developed concepts and themes, and as you are finalizing concepts and themes into an overall analysis. In this phase, you organize the concepts and themes and build toward a few main generalizations or central themes. During selective coding, you may adjust the generalizations and central themes as you find multiple supporting instances of them in the data.

For example, in a study of working-class life in a tavern you decide to make gender relations a major theme. In selective coding, you go through the field notes and search for strong examples of male–female differences in talk about dating, engagements, weddings, divorce, extramarital affairs, or husband–wife relations. You then compare male and female attitudes about each area to your other major theme, marriage.

During the selective coding phase, you refine, reorganize, and elaborate on themes and concepts as you re-examine the data and select supporting evidence. For example, in the working-class tavern study, you re-examine the theme “opinions on marriage” and connect evidence about it to themes of gender relations and stages of the life cycle. You seek evidence on how marriage relates to gender relations and the life cycle.

The three phases of coding work together to move you from a mass of raw data toward a final, integrated analysis.

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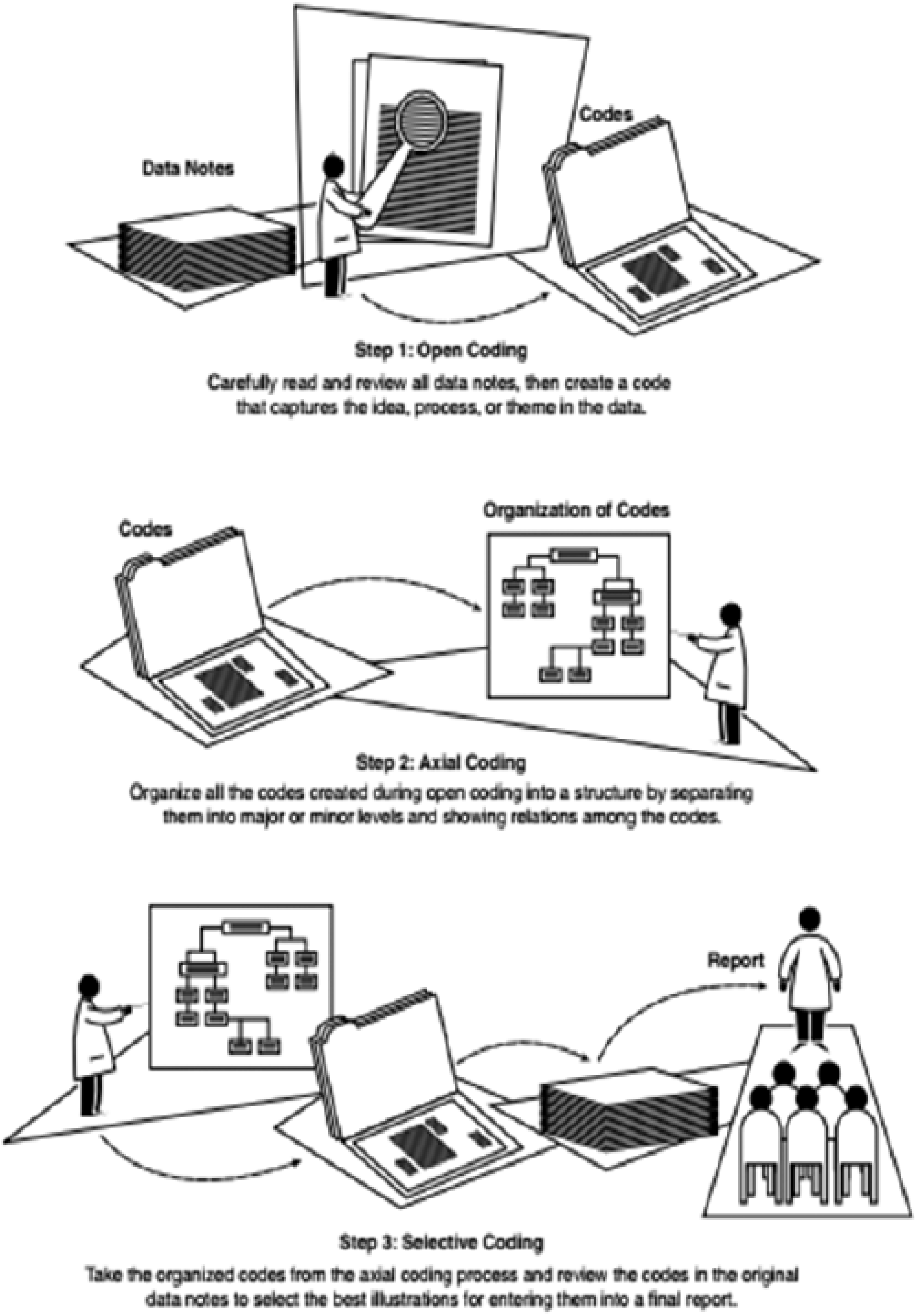


Figure: The Coding Process for Qualitative Data Analysis

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**Coding the Data:**

Before you examine quantitative data, you collected in a study to test hypotheses and answer your research question, you must first organize them in a different form. Here, data coding means systematically reorganizing raw numerical data into a form usable by computer software. You must do this by applying consistent rules for how to transfer information from one form to another.

If you collected data in certain ways, such as a well-organized coding sheet, coding can be a simple clerical task. However, when the data are not well organized or not originally in the form of numbers, it gets complex. You must develop rules for assigning numbers to variable attributes. Each category of a variable and missing information needs a code. For example, you want to examine gender, so assign or code the males as 1 and the females as 2.

All of your rules and procedures for coding are put into a document called a codebook. In addition to describing the coding rules and procedure, it has information on the location of data for variables in a format usable by computer software. It is essential to create a well-organized, detailed codebook and make multiple copies of it. If you fail to write down the details of the coding procedure or misplace the codebook, you have lost the key to the data and may have to recode the data again, requiring many hours or even days of additional work.

You should think about a coding procedure and codebook before you collect any data. For example, you plan to conduct a survey. You should precode the questionnaire before collecting data. Precoding means placing the code categories (e.g., 1 for male, 2 for female) on the questionnaire.1 Some survey researchers also place the location in the computer format on the questionnaire. If you do not precode a questionnaire, your first step after collecting data is to create a codebook. You need to give each respondent an identification number to keep track of them. Information on each respondent is a data record. Next, you transfer the information from each respondent questionnaire into a data record format that computer software can read.

**Master Sheet**

If you are doing tabulation manually, it is always wise to enter the data into a master chart. The master chart is a large sheet which will enable you to enter all the codes of different variables into it. It will help you to generate tables easily.

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After a code book is prepared, the data can be transferred either to a master chart or directly to computer through a statistical package. Going through master chart to computer is much more advantageous than entering data directly to computers because one can check the wrong entries in the computer by comparing ‘data listing’ as a computer output and master chart. Entering data directly to computer is disadvantageous, as there is no way to check wrong entries, which will show inconsistencies in tabulated data at the later stages of tabulation. A sample of master chart prepared in accordance with the code book is presented in Table below:

| Correspondent Number | | | | Variable Lables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Age | Designation | Establishment | Education | Marital Status | Nature of Work | Duration of Work | Wages | Promotions | Attitude of Employer |
| | | | | Question/Variable/Column Number | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 0 | 0 | 1 | 1 | 4 | 1 | 2 | 1 | 2 | 3 | 2 | 3 | 4 | 3 |
| 0 | 0 | 2 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 5 |
| 0 | 0 | 3 | 3 | 3 | 3 | 3 | 4 | 2 | 6 | 7 | 2 | 6 | 3 |
| 0 | 0 | 4 | 4 | 5 | 7 | 8 | 9 | 1 | 3 | 5 | 6 | 1 | 1 |
| 0 | 0 | 5 | 5 | 4 | 5 | 1 | 4 | 2 | 1 | 1 | 4 | 3 | 5 |
| 0 | 0 | 6 | 6 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 3 | 1 | 5 |
| 0 | 0 | 7 | 7 | 5 | 4 | 5 | 6 | 9 | 7 | 8 | 5 | 2 | 4 |
| 0 | 0 | 8 | 8 | 1 | 4 | 2 | 5 | 3 | 6 | 3 | 7 | 8 | 9 |
| 0 | 0 | 9 | 9 | 2 | 2 | 4 | 2 | 6 | 7 | 8 | 2 | 1 | 5 |
| 0 | 0 | 0 | 0 | 9 | 5 | 6 | 8 | 7 | 9 | 2 | 4 | 4 | 3 |
| 0 | 0 | 1 | 1 | 2 | 2 | 8 | 4 | 9 | 3 | 4 | 7 | 3 | 8 |
| 0 | 0 | 2 | 2 | 2 | 5 | 7 | 9 | 5 | 1 | 4 | 2 | 4 | 3 |
| 0 | 0 | 3 | 3 | 2 | 9 | 4 | 5 | 6 | 7 | 2 | 6 | 9 | 6 |
| 0 | 0 | 4 | 4 | 2 | 8 | 7 | 9 | 5 | 2 | 4 | 6 | 2 | 3 |
| 0 | 0 | 5 | 5 | 3 | 5 | 4 | 8 | 7 | 9 | 2 | 4 | 2 | 3 |
| 0 | 0 | 6 | 6 | 2 | 4 | 8 | 7 | 9 | 5 | 8 | 4 | 5 | 6 |
| 0 | 0 | 7 | 7 | 8 | 7 | 4 | 9 | 4 | 3 | 4 | 6 | 3 | 4 |

In the master chart you can enter the data of 14 sample respondents. Likewise you can expand the number of respondents in the column and variables in the rows. It is always better to enter code (numerical number) in the master chart.

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## ANALYSIS OF QUANTITATIVE DATA

The purpose of data analysis is to prepare data as a model where relationships between the variables can be studied. Analysis of data is made with reference to the objectives of the study and research questions if any. It is also designed to test the hypothesis. Analysis of data involves re-categorisation of variables, tabulation, explanation and casual inferences.

The first step in data analysis is a critical examination of the processed data in the form of frequency distribution. This analysis is made with a view to draw meaningful inferences and generalisation.

The process of categorisation in accordance with the objectives and hypothesis of Data Processing and Analysis the study is arrived at with the help of frequency distributions. Re-categorisation is a process to arrange categories with the help of statistical techniques. This helps researcher to justify the tabulation. We have seen earlier that the responses to a statement may be assigned scores or weightage. These scores or weightage are summated and re-categorised on the bases of high, medium and low. The basic principle in the process of categorisation or re-categorisation is that the categories thus obtained must be exhaustive and mutually exclusive. In other words, the categories have to be independent and not overlapping.

### Univariate Analysis

Univariate analysis refers to tables, which give data relating to one variable.

Univariate tables which are more commonly known as frequency distribution tables show how frequently an item repeat. Examples of frequency tables are given below. The distribution may be symmetrical or asymmetrical. The characteristics of the sample while examining the percentages, further properties of a distribution can be found out by various measures of central tendencies. However, researcher is required to decide which is most suited for this analysis. To know how much is the variation, the researcher has to calculate measures of dispersion.

Univariate analysis is the technique of comparing and analysing the dependency of a single predictor and a response variable. The prefix “uni” means one, emphasizing the fact that the analysis only accounts for one variable’s effect on a dependent variable. Univariate Analysis is thought to be one of the simplest forms of data analysis as it doesn’t deal with causes or relationships, like a regression would. Primarily, Univariate Analysis simply takes data and provides a summary and associated pattern.

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Univariate Analysis works by examining the effects of a singular variable on a set of data. For example, a frequency distribution table is a form of univariate analysis as frequency is the only variable being measured. Alternative variables may be age, height, weight, etc., however it is important to note that as soon as a secondary variable is introduced it becomes bivariate analysis. With three or more variables, it becomes multivariate analysis.

Univariate Analysis is a common method for understanding data. Another common example of univariate analysis is the mean of a population distribution. Tables, charts, polygons, and histograms are all popular methods for displaying univariate analysis of a specific variable (e.g., mean, median, mode, standard variation, range, etc).

**Example:** Usually, frequency distribution tables are prepared to examine each of the independent and dependent variables. Tables below present two independent variables and one dependent variable.

Table: Table Showing Awareness of the Respondents
(The Independent Variable)

| Level of Awareness | Distribution of Respondents | |
|---|---|---|
| | Frequency | Percentage |
| High | 110 | 39.3 |
| Medium | 106 | 37.9 |
| Low | 64 | 21.8 |
| Total | 280 | 100 |

Table: Table Showing the Respondents by Regional Development
(The Independent Variable)

| Regional Development | Distribution of Respondents | |
|---|---|---|
| | Frequency | Percentage |
| High | 142 | 57.7 |
| Medium | 86 | 30.7 |
| Low | 52 | 14.6 |
| Total | 280 | 100 |

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Table: Table Showing Wage Differentials of the Respondents

(The Dependent Variable)

| Wage Differential | Distribution of Respondents | |
|---|---|---|
| | Frequency | Percentage |
| High | 78 | 27.9 |
| Medium | 134 | 47.9 |
| Low | 68 | 24.2 |
| Total | 280 | 100 |

Let us consider the frequency distribution (Tables given below) which describes the awareness, wage differentials and regional development of respondents. The tables have four rows, the first three being the categories of variables, which appear in the left-hand columns and the right-hand columns show the number of observations in each category. The last rows are the totals of all frequencies appearing in tables. To analyse the data, it is necessary to convert the frequencies into figures that can be interpreted meaningfully. Note, for instance, while distribution of respondents by regional development displayed in Table above clearly shows the predominance of respondents from 'high' development region whereas, distribution of respondents by wage differential in last Table indicates that the proportions of respondents with 'high' and 'low' wage differentials are almost equal.

**Bivariate Analysis:** Bivariate statistics are much more valuable. They let us consider two variables together and describe the relationship between variables. Even simple hypotheses require two variables. Bivariate statistical analysis shows a statistical relationship between variables—that is, things that tend to appear together. For example, a relationship exists between water pollution in a stream and the fact that people who drink the water get sick. It is a statistical relationship between two variables: pollution in the water and the health of the people who drink it.

Statistical relationships are based on two ideas: covariation and statistical independence. Covariation means that things go together or are associated. To covary means to vary together; cases with certain values on one variable are likely to have certain values on the other one. For example, people with higher values on the income variable are likely to have higher values on the life expectancy variable. Likewise, those with lower incomes have lower life expectancy. This is usually stated in a shorthand way by saying that income and life expectancy are related to each other, or covary. We

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could also say that knowing one's income tells us one's probable life expectancy, or that life expectancy depends on income.

Statistical independence is the opposite of covariation. It means there is no association or no relationship between variables. If two variables are independent, cases with certain values on one variable do not have a special value on the other variable.

We usually state hypotheses in terms of a causal relationship or expected covariation; if we use the null hypothesis, it is that there is independence. It is used in formal hypothesis testing and is frequently found in inferential statistics.

We use several techniques to decide whether a relationship exists between two variables. Three elementary ones are a scattergram, or a graph or plot of the relationship; a percentage table; and measures of association, or statistical measures that express the amount of covariation by a single number (e.g., correlation coefficient).

We use the bivariate contingency table in many situations. It presents the same information as a scattergram in a more condensed form. One advantage of it over the scattergram is that the data can be measured at any level of measurement, although interval and ratio data must be grouped.

The bivariate contingency table is based on cross-tabulation (i.e., tabulating two or more variables simultaneously). It is "contingent" because the cases in each category of a variable are distributed into each category of a second (or additional) variable. The table distributes cases into the categories of multiple variables at the same time and shows us how the cases, by category of one variable, are "contingent upon" the categories of other variables.

