Farook Training College Innovative Academia (FTCIA)

Online Collaborative Learning Project (OCLP)

Study Materials.

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The entire materials are prepared by the M.Ed students (2020-22) of Farook Training College, Calicut, Kerala.

It is expected that this will be a support for those who need simplified, concise but comprehensive study materials for their examination preparation. It is a smart footstep to self learning and peer learning.

A note of appreciation to all student teachers who are the workforce behind this great endeavor.

Team OCLP

FTC

Paper 4
INTRODUCTION TO EDUCATIONAL RESEARCH AND STATISTICS.

MODULE 1

Meaning of research

Research is a way of looking for new information, new understanding, and new facts. Research is often used for solving problems or increasing available knowledge. This can be done by testing theories and making observations. Research usually prefers to be systematic, organised, and objective.

Definition of research

According to Kothari (2006). Research is a pursuit of trust with the help of study, observation, comparison and experiment, the search for knowledge through objective and systematic methods of finding solutions to a problem.

Characteristics of research

Research is based on logical reasoning and involves both inductive and deductive methods.
The data or knowledge that is derived is in real time from actual observations in natural settings.

Research creates a path for generating new questions. Existing data helps create more opportunities for research

Research is analytical in nature. It makes use of all the available data so that there is no ambiguity in inference.

Accuracy is one of the most important aspects of research. The information that is obtained should be accurate and true to its nature.

Reliability refers to how consistently a method measures something. If the same result can be consistently achieved by using the same methods under the same circumstances, the measurement is considered reliable.

Research should be valid.Validity refers to how accurately a method measures what it is intended to measure.

Types of research

Qualitative research

Qualitative research is a process that is about inquiry. It helps create in-depth understanding of problems or issues in their natural settings. This is a non-statistical method.

Qualitative research is heavily dependent on the experience of the researchers and the questions used to probe the sample.

The sample size is usually restricted to 6-10 people.

Open-ended questions are asked in a manner that encourages answers that lead to another question or group of questions. The purpose of asking open-ended questions is to gather as much information as possible from the sample.

Quantitative research

Qualitative research is a structured way of collecting data and analyzing it to draw conclusions. Unlike qualitative methods, this method uses a computational and statistical process to collect and analyze data. Quantitative data is all about numbers.

Quantitative research involves a larger population.

This method uses close-ended questions because the researchers are typically looking to gather statistical data.

Mixed Methods Research

The mixed methods approach collects and uses quantitative and qualitative data in the same study.

As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone.

Purpose of research

Exploratory

As the name suggests, exploratory research is conducted to explore a group of questions. The answers and analytics may not offer a final conclusion to the perceived problem. It is conducted to handle new problem areas which haven’t been explored before. This exploratory process lays the foundation for more conclusive research and data collection.

Explanatory

Explanatory research or causal research is conducted to understand the impact of certain changes in existing standard procedures. Conducting experiments is the most popular form of casual research. For example, a study conducted to understand the effect of rebranding on customer loyalty.

Importance of research

Research expands your knowledge base

The most obvious reason to do research is that you'll learn more. There's always more to learn about a topic, even if you are already well-versed in it. If you aren't, research allows you to build on any personal experience you have with the subject. The process of research opens up new opportunities for learning and growth.

Research gives you the latest information

Research encourages you to find the most recent information available. In certain fields, especially scientific ones, there's always new information and discoveries being made. Staying updated prevents you from falling behind and giving info that's inaccurate or doesn't paint the whole picture. With the latest info, you'll be better equipped to talk about a subject and build on ideas.

Research helps you narrow your scope

When you're circling a topic for the first time, you might not be exactly sure where to start. Most of the time, the amount of work ahead of you is overwhelming. Whether you're writing a paper or formulating a business plan, it's important to narrow the scope at some point. Research helps you identify the most unique and/or important themes. You can choose the themes that fit best with the project and its goals.

Research teaches you better discernment

Doing a lot of research helps you sift through low-quality and high-quality information. The more research you do on a topic, the better you'll get at discerning what's accurate and what's not. You'll also get better at discerning the gray areas where information may be technically correct but used to draw questionable conclusions.

Research introduces you to new ideas

You may already have opinions and ideas about a topic when you start researching. The more you research, the more viewpoints you'll come across. This encourages you to entertain new ideas and perhaps take a closer look at yours. You might change your mind about something or, at least, figure out how to position your ideas as the best ones.

Research helps with problem-solving

Whether it’s a personal or professional problem, it helps to look outside yourself for help. Depending on what the issue is, your research can focus on what others have done before. You might just need more information, so you can make an informed plan of attack and an informed decision. When you know you’ve collected good information, you’ll feel much more confident in your solution.

Research helps you reach people

Research is used to help raise awareness of issues like climate change, racial discrimination, gender inequality, and more. Without hard facts, it's very difficult to prove that climate change is getting worse or that gender inequality isn't progressing as quickly as it should. The public needs to know what the facts are, so they have a clear idea of what "getting worse" or "not progressing" actually means. Research also entails going beyond the raw data and sharing real-life stories that have a more personal impact on people.

Educational research

What is Educational Research

W.M. Travers (1969) defines educational research as "an activity directed towards the development of an organized body of scientific knowledge about the events with which educators are concerned

According to Harris (1960) educational research is any systematic striving towards understanding, on perceiving a certain complex educational problem of more than immediate personal concern and stated in a problematic form"

Steps in Research

1. Identifying the problem

The first and foremost task in the entire process of scientific research is to identify a research problem. A well-identified problem will lead the researcher to accomplish all-important phases of the research process, starting from setting objectives to the selection of the research methodology

2. Review of literature

A review of relevant literature is an integral part of the research process. It enables the researcher to formulate his problem in terms of the specific aspects of the general area of his interest that has not been so far researched. Such a review, not only provides him exposure to a larger body of knowledge but also equips him with enhanced knowledge to efficiently follow the research process.