**Raw Data and Frequency Distributions**

**EXAMPLE OF RAW DATA**

| *Case* | *Age* | *Gender* | *Schooling* | *Attitude* | *Political Party, etc. . . .* |
|---|---|---|---|---|---|
| 01 | 21 | F | 14 | 1 | Democrat |
| 02 | 36 | M | 8 | 1 | Republican |
| 03 | 77 | F | 12 | 2 | Republican |
| 04 | 41 | F | 20 | 2 | Independent |
| 05 | 29 | M | 22 | 3 | Democratic Socialist |
| 06 | 45 | F | 12 | 3 | Democrat |
| 07 | 19 | M | 13 | 2 | Missing Information |
| 08 | 64 | M | 12 | 3 | Democrat |
| 09 | 53 | F | 10 | 3 | Democrat |
| 10 | 44 | M | 21 | 1 | Conservative |

(Attitude scoring, 1 = Agree, 2 = No Opinion, 3 = Disagree)

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**TWO FREQUENCY DISTRIBUTIONS:
AGE AND ATTITUDE TOWARD CHANGING THE DRINKING AGE**

| *Age Group* | *Number of Cases* | *Attitude* | *Number of Cases* |
|---|---|---|---|
| Under 30 | 26 | | |
| 30–45 | 30 | Agree | 38 |
| 46–60 | 35 | No Opinion | 26 |
| 61 and older | 15 | Disagree | 40 |
| Missing | 3 | Missing | 5 |
| Total | 109 | Total | 109 |

**COMPOUND FREQUENCY DISTRIBUTION:
AGE GROUP AND ATTITUDE TOWARD CHANGING THE DRINKING AGE**

| *Age* | *Attitude* | *Number of Cases* |
|---|---|---|
| Under 30 | Agree | 20 |
| Under 30 | No Opinion | 3 |
| Under 30 | Disagree | 3 |
| 30–45 | Agree | 10 |
| 30–45 | No Opinion | 10 |
| 30–45 | Disagree | 5 |
| 46–60 | Agree | 4 |
| 46–60 | No Opinion | 10 |
| 46–60 | Disagree | 21 |
| 61 and older | Agree | 3 |
| 61 and older | No Opinion | 2 |
| 61 and older | Disagree | 10 |
| | Subtotal | 101 |
| Missing on either variable | | 8 |
| Total | | 109 |

**RAW COUNT TABLE (a)**

| | AGE GROUP (b) | | | | |
|---|---|---|---|---|---|
| **ATTITUDE (b)** | *Under 30* | *30–45* | *46–60* | *61 and Older* | **TOTAL (c)** |
| Agree | 20 | 10 | 4 | 3 | 37 |
| No opinion | 3 (d) | 10 | 10 | 2 | 25 |
| Disagree | 3 | 5 | 21 | 10 | 39 |
| Total (c) | 26 | 25 | 35 | 15 | 101 |

Missing cases (f) = 8. (e)

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**THE PARTS OF A TABLE**

(a) Give each table a *title*, which names variables and provides background information.
(b) Label the row and column variable and give a name to each of the variable categories.
(c) Include the totals of the columns and rows. These are called the **marginals.** They equal the univariate frequency distribution for the variable.
(d) Each number or place that corresponds to the intersection of a category for each variable is a **cell of a table.**
(e) The numbers with the labeled variable categories and the totals are called the **body of a table.**
(f) If there is missing information (cases in which a respondent refused to answer, ended interview, said, "don't know," etc.), report the number of missing cases near the table to account for all original cases.

**FIGURE: Age Group by Attitude about Changing the Drinking Age, Raw Count Table**

**Trivariate Analysis:**

Sometimes researcher might be interested in knowing whether there is a third variable which is affecting the relationships between two variables. In such cases the researcher has to examine the bivariate relationship by controlling the effects of third/variable. This is performed in two ways. One way of controlling the effects of a third/variable is to prepare partial tables and examine the bi-vairate relationship, and the second method of assessing the effects of a third/variable is to compare the co-efficient of partial correlations. Let us take an example. In the above table, if researcher wants to examine whether there is effect of regional development on the bivariate relationship, he may prepare three partial tables giving data relating to awareness of the Act and wage differential for high, medium and low regional development.

**Table: Regional Development = High (N = 142)**

| Awareness about the Act | Wage Differential | | | Total |
|---|---|---|---|---|
| | High | Medium | Low | |
| High | 7<br>-21.9 | 10<br>-21.8 | 3<br>-9.3 | 20 |
| Medium | 13<br>-40.6 | 26<br>-33.3 | 9<br>-28.1 | 48 |
| Low | 12<br>-37.5 | 42<br>-53.8 | 20<br>-62.5 | 74 |
| Total | 32 | 78 | 32 | 142 |

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**Table: Regional Development = Medium (N = 86)**

| Awareness about the Act | Wage Differentials | | | Total |
|---|---|---|---|---|
| | High | Medium | Low | |
| High | 8<br>36.4) | 11<br>-25.6 | 4<br>-19 | 23 |
| Medium | 9<br>-40.9 | 17<br>-39.5 | 8<br>-38.1 | 34 |
| Low | 5<br>-34.9 | 15<br>-34.9 | 9<br>-42.9 | 29 |
| Total | 22 | 43 | 21 | 86 |

**Table: Regional Development = Low (N = 52)**

| Awareness about the Act | Wage Differential | | | Total |
|---|---|---|---|---|
| | High | Medium | Low | |
| High | 14<br>-58.3 | 7<br>-53.8 | 7<br>-46.7 | 28 |
| Medium | 8<br>-33.3 | 4<br>-30.8 | 6<br>-40 | 18 |
| Low | 2<br>-8.3 | 2<br>-15.4 | 2<br>-13.3 | 6 |
| Total | 24 | 3 | 15 | 52 |

On examination of these three partial tables, if the researcher finds out that bivariate relationships do not hold good, he/she may infer that it is the third variable, the regional development which is affecting the bivariate relationship. In the partial tables for higher regional development, the proportion of people perceiving high wage differential are those who are having high level of awareness about the Act. The similar trend can be noticed in the remaining two partial tables. Which means regional development does not affect the bivariate relationships between wage differential and awareness about the Act.

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**Multivariate Analysis**

When a researcher is interested in assessing the joint effect of three or more variables, he/she uses the techniques of multivariate analysis. The most common statistical technique used for multivariate analysis is regression analysis. In the first step of multivariable analysis, the researcher has to obtain the correlation between the variables which are having statistically significant correlation. These variables are put in the regression analysis. One important point in applying correlation and regression analysis is the data must be measured on ratio or interval level. Another point a researcher has to keep in mind is that these two statistical techniques are based on certain assumptions. Hence, before applying these techniques, the researcher has to see whether the sample selected by him fulfils those conditions.

Multiple regression's great advantage is its ability to adjust for several control variables (i.e., alternative explanations) simultaneously. With percentage tables, you can rarely use more than one control variable at a time. In addition, multiple regression is widely used, and you are likely to encounter it when reading research reports or articles. Multiple regression results tell the reader two things. First, it tells the overall predictive power of the set of independent and control variable on the dependent variable. A statistic, R-squared ($R^2$), tells us how well a set of variables "explains" a dependent variable. Explain here means making fewer errors when predicting the dependent variable scores on the basis of information about the independent variables. A good model with several variables might account for, or explain, a large percentage of variation in a dependent variable. For example, an $R^2$ of 0.50 means that knowing the independent and control variables improves the accuracy of predicting the dependent variable by 50 percent and that you would make one-half as many errors in predicting the dependent variable with the variable as you would not knowing about the independent and control variables.

Second, multiple regression results give the direction and size of the effect of each variable on a dependent variable. The effect is measured precisely with a numerical value. The higher the value, the larger the effect of a variable on predicting the dependent variable. The sign (positive or negative) of the effect tells you the direction of the impact on the dependent variable. For example, you can see how five independent or control variables simultaneously affect a dependent variable with all variables controlling for the effects of one another. This is especially valuable for testing theories that state that multiple independent variables cause one dependent variable.

**Summary of Major Types of Descriptive Statistics**

| TYPE OF TECHNIQUE | STATISTICAL TECHNIQUE | PURPOSE |
|---|---|---|
| Univariate | Frequency distribution, measures of central tendency, standard deviation, *z*-score | Describe one variable. |
| Bivariate | Correlation, percentage table, chi-square | Describe a relationship or the association between two variables |
| Multivariate | Elaboration paradigm, multiple regression | Describe relationships among several variables, or see how several independent variables have an effect on a dependent variable. |

## 8.11 Hypothesis Testing and Inferential Statistics

Hypothesis testing generates new knowledge. The human brain is constantly trying to find connections and draw conclusions about the world around us. These conclusions become ideas, hunches, or gut feelings that we believe are true about the world. You can operate in many parts of life solely by using these ideas or hunches, but as a social worker you want to use evidence-based practices. Rigorously testing your ideas about how the world works is an important way to ensure that your judgment, preconceptions, and biases are not infiltrating your work. Inferential statistics are a tool to test ideas—or hypotheses, in the jargon of statistics—to determine if the differences or relationships are due to chance or to the treatment being tested.

**WHAT IS A HYPOTHESIS?**

A hypothesis begins as a question about the world that forms the basis of a theory to be tested. You can think about a hypothesis as “an educated guess.” Anytime you

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observe the world, you look for relationships and try to make sense of what you are seeing. Hypotheses are a way to make explicit the ideas you have about how any given relationship works. They allow you to rigorously test your educated guesses.

When doing research, you start by assuming no relationship exists between the variables you are studying. You seek to prove this assumption incorrect, and you use statistical tests to quantify the likelihood that the relationship occurred by chance.

Imagine observing that when you offer childcare for attendees at a community meeting, more people show up for the event. You might think that the opportunity to bring their children and have someone to watch them allowed more people to come. That might be enough for you to start offering childcare at your next community meeting, but maybe the change in attendance just occurred by random chance. Maybe what drove the change was that you had the meeting on a Monday instead of a Friday and the timing worked better for people. Maybe your last meeting conflicted with an event at the local school. Maybe it was raining. Maybe parents decided tonight was a better night than other nights. You cannot know if childcare drove the increased turnout unless you test your hypothesis.

In any given inferential test, there are two hypotheses at play:

1. Null hypothesis
2. Alternative hypothesis

## NULL HYPOTHESIS

The null hypothesis (expressed mathematically as $H_0$) represents the possibility that there is no significant difference between the populations you are interested in. The null hypothesis argues that any differences are due to error or chance, or that the two groups are the same. This would mean that there is no difference in turnout for your event whether you offer childcare or not. Any variation is either random or linked to another factor.

## ALTERNATIVE HYPOTHESIS

The alternative hypothesis (expressed mathematically as H a ) represents your assumption that the intervention made a difference. The alternative hypothesis is your expectation about how the independent variable affects the dependent variable. Your alternative hypothesis is that more people attend community meetings when childcare is offered.

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The null hypothesis is a check on your assumption. It represents the possibility that, even after the intervention, there is no difference between the group that received the intervention and the group that did not.

The null and alternative hypotheses are structured like this:

$H_0$: There is no difference between the group that received the intervention and the one that did not.

$H_a$: There is a difference between the group that received the intervention and the one that did not, and the difference is due to the independent variable (the intervention).

Here is another example:

$H_0$: M 1 = M 2 (The null hypothesis is that the first mean is equal to the second.)

$H_a$: M 1 ≠ M 2 (The alternative hypothesis is that the first mean is not equal to the second.)

The first equation indicates that the mean for the first group is the same as the mean for the second group; there is no difference between the groups. This is the null hypothesis. The second indicates that the mean for the first group differs from the mean for the second group. This is the alternative hypothesis.

**NONDIRECTIONAL ALTERNATIVE HYPOTHESIS**

Stating that there is a difference makes this alternative hypothesis a nondirectional alternative hypothesis. The hypothesis in this case is that there is a difference, but the direction is not specified. An example would be "Parental engagement affects child behaviour." This hypothesis does not venture a guess about whether parental engagement will improve child behaviour or worsen child behaviour, but it asserts that there will be a difference.

**DIRECTIONAL ALTERNATIVE HYPOTHESIS**

A directional alternative hypothesis goes a step further. If the evidence or your experience makes you confident in the direction of a relationship, then you can incorporate that into a hypothesis. "Providing childcare improves attendance" is a directional hypothesis, as is "Parental engagement improves child behaviour."

CONSIDERING THE MEANS

As we have discussed previously, the mean of a dataset can provide quick, useful information about groups you are comparing. You are more likely to find a

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statistically significant difference and reject the null hypothesis if the means of the groups are very different. Of the two groups shown in table below, without further testing, which one is more likely to result in rejecting the null hypothesis?

Table: Comparing Groups

| | | | |
|---|---|---|---|
| Experiment 1: Sample A | | Experiment 1: Sample B | |
| Mean = 15 | SD = 5 | Mean = 40 | SD = 10 |
| Experiment 2: Sample A | | Experiment 2: Sample B | |
| Mean = 10 | SD = 2 | Mean = 11 | SD = 1 |

Without any additional information, you might guess that the first experiment makes rejecting the null hypothesis more likely. The means in experiment 1 appear much more different than those in experiment 2. You would assume that there is less overlap between those distributions compared to the second set of distributions, even without having any other information.

Using figure 1, you can see by looking at the two distributions on a graph that the overlap in the second pair is greater than the overlap in the first. You can think of the shaded area as the area where you could not differentiate a person who was part of sample A from a person who was part of sample B. The larger that area, the more difficult it is to determine if there are significant differences between the two groups. Comparing distributions using the means and standard deviations gives you a sense of whether your inferential test will return a significant result.

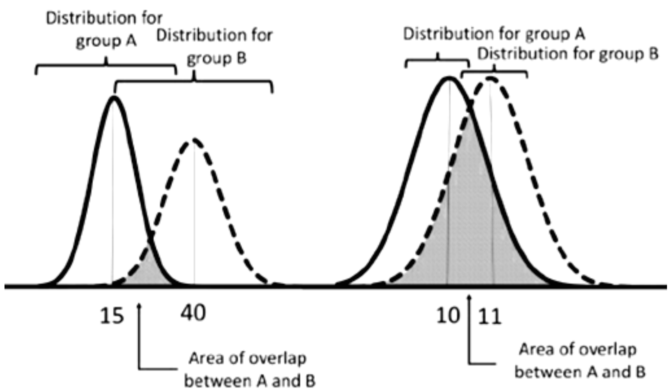


FIGURE .1 Using distributions to see group differences

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Two sets of distributions are graphed. Each set includes two curves that graph the data for two groups. In the first set, there is a very small area where the two curves overlap. In the second set, the curves have a much large area of overlap. Telling the difference between the two groups where the distributions have a lot of overlap would be more difficult than telling the difference between the groups with only a small area of overlap.

**HOW DO I TEST A HYPOTHESIS?**

Now that you understand how to make your assumption explicit by identifying a hypothesis, you can test that hypothesis. The goal of inferential statistics is to establish a level of confidence that a difference you observe is due to the independent variable you are testing.

In figure 1, the first pair of distributions has little overlap, which is promising for finding a statistically significant result. Little overlap is not sufficient though. You must to do an inferential test.

This chapter will introduce the t-test, a test for two groups. The following chapter will build on that concept with ANOVA and chi-square tests, which are used if there are three or more groups.

**WHAT IS A T-TEST?**

As a professional, you will want to know whether interventions you deliver have the desired effects. To do this, you first identify a group of people who could benefit from the intervention. These may be your clients, community members, or some other group. From there, you develop a test for your intervention. The most common tests are to evaluate a group prior to providing the intervention and then again after receiving the intervention (a pre/post-test) or to give the intervention only to a subset of the larger group, so some members receive the intervention and others do not (experimental design). In either of these situations, you are focusing on only two groups, so the t-test is the most useful option in your statistics toolkit.

A t-test is used to determine whether there is a statistically significant difference between two groups. There are two kinds of t-tests (table 2):

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Table 2: T-Test Matrix

| Dependent t-Test | Independent t-Test |
|---|---|
| A t-test for dependent means is used when a single group of subjects is being studied under two conditions—for example, evaluating the same subjects before an intervention (pre) and after an intervention (post). | The independent groups t-test is used to evaluate whether the means of two independent samples are equal—for example, comparing the effectiveness of an intervention by comparing the mean for a treatment group (intervention received) and a control group (no intervention). |
| Use this test when:<br>The same participants are being tested more than once. There are two samples (before and after). | Use this test when:<br>Differences between two separate groups are examined. Participants are being tested only once. |

## HOW DO I INTERPRET A TEST STATISTIC?

Results for t-tests in academic literature will look something like this: image (image) Unless you are doing research, interpreting the results of t-tests is more important than calculating a t-value. We do not cover the calculation for finding a t-value, but the results from a t-test break down into three distinct pieces of information, and you should understand how to interpret these results.

$t = 2.04$, $df = 30$, $p < 0.05$

1. $t = 2.04$: The t-value is a test statistic, which is a standardized value calculated from your data, but not in the same units as your measurements. While knowing $t = 2.04$ may not tell you much, knowing that a t-test was done tells you that the study had two groups—either two samples from the same groups (pre/post) or two independent groups.
2. $df = 30$: The notation df refers to degrees of freedom. For t-tests, $df = n - 1$. If you remember from previous chapters that n is the notation for sample size, the degrees of freedom are one less than the sample size. If you know the degrees of freedom, you also know the size of the sample.
3. $p < .05$: To know if there was a statistically significant result, you need to understand the p-value. You will learn in the next section that the most common threshold for statistical significance is $p < .05$. These results meet that threshold, so the results are statistically significant.

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Consider if, instead, you see results like these:

$t = 1.7$, $df = 24$, $p < 0.10$

1. t = 1.7: A t-test was done, so you are dealing with only two groups—either two samples from the same groups (pre/post) or two independent groups.
2. df = 24: The sample size was n = 25.
3. p < .10: The most common level for statistical significance is p < .05. These results do not meet that threshold, so they are not statistically significant.

**WHAT IS STATISTICAL SIGNIFICANCE?**

Statistical significance is a key concept for consuming research findings and understanding the limitations of "knowing" based on statistical tests. Statistical significance is the probability that a value has a certain level of precision.

**P-VALUE**

We describe statistical significance with something called a p-value. The p-value can also be referred to using the Greek symbol alpha (á). The most commonly used threshold for statistical significance is p < .05.

A p-value, or significance level, of p < .05 indicates less than a 5 percent chance of seeing the results you found if the null hypothesis is true. If there is truly no difference between the two groups, then there is less than a 5 percent risk that these results would occur by chance. Put another way, a 5 percent significance level means that there is a 5 percent risk of rejecting the null hypothesis when it is true. (This is called a Type I error; you will learn about error in the next section.)

Prior to conducting an inferential test, the p or alpha (á) level must be set to determine the level of risk that is acceptable for rejecting or accepting the null hypothesis. The alpha level is most commonly set at p = .05, but it could be set higher or lower based on the appetite for risk in a given situation. You could imagine that in a scenario where the treatment could cause harm or the side effects might be severe, your appetite for risk would be lower, so a p-value of p = .01 would be more appropriate.

Consider a situation in which a teenager is tested for and diagnosed with a severe mental illness. This teenager will now be prescribed medications that can have serious side effects and will have to face potential stigma from this diagnosis. Would

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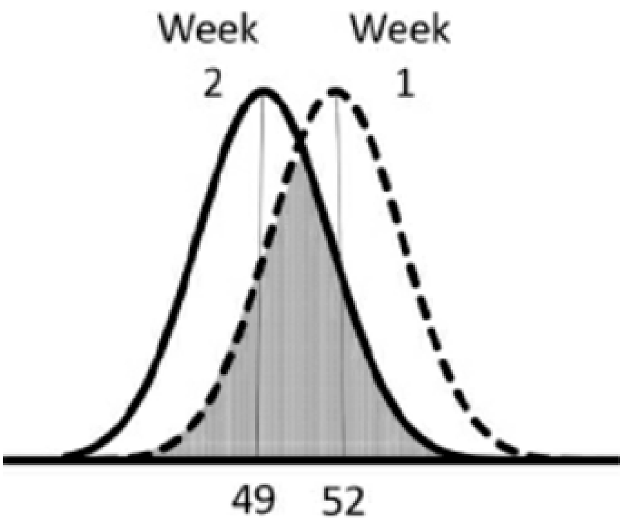
you be willing to accept a 5 percent risk that the test generated a false positive and the teenager does not have the diagnosed condition? Would a 1 percent chance be more acceptable? When the consequences are severe, you accept less risk. You use p-values to set the acceptable level of risk.

**Statistical Significance in Political Polling**

Statistical significance is regularly mentioned in the news. For example, during political campaigns, the media often report the results of public opinion polling in the form "Candidate A has the support of 52 percent of the electorate, with a 4 percent margin of error." Given that most polling uses the standard alpha (á) level of p = .05, this means that there is a 95 percent chance that the true rate of support among the entire population for candidate A is between 48 and 56. When the next week the media report a "fall" in support for candidate A to only 49 percent (with the same margin of error), all that means is that there is now a 95 percent chance that the true rate of support among the entire population for candidate A is between 45 and 53. Even though the media reported a "drop in support," in reality candidate A's support may have held steady at anywhere between 48 and 53 ( figure 2 ).

The distributions representing support of a candidate over two weeks have a large area of overlap, which means that the candidate's support level could have been the same despite being reported as having declined.

**FIGURE 7.2 Distributions for support of a candidate over two weeks**



If a test results in a p-value that is equal to or less than the alpha (á), then reject the null hypothesis (thus accepting the alternate hypothesis—your “educated guess”). If the result is greater than the á level, then you cannot reject the null hypothesis. If you cannot reject the null hypothesis, then there is not a statistically significant difference between the groups.

Remember that if a test does not reach the desired á level, you do not know that the intervention failed. The null hypothesis may not be true, but the sample data used in the calculation did not provide sufficient evidence to reject it. Similarly, a p-value of .05 does not mean that you have proved the alternative hypothesis. Even if the null hypothesis were true, there would still be a 5 percent chance of getting your result. If you were so convinced of the relationship that you kept testing for it, in 1 out of every 20 tests, you would be able to get a result where $p < .05$. Remember that each time you see a positive result reported in research literature, you may not see hundreds of attempts to test the same thing that did not find significant results.

Another risk is adhering too closely to the standard of $p = .05$. If a study found that the results of an intervention were significant to $p < .06$, that result would not reach the á level of $p < .05$, but it might still be promising enough to continue testing the intervention. The strict focus on $p < .05$ can be an overly narrow way to indicate the success of an intervention. The focus on this “bright line” result in published academic research has had the unfortunate consequence of driving some researchers to manipulate data in ways they otherwise might not have to find $p < .05$. (This is called p-hacking.)

**HOW DO I KNOW IF A SIGNIFICANT RESULT IS MEANINGFUL?**

Statistical significance does not always translate into meaningful differences that non-statisticians appreciate. A “significant” result in statistics refers to solely the p-value, even though that use does not necessarily match the colloquial use of the word.

A small p-value does not necessarily ensure a larger or more important effect, and a larger p-value does not mean the results are unimportant or prove that the intervention does not work. With a large enough sample size, any effect, no matter how tiny, can produce a small p-value, and with a small sample or imprecise measurements, even an intervention that has a large effect may result in a nonsignificant p-value.

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A study may be statistically significant but not meaningful. If a study found statistically significant results that extracurricular activities for teenagers lowered their use of alcohol, administrators would want to fund additional activities. However, if the statistically significant result showed that extracurricular activities lowered alcohol consumption by an average of only 0.5 drinks per week, then the practical implications may be limited. Schools may not be willing to spend more money encouraging students to participate in extracurricular activities or creating new clubs or sports teams to lower alcohol consumption by only half a drink a week if reducing alcohol consumption is their primary goal.

## Using a t-Test in Practice

A city's Department of Human Services plans to launch a new flexible rent-subsidy pilot to reduce the number of families who become homeless and need shelter provided by the city. The subsidy is designed to help low-income families stay in housing despite short-term fluctuations in their income. This flexible subsidy could allow them to adjust for shifting or unstable hours at work or unexpected costs like flat tires or medical bills.

There are not enough funds to serve every eligible family, so the city randomly selects families to receive the subsidy and creates a waiting list. They can then compare the families who receive the subsidy (n = 138) to those who are still on the waiting list (n = 234) to see if there is a difference between the two groups in the average amount spent on social services (table 3).

**Table 3 Mean Spending for Families in Treatment and Control Groups**

| | **Received Subsidy** | **On the Waiting List** |
|---|---|---|
| **Mean spending per family during program year** | **$9,329** | **$13,321** |

There are two groups, the treatment and control group, which means that an independent t-test is the most appropriate test to determine if there is a difference in the amount spent on social services for families at risk of homelessness. After completing a t-test, the city staff found the following results:

$$t = -12.46, \text{ and } p < 0.0001$$

A p-value of < .0001 is extremely small. This p-value indicates that there is only a 1 in 10,000 chance that these results are due to chance or that they represent a false positive. Given this result, the staff feel confident that the flexible subsidy has lowered the overall cost of supporting families, and they can use this information to advocate for expanding the program in the next year.

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Similarly, if a study found statistically significant results that a job training program placed participants in jobs but that they held those jobs for less than two months, then the practical implications may be limited. The state may not be willing to spend more money on job training programs if they do not lead to long-term employment.

In each case, the results were statistically significant, but the implications for practice were not meaningful. Return to the previous examples of t-test results:

$$t = 2.04,\ df = 30,\ p < 0.05 \text{ or } t = 1.7,\ df = 24,\ p < 0.10$$

You now know that the commonly accepted level of risk is .05. When $p < .05$, you have sufficient confidence that there is a difference between the groups being examined. At $p < .10$, you have not reached a sufficient level of confidence that the difference is produced by the intervention rather than by chance.

## WHAT DO ERRORS TELL ME ABOUT MY RESULTS?

When you think about testing hypotheses, you may think that the alternative hypothesis (your educated guess) will either be rejected or not. Unfortunately, since you are never testing the entire population, determining if your result is valid is more complicated than that. For example, there is some chance that you will find no difference between the group that received the intervention and the one that did not, when in reality there was a difference. Alternatively, your test might find a difference between the two groups, when in reality there was not a difference.

## TYPE I ERROR

Type I errors (á) occur when you conclude there is a difference when there is not (table 4). It is a false positive finding. If you are testing an antidepressant and find that the people who took the medication have lower levels of depression, but really the difference was just due to chance, then that is a Type I error.

**Table 4 Analysing Hypotheses**

| | $H_0$ is True | $H_0$ is False |
|---|---|---|
| Reject $H_0$ | Type-I error (false positive) | Finding reflects reality |
| Do not reject $H_0$ | Finding reflects reality | Type-II Error (False negative) |

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**TYPE II ERROR**

Type II errors (â) occur when you do not find a difference that exists. It is a false negative finding. If you found that the antidepressant did not make a difference when it actually lowered levels of depression, you have made a Type II error.

You cannot completely eliminate the risk of a Type I or Type II error when conducting tests, but you should understand the risk of each type of error and its implications. Calculating the precise risk of error is beyond the scope of this book. For most practitioners, it is sufficient to understand the implications of either a Type I or Type II error and know that there is always some risk involved.

Type II error can occur because a small sample size limits the power of the test. When you review literature, or are testing interventions yourself, keep the risk of Type II error in mind if you are working with only a few people. You will have trouble overcoming Type II error unless you can test the intervention with a larger group.

**Error in Practice**

Imagine you are a counsellor at a high school who is concerned about an increase in the number of teenage suicides. You want to help mediate this risk with your students. Your hypothesis is that a crisis intervention you designed will help your students, but you must test your hypothesis to be certain.

The null hypothesis is that your intervention does not make a difference and that the risk is the same for a group that receives the intervention and a group that does not. The alternative hypothesis is that your intervention reduces suicidal ideation—thinking about or planning to commit suicide.

If you conducted an experiment to test your intervention and found that the intervention was effective at reducing suicidal ideation, but in fact your results were just random chance, that is a Type I error. This result would lead to the belief that the intervention helps when it does not. Teenagers may receive a treatment that does not help them, possibly wasting time and resources or keeping them from an intervention that would be more effective. You obtained a false positive.

Instead, imagine you conducted an experiment and found that your intervention did not make a difference in students' suicidal ideation, when in fact it was making a difference. That result is a Type II error. This would lead to the belief that the

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intervention did not work when in fact it could reduce the risk of suicide. Here, teenagers are not receiving a treatment that could save lives.

If you are the counsellor conducting the test, which risk is more acceptable, Type I or Type II? Do you continue testing an intervention that may not work, or do you set aside an intervention that may be helping but that you do not yet have statistical proof to back up?

**WHAT IS THE EFFECT SIZE?**

Effect size is a simple way of quantifying the magnitude of the difference between two groups. Effect size emphasizes the size of the difference in terms of standard deviations, so the difference is more easily compared across groups.

The effect size is particularly valuable for quantifying the effectiveness of a particular intervention relative to some comparison. It allows you to move beyond the simplistic "Does the intervention work or not?" to the far more sophisticated "How well does the intervention work in a range of contexts?" Moreover, by placing the emphasis on the size of the effect rather than any statistical significance, you can more easily translate results into their practical implications.

**HOW DO I CALCULATE THE EFFECT SIZE?**

The effect size is calculated using Cohen's d. Cohen's d is a measure of effect size based on the difference between two means. Because Cohen's d uses the means for two groups, this measurement of effect size is only useful in conjunction with t-tests.

The effect size is calculated as follows:

**Cohen's d = $(x_1 - x_2)/ \{(SD_1 + SD_2)/2\}$**

**= (mean of Experimental Group – Mean of Control Group)/Pooled Standard Deviation**

You can evaluate the effect size using the following guidelines (figure 3). If Cohen's d is around 0.2, then the effect size is small. If it is around 0.5, then the effect size is considered medium. If the effect size is around 0.8, this is considered a large effect size. If the effect size is greater than 1, then that is a very large effect size.

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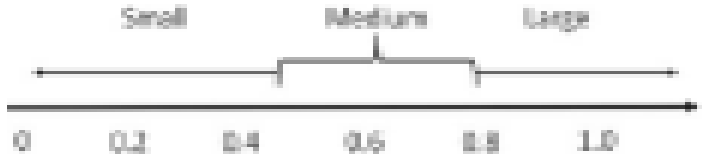


**FIGURE 3 Measuring magnitude of effect size**

A scale for measuring the magnitude of the effect size, ranging from 0 (no effect) to 1 or more (a large effect). In the middle is a range from about 0.5 to 0.8 where the effect size is considered medium.

When calculating Cohen's d, you may find a negative result. If x 1 in your equation is the experimental group and x 2 is the control group, then a negative effect size indicates that the effect was negative (rather than improving the condition, it caused deterioration, or rather than an increase, there was a decrease). In general, the sign of the effect size is not as important as the magnitude. However, you should always verify that the direction of the change matches your assumption.

Finding a small effect size does not mean that the treatment under consideration has no effect. Finding a small effect size means that the only way to identify the effect or difference is by using precise instruments with a large sample size. For large effect sizes, you may be able to see the difference between the two groups simply by observing them. Consider an effective antibiotic. If an antibiotic was given to one group of people suffering from an illness while the other group received a placebo, you should be able to tell who received the antibiotic by looking at whose symptoms have ceased. This is an example of a very large effect size. You can observe the difference without careful testing (though you should still conduct tests!).

It should make sense that if Cohen's d is larger than 1.0, it is a very large effect size. Effect size indicates how many standard deviations the mean of the experimental group is from the mean of the control group. If Cohen's d is equal to 1, then there is a full standard deviation between the means. You will remember from chapter 4 that nearly all scores fall between +/"3 standard deviations from the mean, and that 68 percent of scores fall between +/"1 standard deviation from the mean. Finding more than 1 standard deviation between the means is a substantial difference.

## UNDERSTANDING EFFECT SIZE USING DISTRIBUTIONS

Using graphical representations can help clarify the meaning of the effect size.

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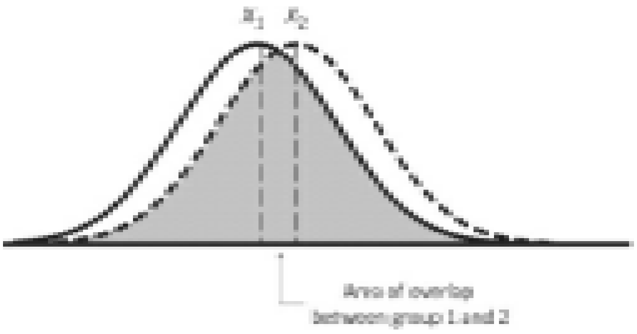
The goal of the effect size is to standardize the size of a difference between two means using the variance between the two distributions.

Start by considering the distribution in figure 4




Two distributions with means that are close together and large standard deviations have a large amount of overlap. In this situation, you would assume the effect size is small.

You can see that the means are close and the overlap is large. The distributions are also flat, which indicates larger standard deviations. What does this tell you about the effect size?

First, the large amount of overlap between the two distributions indicates that identifying whether a person was in the treatment or control group would be difficult. The differences would not be clear. Second, the large standard deviation (the distributions are more flat than peaked) means that the denominator of the effect size calculation will be larger and the resulting Cohen's d will be smaller.

Compare the distributions in figure 4 to the distributions in figure 5.

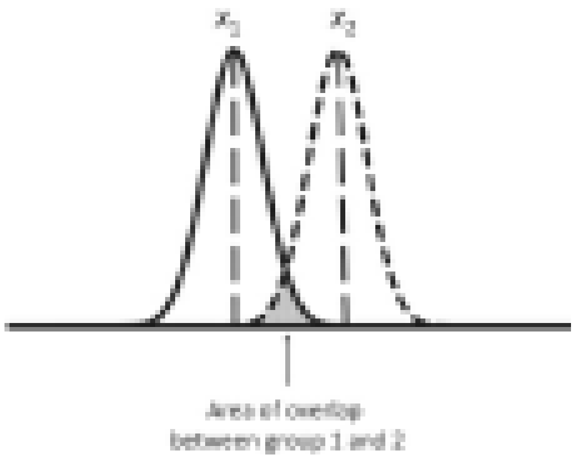



FIGURE 5 Understanding distributions with a medium effect size

Two distributions with means that are not close together and large standard deviations have a smaller amount of overlap. In this situation, you would assume the effect size is medium.

The means in figure 7.5 appear to be more different. There is little overlap between the two distributions, but they also appear to have large standard deviations. The denominator of the effect size calculation will be large, and the resulting Cohen's d will be small, though not as small as in the first set of distributions because the overlap between the two distributions is smaller.

Finally, compare the distributions in figure 4 and 5 to the distribution in figure 6.

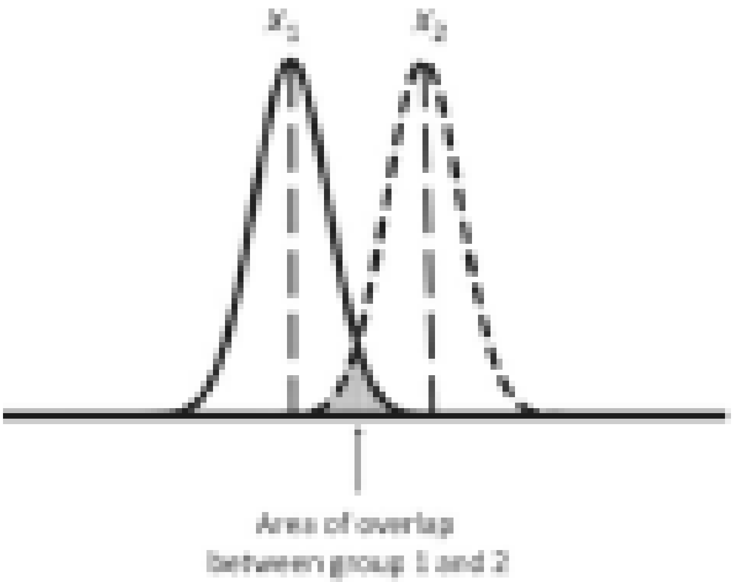



FIGURE 6 Understanding distributions with a large effect size

Two distributions with means that are close together and small standard deviations have a small amount of overlap. In this situation, you would assume the effect size is large.

The means in figure 6 appear to be more similar, like those in figure 4. But the distributions are quite peaked, indicating smaller standard deviations, so there is little overlap between the two distributions. These distributions will have a larger effect size than the distributions in figure 4.

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KEY TAKEAWAYS

- T-tests tests allow you to determine if there is a difference between two groups.
- The significance level is the amount of risk you are willing to accept that you rejected the null hypothesis, or said there was a difference between groups, when there was no difference.
- Not all statistically significant results have meaningful practical implications.
- If Cohen's d is around 0.2, it is considered small. If it is around 0.5, it is considered medium. If it is around or above 0.8, then it considered a large effect size.

**MORE ON HYPOTHESES: ONE- AND TWO-TAILED TESTS**

You can further refine your practice by understanding the differences between one- and two-tailed tests.

For either a one- or two-tailed test, assume you are still using the significance level of .05. A two-tailed test distributes half of your alpha to testing the statistical significance in one direction and half to testing statistical significance in the other direction (figure 7). This means that each tail of the distribution uses an alpha of .025. A two-tailed test analyses the possibility that a relationship exists, without predicting its direction. For example, it tests for the possibility that a treatment improved outcomes or worsened outcomes. Similarly, you could be interested in whether an intervention affected a family's earnings; a two-tailed test would test if incomes were either greater than or less than the value of the null hypothesis. With a two-tailed test, in order to be statistically significant, the results must be in either the top or the bottom 2.5 percent of the distribution, resulting in a p-value less than .05.

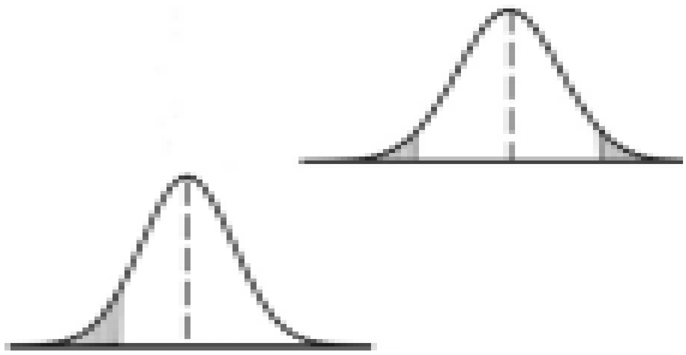

FIGURE 9.2 One- and two-tailed tests

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A one-tailed test indicates a hypothesis that specifies whether the effect of a treatment or a relationship will be greater or less than the control. A two-tailed test is used for nondirectional hypotheses. For a one-tailed test, the area under the curve that represents $p < .05$ is situated at one end of the distribution, where the effect is expected to be found. For a two-tailed test, the area is split, with an area of .025 under each end of the curve.

Alternatively, a one-tailed test distributes the alpha of .05 exclusively to one end of the distribution and does not test the other end of the distribution at all. If you wanted to know if an intervention increased family income, a one-tailed test would give you more power to detect the increase, but it would not test for a decrease at all. You are more likely to find a statistically significant result, but you risk missing results on the other end of the distribution. In some situations, missing an effect on the other end of the distribution can be a serious problem. Consider the possibility that you are interested in testing an antipsychotic medication. You want to maximize the chance of finding a statistically significant result for improved functioning on the medication, so you use a one-tailed test. In doing so, you can no longer find evidence that the medication is less effective than an existing drug or no treatment, whichever control you are using. Because this type of oversight is not acceptable in many situations, two-tailed tests are generally preferred. One-tailed tests should only be used when there is no risk or ethical concern in disregarding one direction of the effect.

P-HACKING: THE PRESSURE FOR STATISTICAL SIGNIFICANCE

In previous chapters, you have learned that the standard threshold for statistical significance is $p < .05$. This standard has been central to decisions about what studies are published and spread through the academic literature, but there is now a debate about its utility. A growing number of studies that reached the $p < .05$ threshold have not been replicable, calling into question their original validity. Additional studies have also found that there is a preponderance of published studies with results exactly equal to $p < .05$. Stunningly, about 90 percent of the papers published in academic journals documented positive findings where $p < .05$ .

The problem with the struggle to find statistical significance is that researchers can consciously, or unconsciously, alter their results in such a way that they reach a statistically significant result and are able to publish a more interesting article than one that fails to reject the null hypothesis.

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Suppose some researchers are considering the effect of income on mental health. They first consider income as all resources of the household (pay checks, food stamps, tax refunds, health insurance, and gift), and they do not find a statistically significant result. Then maybe they consider income to be only money coming in from pay checks. This time they do find a statistically significant result, and they publish this finding instead. In this case, the researchers can likely justify the change without using complicated calculations to achieve a statistically significant p-value (though that can also happen). The problem arises when, in the search for statistical significance, the researcher keeps trying until a statistically significant result is found. A disturbing number of published findings cannot be replicated when the experiment is conducted again by different researchers. This has led to calls to lower the p-value required for statistical significance or to abandon statistical significance in favour of effect size and the inclusion of descriptive statistics. One other emerging trend is prominent academic journals' actively promoting the publishing of results that fail to reach statistical significance, emphasizing that data from studies that are not statistically significant should also be considered as part of the body of literature.

For your practice, you should be aware that while the $p < .05$ level is a useful threshold and can be suggestive of interesting results, a study that finds this result does not necessarily mean you will get the same outcome if you repeat the intervention with the population you work with.

## 8.12 Conclusion

Thus we get an elaborate idea about the vari our statistical application's along with this we developed a concept about Coding & Hypothesis.

## 8.13 Exercise

1. You manage an agency that provides tutoring services. You are interested in starting a new literacy program for clients at your agency. You serve many people at your agency, but logistically you think you can only study the effect of the new program with 60 people. You randomly assign those 60

people so that 30 people receive services as usual and 30 people participate in your new literacy program. The results are shown in table 5.

| | Mean Score on Standardized Reading Test (Out of 200) | Standard Deviation |
|---|---|---|
| Services as usual | 150 | 29 |
| Literacy program | 175 | 35 |

a. What are the null and alternative hypotheses?

b. Which t-test should you use?

c. What significance level would you set?

2. Identify if each of the following situations is an example of an independent or a dependent t-test.

   a. You want to know if there is a difference in stress level between a group that did not participate in a meditation training workshop and a group that did.

   b. You test older adults' stability while walking before and after completing a falls-prevention and physical activity program.

   c. You gauge whether or not a campaign against bullying changed student attitudes.

3. Identify if each of the following situations is an example of Type I or Type II error.

   a. You track stress levels for children who are taken into the foster care system, measuring their stress level when they are removed from the home, when they are in foster care, and once family reunification has occurred. Your results indicate that family reunification does not lower children's stress levels, but in reality, reunification does lower stress levels.

   b. You are working with patients recently released from the hospital who need to monitor and manage their diabetes. You test a system of text-message reminders for when they should take their medicine and check their blood sugar. The results show that this intervention improved their

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management of the disease, but in reality, the improvement was just random chance.

4. Which of the following represents a statistically significant result?
   a. $t = 1.350$, $df = 13$, $p < .08$
   b. $t = 2.074$, $df = 22$, $p < .025$
   c. $t = 1.108$, $df = 8$, $p < .15$
5. Calculate Cohen's d using the information in table 6.

   Table 6 scores for Experimental and Control Groups

| | Mean | Standard Deviation |
|---|---|---|
| Experimental Group | 20 | 2 |
| Control Group | 15 | 4 |

## ANSWER KEY FOR REVIEW QUESTIONS

**1.** a. $H_0$: The literacy program has no effect on scores on the standardized reading test.

$H_1$: The literacy program increases scores on the standardized reading test.

or

$H_1$: The literacy program affects scores on the standardized reading test.

b. independent t-test

c. $p < 0.05$

**2.** a. Independent

b. Dependent

c. Dependent

**3**. a. Type II

b. Type I

**4**. b

Cohen's d = (20-15)/ {(2+4)/2}

Cohen's d = 5/3

**5.** Cohen's d = 1.67

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# Unit 9 ❑ Computer Applications in Social Research

***Structure***



## 9.0 Objective

The learner will learn about—

- The internet and social research
- Common packages in social science research – qualitative and quantitative
- E-resources and its proper use.

## 9.1 Introduction

Computer has become a very important device of our life. It has also made our life very easier. We cannot think of a life without it. Computer can be very effectively used in conducting research activities also. This unit will help us to discover how computer application can used while we carry out our data collection & interpretation & analysis.

## 9.2 The Internet and Social Research

The employment of digital technologies in social research is a rapidly growing area of development, deliberation and reflection. At its core is the employment of Internet technologies, tools and services as an object of research, as well as a tool and platform for the conduct of research and the creation of innovative methodological practices.

Social researchers put forward the premise that digital technologies can both expand existing research interests and yield new themes and questions for research. For instance, hyperlinks have given rise to (hyper) link research. Similarly, web sites and web content have given rise to website analysis, while search engines have fed the study of search-engine results and their politics.

At the same time, digital technologies have driven researchers to revisit old methods and devise new methodological tools for research. To overcome the drawbacks of offline methods of research, researchers often employ Internet tools and application that alter conventional methodologies and create virtual or online versions of them. Some have even stressed the need for the research community to dispose the necessary capacity so as to treat digital methods as 'mainstream methodology'. Along these lines, the employment of digital technologies in research suggests the collaboration of social and computer researchers, with knowledge elements from various disciplines being combined so as to boost new areas of research or niche spaces for the operation of new knowledge networks and fields of study (e.g., artificial intelligence). This leads to the deployment of new research models (e.g., computational social science, agent-based models) and data, the pursuit of large-scale research and the initiation of new practices and communities of inter-disciplinary collaboration that often involves technology experts, funders, creative practitioners, industry actors and ordinary technology users.

***Integrating Data and Documentation***

To what extent can the various tasks mentioned above be integrated into a single process? Using a single computer program or an integrated set of programs to carry out these tasks simplifies data management, reduces costs, and is more reliable. It is advisable to determine which program or programs will handle data management and documentation tasks at the outset of the project.

***Computer-assisted interviewing.***

Computer-assisted interviewing (CATI/CAPI) is increasingly being used for both telephone and personal interviews. These programs — e.g., Blaise, CASES — typically perform a number of functions simultaneously including direct data entry, integrity checks, and skips and fills. Somewhat similar software can be used to format mail questionnaires and prepare data entry templates. Be aware that not all CAPI-generated variables are needed in the data file that is deposited in an archive; variables that are artefacts of the CAPI process do not contribute useful information for analysis. If possible, it is desirable to program the instrument to be fielded according to specifications of the resulting data files. Keeping a focus on the ultimate desired form of the data collection can make dataset preparation much easier.

***Using integrated software.***

Most large-scale data collection efforts now involve computer assisted interviewing, but there are still situations in which data entry will be required — e.g., inputting of administrative records, observation data, or open-ended question responses. A number of software tools are available to make the documentation task easier. For projects requiring data entry directly from mail questionnaires or interview instruments, a variety of programs will not only make data entry easier, but also carry out data integrity checks as the data are entered and create programming statements to read the data into other programs. A good data-entry program will also recognize automatic skips and fills. For example, suppose that a questionnaire contains a series of items on work experience. If the respondent has never worked, then as soon as that code is keyed, the program skips to the next valid entry, filling in missing data codes in intervening fields as appropriate.

***Spreadsheets and databases.***

Spreadsheet packages can also be used for data entry. These packages usually can be programmed to perform integrity checks as data are entered. In addition, a variety of database packages such as Microsoft Access, MySQL, and Oracle can be used for both data entry and documentation. Note that when such systems are intended to serve as the format for deposit, it is important to provide full documentation for all of the fields and relationships built into the files.

Other kinds of software can be used to perform many documentation tasks. For example, word processing packages like Microsoft Word can be used for data entry, maintenance of dataset documentation, and similar tasks, but they are not suitable tools for data integrity checks. Producing an attractive final document using word processing is also quite simple. In fact, if the basic document has been set up in a word processor, retrieving and merging statistical information such as frequencies and descriptive statistics from computer output stored in an external file is a relatively easy task.

## 9.3 Common packages in social science research – qualitative and quantitative

One of the most obvious ways to categorize information is by whether it is quantitative or qualitative. Some sources contain either quantitative information or qualitative information, but sources often contain both.

Many people first think of information as something like what's in a table or spreadsheet of numbers and words. But information can be conveyed in more ways than textually or numerically.Examples of social science data include:

- survey data (opinion polls, voting records)
- nonsurvey data (images, maps, sound, video, multimedia)
- raw measurments, numeric tables, government statistics, and indices
- text (fieldnotes, transcripts, blogs, e-mails)
- spatial (zonal, event, spatial referent)

***Quantitative Information*** – Involves a measurable quantity—numbers are used. Some examples are length, mass, temperature, and time. Quantitative information is often called data, but can also be things other than numbers.

***Qualitative Information*** – Involves a descriptive judgment using concept words instead of numbers. Gender, country name, animal species, and emotional state are examples of qualitative information. Examples of types of qualitative data that may be archived for secondary analysis include: • In-depth/unstructured interviews, including audio and video • Semi-structured interviews • Structured interview questionnaires containing substantial open comments • Focus groups • Unstructured or semi-structured diaries • Observation field notes/technical fieldwork notes • Case study notes • Minutes of meetings • Press clippings

### Data Analysis Tools for Social Sciences

R is free to download and use, and all the codes are open. At the same time, users can easily add their own programs (once they are familiar with statistics and programming).

SAS is a powerful statistical-analysis and data-management system for complex data sets. It is especially strong in analysis of variance (ANOVA), the general linear model, and their extensions.

**SPSS** performs statistical analysis on quantitative data. The graphical user interface makes statistics analysis easier, including most complex models. It is a software that is widely used on computers and it is used for scientific, social and econometric research. SPSS is also used as an optimal tool for parametric analysis, correlation analysis, scale reliability testing

**PSPP** is a statistical analysis tool developed to be a free, open-source alternative to SPSS (which is now developed by IBM). Although not identical, it is similar in many respects, and allows one to work with file formats common to SPSS. Unlike SPSS, PSPP does not limit the number of cases or variables which you are able to use, nor will it require you to purchase add-ons to gain access to more advanced functions. As a fully functional statistical analysis program, it is capable of performing descriptive statistics, y-tests, linear regression, as well as non-parametric tests. Included in its basic design is the ability to perform analyses as quickly as possible, regardless of the volume of data entered. In addition, you have the option of using the program through its graphical user interface (GUI), or through the more traditional method of utilizing syntax commands.

Stata is a command-based statistical package that offers a lot flexibility for data analysis. The program language keeps a simple structure, so is easy to learn, allowing users to focus on the statistical modeling.

Excel is good is for the simplest descriptive statistics, or for more than a very few columns. It is easy to use for basic data analysis, and is much more convenient for data entry and shape manipulating.

NVivo is a qualitative data analysis package. It helps researchers organize and analyze complex non-numerical or unstructured data, both text and multimedia. The software allows users to classify, sort, and arrange thousands of pieces of information. It also accommodates a wide range of research methods. It supports documents in many languages.

Quantum GIS (QGIS) is open source GIS software, available for both Windows and Mac OS. This software is free and comes with surprisingly powerful and useful tools.

***Codes and Coding***

Before survey data are analyzed, the interview or questionnaire responses must be represented by numeric codes. Common coding conventions (a) assure that all statistical software packages will be able to handle the data, and (b) promote greater measurement comparability. Computer-assisted interviewing systems assign codes automatically by programming them into the instrument, so that most coding decisions are made before the instrument is fielded. The principles discussed here apply to such situations as well as those in which coding follows data collection.

## E-resources and its proper use

The term ‘e-resources’ an acronym used in reference to electronic resources or electronic information resources. These are collections of information in electronic or digital format that are accessed on an electronic device, such as a mobile phone, computer, etc. They are published resources in electronic versions or format such as encyclopaedias, pamphlets, e-books, e-journals, databases, etc. A number of authors have also provided their own definitions. Adams and Bonk (1995), Scan (2010), Moyo (2004), Liu (2006) and Nicholas et al. (2009) defined electronic resources as databases, books, journals, newspapers, magazines, archives, theses, conference papers, examination papers, government papers, research reports, scripts and monographs in an electronic format. Swain and Panda (2009a) regarded e-resources as reservoirs of information that may be milked through various electronic devices such as computers, smart phones, tablets, etc. ‘They are fine grained and restructured and often stored within the cyberspace in a compact form’. The major advantage of e-resources is that they can be simultaneously accessed ubiquitously around the world by a great number of users. Nicholas et al. (2017) also concurred that the use of electronic resources, such as search engines, was highly popular among early-career researchers irrespective of country, language and discipline.

According to AACR2, an electronic resource is: “Material (data and/or program(s)) encoded for manipulation by a computerized device. This material may require the use of a peripheral directly connected to a computerized device (e.g., CD-ROM drive) or a connection to a computer network (e.g., the Internet).” IFLA defines Electronic Resources as “to those materials that require computer access, whether through a personal computer, mainframe, or handheld mobile device. They may either be accessed remotely via the Internet or locally". Some of the most frequently encountered types are: E-journals, E-books, Full-text (aggregated) databases, Indexing and abstracting databases, Reference database (biographies, dictionaries, directories, encyclopedias, etc.), Numeric and statistical databases, E-images, E-audio/visual resources (IFLA,2012).

The rapid advancement of information and communication technology has brought a revolutionary change in the information scenario and gives rise to a number of options to handle varied information sources conveniently and effortlessly. Electronic resources (E-resources) have become the most sought after modern library's reserves in satisfying varied needs of students, teachers, and researchers with minimum risk and time. Information technology has changed the world and has become one of the important tools for retrieving information. The electronic information resources have acquired a major portion of library collections. The value and use of information resources, particularly E-resources, have increased with the time. Therefore, there is necessity to make study on the different aspects of resources and the issues relating to the use of E-resources by users, more particularly by the faculty members of academic institutions.

## 9.4 Types of E-Resources

The Internet is a heterogeneous channel with vast educational resources. These resources include: e-books, ejournals, e-mail, inter-linked hypertext documents, online help centres, expert's view, file transfer protocol and so on. Each of these resources has its own set of rules, but they relate to one another in several ways (Monereo et al., 2000). Some of these resources are discussed as follow.

***E-books:-***

An e-book is the electronic version of a book covering its full contents (text, tables, diagrams, illustrations, etc.). An e-book collection is usually set up in an e-database, which supports full-text searching within and across titles, advanced search and bookmark functions. Users can view full text of e-books in HTML or PDF format online. Ebooks are usually read on dedicated e-book readers or tablets using e-reader applications. Personal computer and many smart phones can also be used to read e- books.

***E-thesis:-***

An e-thesis or electronic thesis describes a thesis in digital form that is generally accessed via the internet. It is intellectual works or research of a researcher. It provides a technologically advanced medium for expressing ideas with less expensive, small space, easy handling and high longevity. Access to, and storage of, electronic theses is usually facilitated by open access repositories such as the UCC (Uniform Commercial Code) institutional repository, CORA (Cork Open Research Archive). UCC is developing an e-thesis programme to ensure that postgraduate research conducted in UCC is widely disseminated. In many countries, a move has been made in recent years to electronic submission of theses, in parallel with hard-copy submission, enabling theses to be searchable and readable online. E-thesis is stored in CORA, the UCC institutional repository. This is an open access repository based on DSpace software. There is no file size limit imposed on e-theses in CORA.

***E-journals:-***

With the advent of the internet, researchers and academics have recognized the capabilities of the information and communication technologies as efficient means to share results and to get around barriers by full transfer of intellectual property rights from the author to the publisher; it is also a means of improving the slow turn-over of traditional publishing (Correia and Neto, 2006).

An electronic journal is a periodical publication which is published in electronic format, usually on the Internet. An e-journal is a journal available online or offline containing research papers, review articles, scholarly communications etc. It is useful in higher education.Electronic journals relatively provide efficient access to information and thus they are easier to distribute to library patrons than traditional print; in the financial stringent environment of higher education system, electronic journals have become a medium which is cheaper than the traditional printed journals (Ellis and Oldman, 2005). According to Rowley (2006) electronic journals take two different forms: journals that are published in print form, available in digital form and electronic journals which do not necessarily need a publisher, and which can be managed by an editor and the scholarly community. Both types may have a significant impact on scholarly communication and in the way knowledge is created and disseminated.

***Online databases:-***

The most effective way to provide access to electronic books/journals in University libraries is through subscription to online databases which can be accessed through the internet. Online databases are a collection of electronic information sources (e-journals/e-books) by publishers from various fields and disciplines (Afolabi, 2007). Some ofthese databases are provided free of charge to libraries in developing countries by their publishers or vendors.

***CD-ROM databases:-***

CD-ROM databases allow users access to relevant databases without robust Internet connectivity in libraries. It is therefore cost effective than online databases as information could be accessed off-line without paying for telecommunications fee (Afolabi, 2007). Besides, CD-ROM databases are of immense value over print if the system is networked, as patrons at their terminals could access information without coming to the library. The information revolution brought forth by advances in information and communication technology has enabled universities and colleges around the world to take advantage of these developments. New modes of teaching, learning and accessing information have emerged as a result of Internet and World Wide Web (Darkwa et al., 2007). CD-ROM databases are important tools for identifying the bibliographic details of potentially useful documents and ensure easy access to large volumes of literature for research.

***Electronic Mail (e-mail):-***

This is an instantaneous electronic message from a sender to the recipient. It is the most used application on the internet. Another variant of the e-mail is to provide a list through which a subscriber receives and participates in a group discussion through e-mail. Each user has a mail box address to which messages are sent (Griffith, 2002; UCB Library; 2004c&d, University Libraries, 2003;Steinger, 2001). The e-mail is relevant for communication between teachers and students, peers (teacher-teacher, student-student), and with parents.

***File Transfer Protocol (FTP):-***

File Transfer Protocol (FTP) is a standard internet protocol for transmitting files between computers on the internet. It allows a computer to rapidly retrieve complex files intact from a remote computer and view and save such files on your computer (UCB Library, 2004d). ***Remote Login:-***

This permits a computer user to log on to another computer and use it as if the user were there. Through remote login, lecturers can access to their university's computer from any other computer connected to the internet anywhere in the world. Files can be downloaded, even common computer operation like rebooting can be accomplished (UCB Library, 2004c&d). To remote login to a computer, you must know its address which can be words (mail.yahoo.com) or numbers (216.109.127.28).

***Gopher:-***

It is one of the earliest resources on the internet. It is the only method for assessing internet documents. Some gopher texts may still be found linked on the web page, but they are more or less subsumed in the World Wide Web (Griffith, 2002; UCB Library, 2004d).

***The World Wide Web (WWW):-***

The World Wide Web (www, W3) is an information system of interlinked hypertext documents that are accessed via the internet. It has also commonly become known simply as the Web. The WWW incorporates almost every protocol available on the internet (e-mail, FTP, Telnet, Usenet, etc.). The web provides opportunities for retrieving text documents, viewing images, animation, and video, listening to sound, speaking and hearing voices, provided one's computer has the capacity and software (UCB library, 2004a&d; University Libraries, 2003). The web relies on hypertext as its means of information retrieval. Hypertext is a document that connects to other documents, that is, the ability to have web pages containing links, which are areas on pages or button or graphic which can be clicked to retrieve another file unto the user's computer.

## Advantages of E resources

***Accessing information through electronic Libraries:-***

Electronic Libraries which offer an important advantage in accessing information required from related sites are classified into two different groups: open or closed access web sites of universities, and other web sites which are completely open through the internet. The closed sources in Electronic Libraries in universities are based on e-books and e-journals and are completely trustworthy. These collections are ideal for the undergraduate, post-graduate students, researchers, and academicians.

***Helpful in conducting research:-***

The e-resourcesis a powerful tool for assisting students and educators with conducting research. Going to a library and searching through a card catalogue by hand can be laborious and inefficient compared to searching for the same information on a computer. Many institutions offer online library systems which allow students to find information on books using lab computers and to access databases of scholarly articles that they can read online.

***Submission of assignment through e-mail:-***

E-mail allows students and teachers to contact one another even if they cannot physically meet. It enables educators to send out announcements, such as assignments or a course syllabus, without having to hand out paper copies. Students can submit assignments via email or some other online submission system, which can cut down on the amount of paper waste produced by the institution. E-mail is also advantageous for those students who miss the class and important class-notes.

***Data/ File storage through Cloud Computing:-***

Cloud computing offers the possibility of outsourcing IT requirements to suppliers on the internet. To take full advantage of the opportunities offered requires a professional approach to procuring cloud services and culture change in the way ICT is provided and exploited within research, teaching- learning and the management of universities. Sourcing from the cloud is one way of meeting short-term peaks in demand for computing requirements, individual software applications, or larger and long-term support and processing services.

## Concerns of using E resources

Besides the benefits of e-resources use, a number of publications have shown the adverse impact of e-resources on university and college students, such as discomfiture in reading on the screen, problems in internet access and speed, poor infrastructure, lack of sufficient skills to use the e-resources, and perceptional change resulting from right to use rather than physical possession (Chauhan, 2004) etc. Some of the adverse impact are discussed as follow:

***Plagiarism:-***

The abundance of e-resources on the internet do encourage students to copy out others work to be presented as theirs. These resources are free and downloadable.

Even though they are easily acquired, the continuity of availability of such resource would be an important issue.

***Lack of reliability and quality of information:-***

Not every information on the Internet is useful for educational purposes. At times information comes from unknown and sometimes unreliable sources. The e-resources on the internet are sometimes not regulated or monitored, for there is no quality control. (Monereo et al., 2000; Paris, 2003).

***Quality control issues with online information:-***

Part of what makes the issue of information overload so problematic is that not all of the information on the internet is of high quality, and there is no quality control mechanism to help parcel out the reliable from unreliable information. Many papers that have not been peer reviewed or gone through some other vetting process are now out in the public domain. This results in the need for scholars to sort through and figure out what is quality information on their own.

***Overload of information:-***

Because of the large amount of material on the internet, many scholars feel that they are overloaded with information, and many faculty and students surveyed report that this can be overwhelming for them.

***Financial constraints:-***

E-resources are expensive in nature. Downloading and printing each article will be a costly affair. This means a net increase in economic and ecological costs and it becomes a relatively expensive way to acquire a single copy. Many e- journals do charge subscription fees. The pricing schemes of some suppliers are very complicated and limiting, and this might hinder libraries from utilizing e- journals.

***Changes in work habits:-***

Changes in work habits include reading from a computer screen, and the physical discomfort of eyestrain and hunched posture that accompanies this. Further, many faculty and students expressed a preference for something they can hold in their hands (e.g. a book and journal). A combination of these factors leads faculty and students to print out most online materials. They will read an abstract of an article or glance through an online document to judge if it is something they want to read further, but will print it out in order to read it fully.

## 9.5 Conclusion

This unit gave us a detailed information about the use of Internet in Social Research & how various software may be used. This unit also helped us to know about the e-resources and how we may use these e-resources in developing our material without getting thepped into plagicrism.

## 9.6 Exercise

(1) What are advantages of E-resources.

(2) Discuss some common packager in Social Science Research.

(3) Explain spread sheet.

(4) Discuss the use of Internet in Social Research.

## 9.7 Reference

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# Unit 10 ❑ Research Reports



## 10.0 Objectives

In this unit our learners will know how to develop a Research report.

## 10.1 Introduction

Writing a Perfect Research Report in a special Skill. A Report will considered upto the mark it follows all the steps, of Research. It should be well planned, properly edited with lot of accuracy & if I must have proper referencing. Let us we how we can develop of good Research Report this will also help our learner to writ their dissection also.

## 10.2 Planning Outline of Report

Dissertation / Research is an integral part of academic discipline. The project/ research work must be systematically written in a form of report. The first task to be completed before starting a report is to determine what needs to be addressed.

According to Paul V. Anderson's text, *Technical Communication: A Reader-Centered Approach*, the basic structure for a report and the questions to be answered in each section are the following.

- **Introduction** - What will the readers gain from reading the report?
- **Method of obtaining facts** - Are the facts reliable?
- **Facts** - What have you found that is useful for the readers?
- **Discussion** - How do the facts work from the reader's point of view?
- **Conclusions** - Why are the facts significant to the readers?
- **Recommendations** - What do you think the readers should do?
- **References –** You should provide a list of all the authors you have cited in your report where from you take ideas, theoretical knowledge etc.
- **Attachments /Appendices / Annexure:** These contain supporting information, such as transcripts of interviews, results of surveys, a glossary and results from experiments.

This is a basic structure, not an outline. Some of these elements may be in a different order, addressed together, or completely omitted. An effective report includes these elements to improve the usability and usefulness of the report. Synchronization of elements should be kept in mind while formulating the final points and outline of the report.

**Introduction:** For some reports, the introduction may only need to be a sentence or two, but for longer more extensive reports it may take multiple pages. The introduction is where the objective of research is stated and briefly explained. An introduction should tell the reader what the main focus of the report is and in doing so tell the reader why the research and report is important for them to read. Essentially we answer the question "What will we gain from reading this report?" The introduction should explain the problem that the report is aiming to solve.

For longer reports, your introduction may take multiple pages. Such things such as 1) What problem your report solves, 2) what activities you performed toward solving that problem and 3) how your readers can apply your information to their own efforts towards solving the problem should be answers within the introduction. Also, ensure that within your introduction your main points are stated.

**Method of obtaining facts**: The purpose of this section is to show the readers how you obtained your information. Stating where you obtained your information will help to tell the readers if your research is reliable. Your method will help readers to understand the uses and limitations of your research. A good, descriptive method section will allow anyone else to recreate your experiment exactly and obtain the same result. Be very detailed in the method section and reread it as if you were trying to do this experiment for the first time based on your method section.

**Results:** The results section is the most valuable part of the report to readers. The whole point of research is to find the results so they need to be conveyed clearly and effectively. A results section may likely contain tables, graphs, text, and pictures. Include anything that is important in showing the reader what was found through research. Do not include extraneous information as it will only clutter the results section. Make sure you check the date of your information, where it comes from, and who the source was. Keep the prose simple and descriptive in this section, leave the analysis of the results for the discussion section.

**Discussion:**The discussion section is where you interpret your results. Your results section may be nothing but tables and graphs with a few accompanying sentences. Your discussion section is where you make sense of those tables and graphs and explain how they relate to the problem or question the report is trying to research. The discussion also explains what the results mean to the company. In some reports, mainly shorter ones, the discussion and facts sections may be put into one to make reading the report shorter and easier.

**Conclusion:**The conclusion section explains why the results are important and how they affect the reader. It is a good practice to summarize your facts and restate the problem so the reader clearly understands the importance of your findings. This is your chance to tell the reader how they or the company will benefit from your findings. The conclusion usually does not make recommendations for action but will inevitably get the reader thinking about it.

**Recommendations:** Here is where you state the purpose of the report and what you want to be accomplished after the readers are done with your report. This section may not be in some reports because the decision to be made may be beyond your knowledge and power.

## 10.3 Editing for Accuracy and Neatness

Revising isn't the first step in the process of writing a research paper, but it is perhaps the most important. Many students skip the revision process, mistaking editing for revision. While editing is also very important, revision is an integral part of any good writing process. During revision, you should try to see your work from different perspectives and different angles. When you revise, it's particularly important to keep your target audience in mind. You may need to make changes to content and organization. You may have to go back to the research stage of your process to find more information. You may need to cut out information that doesn't relate to your thesis or focus. Revision is about making big changes to your writing to improve flow, development, and focus.

*Editing* is a stage of the writing process in which a writer or editor strives to improve a draft by correcting errors and making words and sentences clearer, more precise, and as effective as possible. The process of editing involves adding, deleting, and rearranging words to cut the clutter and streamline overall structure.

Revision and editing are both important parts of the writing process, yet many students skip revision and don't spend enough time editing. It's important to remember that these steps are separate and that each step takes time. The following pages will help you develop strong revision and editing strategies for your writing process.The revision process is an essential aspect of writing and one that you should build in time for before submitting your written work.

Revision means to "re-see" the piece of writing.It isn't just proofreading your paper or correcting grammar, punctuation, or spelling errors. Revision is stepping back and looking at your paper as a whole and seeing if you are effectively saying what you intend to say. It is giving your paper a thorough look to see how you can make it stronger. Your goal should always be to write clearly, concisely, and in an engaging way.One way to go about re-seeing your writing is to do it in three stages. Many people skip the first stage, but looking at the big picture is crucial in making sure you have a well-developed essay that expresses your ideas.

**Importance of Editing:**Whether you're working toward completing an assignment or hoping to get something published, tightening your writing and fixing mistakes can actually be a remarkably creative activity. Thoughtful revision of a work can lead to clarification of ideas, a reimagining of images, and sometimes, even a radical rethinking of the way you've approached your topic.

**Types of Editing:**There are two types of editing: the **ongoing edit** and the **draft edit**. Most of us edit as we write and write as we edit, and it's impossible to slice cleanly between the two. You're writing, you change a word in a sentence, write three sentences more, then back up a clause to change that semicolon to a dash; or you edit a sentence and a new idea suddenly spins out from a word change, so you write a new paragraph where until that moment nothing else was needed. That is the ongoing edit. For the draft edit, you stop writing, gather a number of pages together, read them, make notes on what works and doesn't, then rewrite. It is only in the draft edit that you gain a sense of the whole and view your work as a detached professional. It is the draft edit that makes us uneasy, and that arguably matters most.

**Editing Checkpoints**The final step for the writer is to go back and clean up the rough edges... Here are some checkpoints: Facts: Make sure that what you've written is what happened; Spelling: Check and recheck names, titles, words with unusual spellings, your most frequently misspelled words, and everything else. Use a spell check but keep training your eye; Numbers: Recheck the digits, especially phone numbers. Check other numbers, make sure all math is correct, give thought to whether numbers (crowd estimates, salaries, etc.) seem logical; Grammar: Subjects and verbs must agree, pronouns need correct antecedents, modifiers must not dangle (make your English teacher proud); Style: When it comes to repairing your story, leave the copy desk feeling like the washing machine repair guy who has nothing to do. Editing is shaping and creating the writing as much as it is something that refines and polishes it.

## 10.4 Standard Formatting For Referencing

In order to reach unity and standard through which articles, research reports and other scientific documents published, many different kinds of scientific writing styles have been provided to present final research reports in an acceptable and uniform manner. For this reason, different kinds of styles are introduced to the researchers. One of the most comprehensive one was presented by American Psychology

Association (APA). Another one is AMA which is presented by American Medical Association. In addition to the mentioned styles, there are many other styles like IEEE, Harvard and Chicago. Many journals and research centers, based on their scientific domain, choose one of these standard styles. Some journals and academic centers have their own styles and formatting, but theirs are mostly or slightly similar to standard styles introduced by (APA, AMA and on).

Styles try to establish a simple set of procedures, or rules, which would codify the many components of scientific writing to increase the ease of reading comprehension. Rules of style in scientific writing encourage full disclosure of essential information and allow us to dispense with minor distractions. Style helps us express the key elements of quantitative results, choose the graphic form that will best suit our analyses, report critical details of our research protocol, and describe individuals with accuracy and respect. It removes the distractionof puzzling over the correct punctuation for a reference or the proper form for numbers in text.

The authors of all scientific papers, whether university students or researchers, need to have enough knowledge about the specific styles based on which they are going to write. Among authors, university students are the largest group who are asked to prepare many different kinds of scientific essays during their academic years.

Styles and formatting have an important role in increasing access to the content and meaning of text. The importance of obeying styles and formatting rules is of significant importance so that many articles and research reports may be rejected due to lack of adherence to these styles. In this regard, all authors must have a comprehensive knowledge about writing and formatting style so that they could be able to produce their contents according to the standards which are required by each style.

Any research article and research report typically has a standard structure. This structure helps to ease communication and interaction between reader and writer. This standard structure is known as IMRAD which stands for introduction, method, results and discussion. IMRAD is a method to make any scientific text look much more logic. It provides many facilities to writer in expressing his or her ideas in more systematic way and also helps the reader to effectively get the main ideas and gist of the text and enables the reader to scan or skim for information in a more rapid way. IMRAD shape the skeleton and frame of research reports.

Cargill and O'Connor in their book "Writing Scientific Research Articles: Strategy and Steps" considered the needs of those who are early-career researchers in the sciences. This book uses a practical approach to develop scientific skills. The book consists of three necessary stages for providing any successful text like: Developing strategy, developing story and using language. The materials provided in this book are presented in a step by step manner to help the authors prepare their manuscript scientifically.

Booth and Colomb and Williams in their book known as "The Craft of Research" provided some information to meet the needs of all researchers in any field such as academic, political, or commercial. It provides the researchers with information about how to extract a research problem from a topic or a question, how to organize and provide a draft as well as how to revise a research report in order to make it more understandable and comprehensive.

**APA** stands for the American Psychological Association. Most papers that use APA formatting and citation style are those written in the Social Sciences: Psychology, History, Political Science, Economics, Geography, and Sociology.

In addition to the Publication Manual of the American Psychological Association from time to time, the APA maintains its own website with multiple examples of how to format your paper and cite your sources.

Papers constructed according to APA guidelines generally include the following elements:Title Page, Abstract, Body, Subsections within the body, with headings, Tables and Figures,

**Basic Form:** APA style dictates that authors are named with their last name followed by their initials; publication year goes between parentheses, followed by a period. The title of the article is in sentence-case, meaning only the first word and proper nouns in the title are capitalized. The periodical title is run in title case, and is followed by the volume number which, with the title, is also italicized. If a DOI has been assigned to the article that you are using, you should include this after the page numbers for the article. If no DOI has been assigned and you are accessing the periodical online, use the URL of the website from which you are retrieving the periodical.

Author, A. A., Author, B. B., & Author, C. C. (Year). Title of article. Title of Periodical, volume number (issue number), pages. https://doi.org/xx.xxx/yyyy

***Basic Format for Books***

Author, A. A. (Year of publication). *Title of work: Capital letter also for subtitle*. Publisher Name. DOI (if available)

***Edited Book, No Author***

Editor, E. E. (Ed.). (Year of publication). *Title of work: Capital letter also for subtitle*. Publisher. DOI (if available)

***Edited Book with an Author or Authors***

Author, A. A. (Year of publication). *Title of work: Capital letter also for subtitle* (E. Editor, Ed.). Publisher. DOI (if available)

***A Translation***

Author, A. A. (Year of publication). *Title of work: Capital letter also for subtitle* (T. Translator, Trans.). Publisher. (Original work published YEAR) DOI (if available).

***Article or Chapter in an Edited Book***

Author, A. A., & Author, B. B. (Year of publication). Title of chapter. In E. E. Editor & F. F. Editor (Eds.), *Title of work: Capital letter also for subtitle* (pp. pages of chapter). Publisher. DOI (if available)

***Article in Print Journal***

Scruton, R. (1996). The eclipse of listening. The New Criterion, 15(3), 5–13.

***Article in Electronic Journal***

Baniya, S., &Weech, S. (2019). Data and experience design: Negotiating community-oriented digital research with service-learning. Purdue Journal of Service-Learning and International Engagement, 6(1), 11–16. https://doi.org/10.5703/1288284316979

***Article in a Magazine***

Peterzell, J. (1990, April). Better late than never. Time, 135(17), 20–21.

***Article in a Newspaper***

Schultz, S. (2005, December). Calls made to strengthen state energy policies. The Country Today, 1A, 2A.

***Book Review***

Baumeister, R. F. (1993). Exposing the self-knowledge myth [Review of the book The self-knower: A hero under control, by R. A. Wicklund& M. Eckert]. Contemporary Psychology, 38(5), 466–467.

**MLA** stands for the Modern Language Association. Most papers that use MLA formatting and citation style are those written in the humanities, especially in languages and literature. In 2016, the *MLA Handbook* was updated in an effort to simplify much of the documentation process in MLA format.

**The Chicago Manual of Style**, favored by some fields in the humanities, such as history, uses a raised numeral in the text after the item cited, and then either a footnote at the end of the page or an endnote at the end of the essay. These notes contain full bibliographic information about the source. Additionally, a complete bibliography is typically included at the end of the paper.

## 10.5 Footnotes and Bibliography

**The foot/end note list** is a list of all the sources that have been cited in the assignment. The list is in numerical order showing books, journals, webpages and other sources. All sources are in this list regardless of type. There may be items which you have consulted for your work, but not cited. These can be listed at the end of your assignment in a **bibliography**. These items should be listed in alphabetical order by author and laid out in the same way as items in your foot/endnote list.

Footnotes are a very useful way of providing extra information to the reader. Usually, it is non-essential information which can be placed at the bottom of the page. This keeps the main body of text concise. You can either have a footnote list where all the references are at the bottom of each page or an endnote list at the end of the assignment/chapter.

- The list should be in numerical order and each number matches and refers to the one in the text
- Books, paper journal articles, e journal articles, and so on are laid out in a particular format that must be followed
- **Ibid.** can be used when the details of an item have been referred to directly before in the previous reference
- **Op. Cit.** can be used when the details of an item have been referred to before but other references have occurred in between
- You can use square brackets or superscript

### The Use of Footnotes

Footnotes are the acceptable method of acknowledging material which is not your own when you use it in an essay. Basically, footnoted material is of three types:

1. Direct quotations from another author's work. (These must be placed in quotation marks).
2. Citing authority for statements which are not quoted directly.
3. Material of an explanatory nature which does not fit into the flow of the body of the text.

In the text of an essay, material to be footnoted should be marked with a raised number immediately *following* the words or ideas that are being cited.

### Bibliography

The bibliography should be on a separate page. It should list the relevant sources used in the research for the paper. This list should be arranged alphabetically by the surname of the author. (Unlike the footnote reference, the surname is shown first, set off from the rest of the information.) The information required is: author, title, place of publication, publisher and date of publication.

## 10.6 Dissemination of findings

Research dissemination, as the written or oral representation of project findings, usually happens at the end of a research project. Dissemination refers to "a planned process that involves consideration of target audiences and the settings in which research findings are to be received and, where appropriate, communicating and interacting with wider policy and…service audiences in ways that will facilitate research uptake in decision-making processes and practice" (Wilson, Petticrew, Calnan, &Natareth, 2010, p. 91). In other words, dissemination of research findings involves careful planning, thought, consideration of target audiences, and communication with those audiences. Writing up results from your research and having others take notice are two entirely different propositions. In fact, the general rule of thumb is that people will not take notice unless you help and encourage them to do so.

Successful dissemination of your research findings requires you to determine who your audience is, where your audience is, and *how* to reach them. When considering who your audience is, think about who is likely to take interest in your work. Your audience might include those who do not express enthusiastic interest but might nevertheless benefit from an awareness of your research. Your research participants and those who share characteristics with your participants are likely to have some interest in what you've discovered in your research. Other scholars who study similar topics are another obvious audience for your work. Perhaps there are policymakers who should take note of your work. Organizations that work in an area related to the topic of your research are another possibility. Finally, any and all inquisitive and engaged members of the public represent a possible audience for your work.

## 10.7 Preparing research abstract

Communicating research findings is an essential step in the research process. On occasion, you need to write a short abstract of the research paper that precedes the introduction. When you write an abstract, pay attention to these issues:

- Position the theme or case within the framework of theories and discussions
- Formulate a clear objective
- Briefly describe the most significant results of the research
- Make a list that contains at least three relevant keywords

**1. Title (short title)**

Title should be short but informative

**2. Abstract**

An abstract must accompany every article. It should be a brief summary of the significant items of the main paper. An abstract should not normally exceed 200 words. It should not contain literature citations or illusions to the tables or illustrations. All non-standard symbols and abbreviations should be defined. It may be strictly written by following the subheadings.

*i. Purpose of the study:* In simple words tell readers about the aim of this study. No discussion, no story only aim of this study .

*ii. Methodology:* Give name, brand, type of tools, methods, software, review, and survey that has been used to do this study. No discussion or explanation.

*iii. Main Findings:* Write only the main results in few words. No discussion or explanation.

*iv. Applications of this study:* where this study can be useful, give the name of area, disciplines etc.

*v. Novelty/Originality of this study:* what is new in this study that may benefit readers or how it is advancing the existing knowledge or creating new knowledge in this subject?

3**. Keywords**

List of all keywords proposed by the authors, separated by commas. Avoid big phrases

4. **Text**

- introduction: subject, scope of the subject, goals of your paper and finally the organization of your paper are to be mentioned
- main text: all important elements of your scientific message are to be mentioned
- conclusion: summary of the paper

*Results and Discussion* - may be combined or kept separate and may be further divided into subsections. This section should not contain technical details. Abbreviations and acronyms should be used sparingly and consistently. Where they first appear in the text, they should be defined; authors may also explain large numbers of abbreviations and acronyms after the conclusion part.

*Computational Part* - in theoretical papers, technical details such as the computational methods, and models applied or newly developed models should be presented in an appropriately named section. Sufficient detail should be provided to enable readers to reproduce the calculations.

*Acknowledgements* - Information concerning research grant support and the assistance of colleagues or similar notes of appreciation should appear in an Acknowledgements section.

*Tables*

Authors should use tables only to achieve concise presentation, or where the information cannot be given satisfactorily in other ways. Tables should be numbered and referred to in the text by number. Each table should have an explanatory caption which should be as concise as possible.

*Figures*

Authors may use line diagrams and photographs to illustrate these from their text. The figures should be clear, easy to read and of good quality. Styles and fonts should match those in the main body of the article. Lettering and lines should be of uniform density and the lines unbroken. Axis labels should be in bold face. Units should be placed next to variables in parentheses. All figures must be mentioned in the text in consecutive order and be numbered.

*Schemes*

These are sequences of reactions. They should have brief titles describing their contents. Schemes should be numbered.

*Images*

Authors can attach files in formats like BMP, GIF, JPEG formats.

5. **Reference list**

A complete reference should give the reader enough information to find the relevant article. Please pay particular attention to spelling, capitalization and punctuation here. Completeness of references is the responsibility of the authors. A complete reference should comprise the following:

## 10.8 Book review

A book review describes, analyzes and evaluates. The review conveys an opinion, supporting it with evidence from the book.Writing a book review can help increase your understanding of, and appreciation for books you read. Reviews you write can help others decide whether or not to read the book. If this is an assignment, or if you have decided to share your opinions of a book you have recently read, this course can guide you in writing a helpful review.

Book reviews typically evaluate recently-written works. They offer a brief description of the text's key points and often provide a short appraisal of the strengths and weaknesses of the work.

Readers sometimes confuse book reviews with book reports, but the two are not identical. Book reports commonly describe what happens in a work; their focus is primarily on giving an account of the major plot, characters, and/or main idea of the work.

By contrast, book reviews are most often a college assignment, but they also appear in many professional works: magazines, newspapers, and academic journals. They typically range from 500-750 words, but may be longer or shorter. A book review gives readers a sneak peek at what a book is like, whether or not the reviewer enjoyed it, and details on purchasing the book.

**The objectives of this course are to:**

1. Describe the purpose and elements of a book review,
2. Explore examples of good book reviews,
3. Help you form opinions about a book as you read it,
4. Identify questions to consider as you read, assess, and report on a book,
5. Suggest topics to include in a book review,
6. Help you organize and write a book review

While this course specifically refers to *book reviews*, the same approach can be followed to review articles or similar publications.

Begin by deciding if you are writing a book report or a book review.A book report is an essay discussing the contents of a book, written as part of a class assignment issued to students in schools, particularly in the United States at the elementary school level.In contrast, a book review is a form of literary criticism in which a book is analyzed based on content, style, and merit. This course focuses on writing a book review.Book reviews typically evaluate recently-written works. They offer a brief description of the text's key points and often provide a short appraisal of the strengths and weaknesses of the work.

In general, a review is a critical evaluation of a text, event, object, or phenomenon. A book review describes, analyzes, and evaluates. The review conveys an opinion, supporting it with evidence from the book. Above all, a review makes an argument consisting of commentary, not merely a summary.

A book review addresses the question: "Does the book deliver on its promise?" The two resulting questions: "What does it promise?" and "What does it deliver?" are then answered by citing evidence.

**Steps to be followed:**

When writing the review, use the notes gathered above to address the following topics in approximately this order.

1. Introduction— Identify the title, author, publisher, date, length, ISBN, genre (i.e. Fiction, non-fiction?), audience (i.e. age, reading level, interests, specialties…)

2. Content Summary— Briefly summarize the book. If you can convey both the tone and the message of the book in a single sentence, your review will be off to a good start. For nonfiction books identify or formulate the book's thesis statement. Describe the general argument and evidence provided to support that thesis. For fiction books, include a plot summary, themes, character descriptions, background context and how the story corresponds to reality or similar books. Avoid plot spoilers.

3. Analysis and Evaluation—Focus on your subjective evaluation of the book. Consider the list of analysis topics to cover and address those topics that are most relevant and important to this review. Consider the list of questions to answer and address those questions that are most relevant and important to this review. Much of this section will consist of paragraphs of the form: Conclusion, evidence, evidence, and evidence, or Evidence, evidence, evidence, and conclusion.

4. Conclusion—Briefly state your opinion of the book based on the preceding analysis. Answer the question, "Does the book deliver on its promise?" Make a clear recommendation to any prospective readers.

Reread, reflect, refine, and revise—Read over your first draft and revise it to improve its flow, coherency, clarity, and overall impact. Ensure the review makes clear what you want to say.

Request Comments from a colleague— Ask someone who's opinion you trust to read over your draft and suggest how it can be improved. Use their feedback to improve the review. If you are a student ensure this form of collaboration is permitted by the academic polices of your school.

**When you are ready to write**

Begin with a short summary or background of the work, but do not give too much away. Many reviews limit themselves only to the first couple of chapters or lead the reader up to the rising action of the work. Reviewers of nonfiction texts will provide the basic idea of the book's argument without too much detailed.

The final portion of your review will detail your opinion of the work. When you are ready to begin your review, consider the following:

- **Establish a Background, Remember your Audience:** Remember that your audience has not read the work; with this in mind, be sure to introduce characters and principles carefully and deliberately. What kind of summary can you provide of the main points or main characters that will help your readers gauge their interest? Does the author's text adequately reach the intended audience? Will some readers be lost or find the text too easy?

- **Minor principles/characters:** Deal only with the most pressing issues in the book. You will not be able to cover every character or idea. What principles/ characters did you agree or disagree with? What other things might the author have researched or considered?

- **Organize:** The purpose of the review is to critically evaluate the text, not just inform the readers about it. Leave plenty room for your evaluation by ensuring that your summary is brief. Determine what kind of balance to strike between your summary information and your evaluation. If you are writing your review for a class, ask your instructor. Often the ratio is half and half.

- **Your Evaluation:** Choose one or a few points to discuss about the book. What worked well for you? How does this work compare with others by the same author or other books in the same genre? What major themes, motifs, or terms does the book introduce, and how effective are they? Did the book appeal to you on an emotional or logical way?

- **Publisher/Price:** Most book reviews include the publisher and price of the book at the end of the article. Some reviews also include the year published and ISBN.

### Revising

When making the final touches to your review, carefully verify the following:

- Double-check the spelling of the author name(s), character names, special terms, and publisher.
- Try to read from the vantage point of your audience. Is there too much/ enough summary? Does your argument about the text make sense?
- Should you include direct quotes from the reading? Do they help support your arguments? Double-check your quotes for accuracy.

## 10.9 Conclusion

This unit gave us a detailed understanding about writing the Research Report. Now it will be easier for our learner to also write their Dissertation which they are supposed to submit in MSW-II.

## 10.10 Exercise

1. What is the structure for writing any Research Report.
2. What is the Importance of Book Review.
3. Explain "Disseminations of finding".
4. How do we prepares the Research Abstract.


5. Davis, F. "The Effective Editor." Poynter, 2000
6. Anderson, Jeff. "*Everyday Editing*." Stenhouse, 2007
7. Zinsser, William. "On Writing Well." Harper, 2006
8. https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide/general_format.html

# Unit 11 ❑ Open Educational Resources



## 11.0 Objectives

The learners will know about Open Educational Resources and how effectively it can be used with CC-licences.

## 11.1 Introduction

OER are teaching resources that have an open-copyright license (such as one from Creative Commons), or they are part of the public domain and have no copyright. Depending on the license used, OER can be freely accessed, used, re-mixed, improved, and shared. Open educational resources (OER) are teaching, learning, and research resources that, through permissions granted by their creator, allow others to use, distribute, keep, or make changes to them."

## 11.2 Open Educational Resources (OER)

**Open Educational Resources (OER)** are teaching, learning, and research materials that are either (a) in the public domain or (b) licensed in a manner that provides everyone with free and perpetual permission to engage in the 5R activities.

- Retain – make, own, and control a copy of the resource
- Reuse – use your original, revised, or remixed copy of the resource publicly

- Revise – edit, adapt, and modify your copy of the resource
- Remix – combine your original or revised copy of the resource with other existing material to create something new
- Redistribute – share copies of your original, revised, or remixed copy of the resource with others

The Open Education program at Creative Commons works to minimize barriers to effective education, supporting the CC mission through education, training, advocacy and outreach on using open licenses and open policies to maximize the benefits of open education (content, practices and policy). Our work spans all levels of education, industry and government.

One goal of Creative Commons is to increase the amount of openly licensed creativity in "the commons" — the body of work freely available for legal use, sharing, repurposing, and remixing. Through the use of CC licenses, millions of people around the world have made their photos, videos, writing, music, and other creative content available for any member of the public to use.

**Examplesof OER**

Types of OER include (but are not limited to) syllabi, lesson plans, learning modules, lab experiments, simulations, course videos, discussion prompts, assignments, assessments, library guides, and course design templates.

Open educational resources (OERs) are learning materials that can be modified and enhanced because their creators have given others permission to do so. The individuals or organizations that create OERs—which can include materials like presentation slides, podcasts, syllabi, images, lesson plans, lecture videos, maps, worksheets, and even entire textbooks—waive some (if not all) of the copyright associated with their works, typically via legal tools like Creative Commons licenses, so others can freely access, reuse, translate, and modify them.

**OER Definitions**

*The William and Flora Hewlett Foundation*

Open Educational Resources are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and repurposing by others. OER include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge.

The term "open education" to encompass the myriad of learning resources, teaching practices and education policies that use the flexibility of OER to provide learners with high quality educational experiences.

**Creative Commons** defines OER as teaching, learning, and research materials that are either in the public domain or licensed in a manner that provides everyone with free and perpetual permission to engage in the 5R activities– retaining, remixing, revising, reusing and redistributing the resources."

*OECD (Organization for Economic Co-operation and Development)*

"digitised materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning, and research. OER includes learning content, software tools to develop, use, and distribute content, and implementation resources such as open licences."

*UNESCO*

"teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions."

*The Cape Town Open Education Declaration*

"Open educational resources should be freely shared through open licenses which facilitate use, revision, translation, improvement and sharing by anyone. Resources should be published in formats that facilitate both use and editing, and that accommodate a diversity of technical platforms. Whenever possible, they should also be available in formats that are accessible to people with disabilities and people who do not yet have access to the Internet."

*The Wikieducator OER Handbook*

"The term "Open Educational Resource(s)" (OER) refers to educational resources (lesson plans, quizzes, syllabi, instructional modules, simulations, etc.) that are freely available for use, reuse, adaptation, and sharing."

**Why are open educational resources beneficial?**

Applying open licenses to educational materials allows educators to collaborate when building materials specifically differentiated for their students. For example, a mathematics teacher might acquire openly-licensed word problems for her students, but re-write the exercises to include language that is more geographically specific or demographically relevant. In turn, she can share her modified problems with others who may wish to use them.

At the same time, collaborating on OERs allows educators to work together when ensuring consistency among their materials. Public school teachers in the United States, for instance, may wish to share resources they've developed in order to adhere to government-mandated educational standards, like the Common Core State Standards.

Some educators suggest that OERs might help reduce costs associated with producing and distributing course materials in both primary and secondary educational institutions. Teachers can download these materials—often at low costs—for use in their classrooms, but they can also update these materials and share their contributions with others, keeping content timely, relevant, and accurate. In this way, they needn't wait for textbook companies to issue entirely new editions of their (traditionally copyrighted) learning materials.

Students also benefit from open educational resources when they access these materials to supplement the education they might receive in a classroom. Some students do not have access to a high-quality education, but using OERs affords them opportunities to enhance their knowledge independently—in spite of the barriers preventing them from acquiring the knowledge and skills they seek.

Using OER can provide tremendous cost savings for students as well as impact student success and completion rates. The cost of textbooks can be a huge financial burden on students, which not only affects student success, but could also delay graduation for students who are taking fewer classes per term because of that cost, further increasing financial costs for students over time. OER provide students with day one access to free course materials, and research reviewed by the Open Education Group shows that most students perform as well or better using OER course materials compared with students using traditional textbooks.

Open Educational Resources allow students to have learning materials as soon as the course starts, so they can make the most of them to support their learning. They no longer have to wait for financial aid disbursements or delayed shipments from online orders.

Open educational resources are most useful when educators distribute them in open formats, so teachers and students can use those resources regardless of the particular technical platforms their schools have adopted. Projects like the OER Commons act as repositories for high-quality open educational resources.

**What are MOOCs?**

Massive open online courses (MOOCs) are online courses accessible to anyone with a computer and access to the Internet. People call these courses "massive" because their enrollment is open to more students than traditional educational institutions might permit—meaning that hundreds (even thousands) of students might participate in a particular MOOC. Today, many colleges and universities have joined organizations committed to providing high-quality education through MOOCs.

One example is *edX*, a non-profit education partnership that in 2012 grew from a collaboration between *MIT* and *Harvard* (Stanford joined the effort in 2013, and now several dozen colleges and universities from around the world have, too). edX offers students tuition-free opportunities to enroll in courses on a variety of subjects from instructors across the globe. Students register, attend, and complete their classes online. In 2013, edX released the source code for its online learning platform, so programmers could download and help improve it. Others could even use it to build their own education platforms.

Similar online educational ventures include *Khan Academy* and *Coursera*. The extent to which various MOOCs license their course materials for remixing and reusing differs from one institution to another.

## 11.3 History and Development

OER and the open movement have recently evolved, and in many ways they challenge age-old educational traditions and conventions. The catalyst has been the pervasiveness of the Internet and the ability to copy and distribute digital content. In

1999, both the University of Tübingen (Germany) and The Open University (UK) released some educational resources for free. However, the most commonly known OER initiative came from the Massachusetts Institute of Technology (USA) in 2001; by 2002, it had released 32 courses with open licences and set a precedent in terms of openness of university courseware. Taking note of this development, UNESCO in 2002 convened the Forum on the Impact of Open Courseware for Higher Education in Developing Countries, where the term OER was coined. Since then, many other education service providers around the world have used open licences and the Internet to share teaching and learning resources. The Cape Town Open Education Declaration (2008) and the Paris OER Declaration (2012) provided guidelines and encouragement for governments to release educational resources—especially those created using public funding—with open licences. The integration of OER into national policy is an ongoing and slow process, but there have been successes in countries such as the USA, South Africa, Kenya, Ghana, Poland, the Netherlands, and the United Kingdom.12 In 2013, Antigua and Barbuda adopted an OER policy within the framework of its national policy on information and communication technology (ICT) in education. In 2014, the National Mission on Education through ICT (NMEICT) in India adopted an open licence policy13 for all of its outputs, releasing as OER all content generated with its funding.

**Types of OER**

OER can be divided into as many "types" as there are needs within the education sector. While assets—such as worksheets, lesson plans, lesson resources, reference articles and so on—are perhaps an obvious category, you will remember from lesson 1 that the term also encompasses open courseware (OCW). Although there is no consensus regarding OER categories, Creative Commons48 has a useful list that includes the following types:

- Digital learning objects (individual digital assets);
- Digitised object libraries (online collections of assets);
- OER encyclopaedias (collaborative written reference materials);
- Open online archives (repositories of collected OER);

- Open textbooks (free and adaptable texts);
- OER courseware (open online university courses and programmes);
- OER courses (short courses);
- Open course archives (libraries or indexes of courses);
- Online tools that support the open community

It is useful to keep these categories in mind when searching for OER on the Internet, as each will generate different results. For example: object libraries are more likely to identify individual assets; an OER encyclopedia will yield definitions and descriptive content; OER courseware repositories will have course materials loosely linked together so that one could, theoretically, run the course again; and OER courses provide both content and a learning pathway through the materials.

**Directories, Platforms and Repositories**

Another way of organising or categorising OER is according to the level of functionality offered by the OER website. For example;

- ***Directories:*** A directory provides lists of OER and links to resources available elsewhere on the Web. Examples include COL's OER Directory and, in the case of open access journals, the Directory of Open Access Journal (DOAJ), which links to research articles in the same way.

- ***Platforms:*** By platform, we mean specific digital tools designed to "do" something with the OER. This could include tools to develop new, or adapt existing, OER. Alternatively, the platform could be designed to license new OER with an open licence. An example of the former is WikiEducator, which provides an online environment for authoring new resources. We saw in the previous lesson an example of the licensing platform designed by Creative Commons.

- ***Repository:*** A repository is a database or collection of OER, usually ones developed by a particular institution. A well-known example of an institutional repository is the MIT's Open Courseware Repository.

Of course, some organizations and institutions offer combinations of the above functionality, so it is quite possible to find a mix of these functions within the same OER website.

## 11.4 Challenges of using OER

Despite the noble intentions behind OER, it turns out that using OER is not always straightforward! Practitioners face various challenges when it comes to harnessing OER. Current frustrations for users of OER often include:

• ***Sourcing appropriate OER***: This is an issue because there is no one-stop shop for OER. They are scattered across the Internet (this problem is explored in lesson 3).

• ***Understanding open licences***: Not everyone is familiar with different open licences and what they ***permit (to overcome this problem, see lesson 2).***

• ***Adaptation of OER requires new skills:*** To adapt and repurpose OER, the practitioner needs more than basic ICT skills and also needs practice in revising and remixing resources.

• ***Traditional mindsets predominate***: Many educators feel it is wrong to use other people's work, and thus they protect, rather than share, their own resources

• ***Robust Internet connectivity and good ICT availability*** are essential to access and adapt OER.

• Schools and universities seldom incentivize lesson creation

**Institutions Promoting OER**

The list of institutions, organisations and individuals involved with developing and promoting OER is ever expanding, and growth has accelerated in recent years. Below, however, are three globally active institutions that are worth highlighting.

***Commonwealth of Learning (CoL)*** is an intergovernmental organisation created by Commonwealth Heads of Government to encourage the development and sharing of open learning/distance education knowledge, resources and technologies. COL has for many years been at the forefront of the OER movement, facilitating numerous initiatives. It was the first intergovernmental organisation to adopt an open licence for all of its publications. COL encourages governments to officially recognise the importance of sharing OER, through policy development—either as a stand-alone policy or within the broader realm of ICT-in-education policy. COL has developed several resources on OER to build teachers' capacity and develop teaching and learning materials as OER. Many such resources are available on its website, and also that of its regional office in New Delhi: the Commonwealth Educational Media Centre for Asia (CEMCA).

***The United Nations Educational, Scientific and Cultural Organization (UNESCO)*** believes that OER "provide a strategic opportunity to improve the quality of education as well as facilitate policy dialogue, knowledge sharing and capacity building." The Paris OER Declaration, adopted during the World OER Congress held in June 2012 at UNESCO headquarters, was a significant step for the development of national policies supporting OER. The declaration's ten points encourage governments to contribute to the awareness and use of OER and to develop strategies and policies to integrate OER in education. In 2013, UNESCO adopted an open access policy for all of its publications, in line with its commitment to promote and support OER and OA.

**OER and e-learning**

OER is not synonymous with online learning or e-learning, although many people make the mistake of using the terms interchangeably.Openly licensed content can be produced in any medium: paper-based text, video, audio or computer-based multimedia. A lot of e-learning courses may harness OER, but this does not mean that OER are necessarily e-learning. Indeed, many open resources being produced currently – while shareable in a digital format – are also printable. Given the bandwidth and connectivity challenges common in some developing countries, it would be expected that a high percentage of resources of relevance to higher education in such countries are shared as printable resources, rather than being designed for use in e-learning.

**OER and open learning/open education**

Although use of OER can support open learning/open education, the two are not the same. Making 'open education' or 'open learning' a priority has significantly bigger implications than only committing to releasing resources as open or using OER in educational programmes. It requires systematic analysis of assessment and accreditation systems, student support, curriculum frameworks, mechanisms to recognize prior learning, and so on, in order to determine the extent to which they enhance or impede openness. Open learning is an approach to education that seeks to remove all unnecessary barriers to learning, while aiming to provide students with a reasonable chance of success in an education and training system centred on their specific needs and located in multiple arenas of learning. It incorporates several key principles:

• Learning opportunity should be lifelong and should encompass both education and training;

• The learning process should centre on the learners, build on their experience and encourage independent and critical thinking;

• Learning provision should be flexible so that learners can increasingly choose, where, when, what and how they learn, as well as the pace at which they will learn;

• Prior learning, prior experience and demonstrated competencies should be recognized so that learners are not unnecessarily barred from educational opportunities by lack of appropriate qualifications;

• Learners should be able to accumulate credits from different learning contexts;

• Providers should create the conditions for a fair chance of learner success. (Saide, n.d.)

As this list illustrates, while effective use of OER might give practical expression to some of these principles, the two terms are distinct in both scope and meaning.

## 11.5 OER and resource based learning

There has been significant emphasis placed in OER discussions on the quality of OER. This makes the concept of resource-based learning of particular interest. Despite this, debates over OER have typically made little reference to the concept of resource-based learning until recently. This may be because the emphasis in most global OER discussion has been on the sharing and licensing of existing materials, a significant proportion of which has included simply sharing lecture notes and PowerPoint presentations used in face-to-face lectures. What does the notion of resource-based learning mean, in essence? It means moving away from the traditional notion of the 'talking teacher' to communicate curriculum; a significant but varying proportion of communication between students and educators is not face to face but rather takes place through the use of different media as necessary. Importantly, the face-to-face contact that does take place typically does not involve simple transmission of knowledge from educator to student; instead it involves various forms of student support, for example, tutorials, peer group discussion, or practical work. Resource-based learning is not a synonym for distance education. Rather, resource based learning provides a basis for transforming the culture of teaching across all educational systems to enable those systems to offer better quality education to significantly larger numbers of students. Many courses and programmes at all levels of education now incorporate extensive use of instructionally designed resources, as educators have learned the limitations of lecture-based strategies for communicating information to students. The use of resource-based learning does not of course imply any intrinsic improvements in quality of learning experience. The extent to which shifting the communication of curriculum to instructionally designed resources leads improves the quality of education depends entirely on the quality of the resources developed.

To summarize:

• There is no direct relationship between OER and resource-based learning.

• Many OER available online have not explicitly been designed as part of a deliberate strategy to shift to resource-based learning.

• Likewise, most practice in resource-based learning currently uses fully copyrighted materials rather than OER.

Nevertheless, linking OER and resource-based learning provides an opportunity to leverage both most effectively.

***Understanding Copyright***

Copyright is an exclusive, transferable right given by law to a creator/author for a fixed number of years to copy, print, publish, perform, film, record or otherwise control the use of literary, musical, dramatic or artistic works. Copyright is a legal protection given to the original creator of a work, which may be in any form. In this context, “work” means an explicit description or expression of an idea, not just the ideas themselves; the law only protects the specific and original expression of ideas.Copyright is a legal right created by the law of a country that grants the creator of an original work exclusive rights to its use and distribution, usually for a limited time, with the intention of enabling the creator (e.g., the photographer of a photograph or the author of a book) to receive compensation for their intellectual effort. The exclusive rights are, however, not absolute and do not give the creator total control of their work, because the rights are bound by limitations and exceptions to copyright law. Copyright is a form of intellectual property, applicable to any expressed representation of a creative work. The rights that copyright reserves include control over reproduction, derivative works, distribution and public performance, as well as "moral rights," such as attribution.

Although copyright law varies by jurisdiction, there is generally a clause that makes special permission for "fair use" or "fair dealing"; normally, this allows a written work (for example) to be copied for the purpose of private study, research, book review, reporting and similar non-commercial uses. Fair use does not give permission to use copyrighted materials in full. Moreover, the extent of the use is limited and not clear, which can lead to litigation. Normally ownership of the intellectual property of an article or book resides with the author, except when the author's employer claims ownership under the conditions of employment. This may be the case when teachers are employed by universities to write learning content. However, works for hire are handled differently in various institutions. As long as the copyright of a work remains with the author, legally the author can undertake economic activity associated with the work. This economic right introduces conflict when certain types of works are developed using public funds. The issue of the "moral rights" related to the work arises when the right of the work is with the employer or the funding agency.

***The Creative Commons Licensing System***

In recent years, Creative Commons (CC) has, in education, become the most popular licensing system. Creative Commons has designed a collection of licences to ensure that there is a suitable licence for sharing content under various conditions. The advantages of using a Creative Commons licence are:

- There is almost certainly a ready-made licence that will suit the publisher's requirements, saving time and effort in drawing up a custom licence.

• Creative Commons licences are easily understood and commonly used, so a potential reader or reuser of a work will immediately understand the conditions of the licence.

• The licences have machine-readable metadata to make it easier for others to find a CC-licensed resource on the Web.

• The Creative Commons licences are based on the following:

• Legal code: Expansive legal language, tested in several cases.

• Commons code: Simple, icon-based approach to recognise the features of a licence

• Digital code: Enables search engines to locate resources using CC Rights Expression Language.

All Creative Commons licences are constructed from a combination of four specific "rights" or conditions that can be reserved by the creator or author of the resource. These include the following:

***A.*** ***Attribution:***All CC licences require that others who use your work in any way must attribute it – i.e., must reference the work, giving you credit for it – the way you request, but not in a way that suggests you endorse them or their use of the work. If they want to use your work without giving you credit or for endorsement purposes, they must get your permission first.

***B.*** ***Non Commercial:*** You let others copy, distribute, display, perform, modify (unless you have chosen No Derivatives) and use your work for any purpose other than commercially. If they want to use your work commercially, they must get your permission first.

***C.*** ***No Derivatives:*** You let others copy, distribute, display and perform only original copies of your work. If they want to modify your work, they must get your permission first.

***D.*** ***Share Alike:*** You let others copy, distribute, display, perform and modify your work, as long as they distribute any modified work on the same terms. If they want to distribute modified works under other terms, they must get your permission first.

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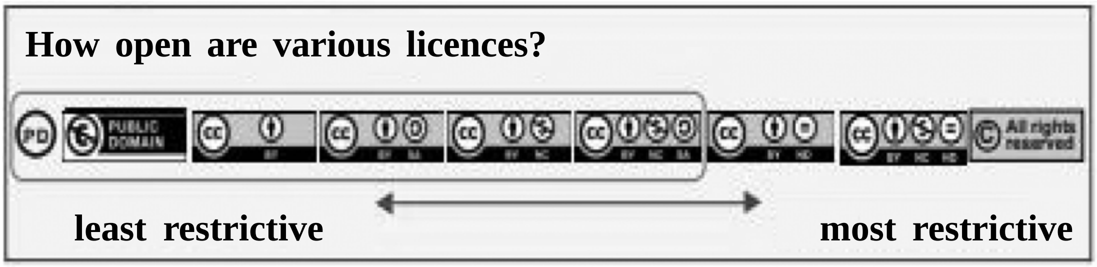
While all of these six Creative Commons licences are more open than full copyright (i.e., all rights reserved), some are more open than others.

It is up to the author or creator of the resource to determine how open the new resource's licence should be and to choose the appropriate licence. The less restrictive the licence, the more useful the resource can potentially be for other educators. It is worth trying out the Creative Commons' online licence generator to help you work out what is the most appropriate licence for you.

The diagram below illustrates the relative restrictiveness of each licence:




## 11.6 Conclusion

Our learner understood about licencing & copyright issuer, white using the OER. This will help our learners to get resource from right sitar & develop their own material scientifically.

## 11.7 Exercise

1. What is OER?
2. What is MOOCs.
3. What are the challenger of using OER.
4. What is creative common licensing system.

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