3. Setting research questions, objectives, and hypotheses

After discovering and defining the research problem, researchers should make a formal statement of the problem leading to research objectives.

An objective will precisely say what should be researched, to delineate the type of information that should be collected, and provide a framework for the scope of the study.

A hypothesis is an unproven statement or proposition that can be refuted or supported by empirical data. Hypothetical statements assert a possible answer to a research question.

4. Formulating the study design

The research design is the blueprint or framework for fulfilling objectives and answering research questions. It is a master plan specifying the methods and procedures for collecting, processing, and analyzing the collected data. There are four basic research designs that a researcher can use to conduct his or her study; survey, experiment, secondary data study, and observational study. It also includes whether the data is qualitative or quantitative.

5. Collection of data

The most common means for collecting quantitative data is the structured interview. Studies that obtain data by interviewing respondents are called surveys. Data can also be collected by using self-administered questionnaires. Telephone interviewing is another way in which data may be collected.

Other means of data collection include the use of secondary sources, such as the census, vital registration records, official documents, previous surveys, etc.

Qualitative data are collected mainly through in-depth interviews, focus group discussions, and observational studies.

6. Processing and analyzing data

Data processing generally begins with the editing and coding of data. Data are edited to ensure consistency across respondents and to locate omissions, if any. In survey data, editing reduces errors in the recording improves legibility and clarifies unclear and inappropriate responses.

Data analysis usually involves reducing accumulated modata to a manageable size, developing summaries, searching for patterns, and applying statistical techniques for understanding and interpreting the findings in the light of the research questions. .

7. Preparing the research report

The end goal of a scientific study is to interpret the results and draw conclusions.

To this end, it is necessary to prepare a report and transmit the findings and recommendations to administrators, policymakers, and program managers for the intended purpose of making a decision.

Purpose of Educational Research

- To build new knowledge regarding the methodology or other core subject areas
- Adding of existing stock of knowledge related to educational field
- To solve a problem related to classroom, institution, administrative level, policy level

- Invention of new teaching methods, curriculum transaction strategies, effective grouping technique and so forth.
- Realizing the exact problem of educational sector.
- Assess the effect of new methodology of teaching
- To understand the teachers knowledge on latest evaluation techniques

Scope of Educational Research

The scope of a subject can usually be discussed under two heads:

1. The branches, topics and the subject matter it deals with
2. The limits of its operations and applications

The fields of educational research can be classified in terms of following content areas.

1. Educational Psychology
2. Philosophy of Education
3. Sociology of Education
4. Economics of Education

5. Educational Administration
6. Comparative Education
7. Curriculum construction and Textbooks
8. Educational Measurement and Test development
9. Teacher education and teaching behavior
10. Guidance and counselling
11. Educational Technology

LIMITATIONS OF EDUCATIONAL RESEARCH

1 Difficulties in observation:

2 Interdisciplinary nature of education : Borrows concepts, theories, methodologies from other disciplines.

3 Difficulties in replication

4 Difficulties in control

5 Measurement problems

6 Interaction of observer and subject
7 Complexity of research problems
8 Legal and ethical concerns
9 Program variability
10 Methodological difficulties
11 Diversity
12 Public institutions

Fundamental, Applied Research & Action research

Classification is based on the goal or purpose of the research

Research can be classified on the basis of its goal as fundamental (basic) research and applied research.

Fundamental research: -

This type of research aims at obtaining the empirical data that can be used to formulate, expand or evaluate a theory. The primary concern of basic research is the creation of theory. That is, adding something to the existing body of knowledge

Applied Research: -

Applied research has most of the characteristics of basic research. However, its purpose is improving a product or a process through testing hypothetical concepts in actual problem situations. Most educational research is applied research. The purpose of applied research is to solve a practical problem. One type of applied research is action research.

Action research: -

Action research is focused on immediate application, not on the development of theory or on generalization of applications. Action research focuses on the solution of day-to-day problems at the local level. Action research usually is less rigorous in terms of design and methodology than other educational research. It is usually conducted by teachers and administrators for solving a specific problem or for providing information for decision making at the local level. Its findings are to be evaluated in terms of local applicability, not universal validity

MODULE 2

IDENTIFICATION AND CONCEPTUALIZATION OF RESEARCH PROBLEM

Formulation of research problem

1. Research problem- conceptualization
2. Formulation of research problems.

- First and most important step of the research process
- Like a foundation of building
- Determines the study design, type of Sampling strategy, research instrument ,type of analysis etc.

3. Source of research problems.

4 Ps people problem problem phenomenon people individuals, organisation, groups ,communities, problem- issues, needs, situations etc programme contents, structure, outcomes, attributes phenomenon cause and effect relationship, study of a phenomenon etc.

4 Selecting research problems- consideration.

- Interest: research needs hard work and usually it is time consuming. So if you are not really interested in the topic it could become a tedious task.
- Magnitude: researchers should carefully consider the magnitude of the research. Narrow down the topic to something manageable, specific and clear.
- measurement of Concepts: clear about the indicators Measurement of Concepts: clear about the indicators of the study.

5. Selecting the research problem- consideration.

- Level of expertise: have an adequate level of expertise.
- Relevance: either adds to the existing body of knowledge, bridges current gaps, or useful in policy formulation.
- Availability of data: make sure that needed data are available.
- Ethical issues: how ethical problems can be overcome should be thoroughly examined at the problem formulation stage.

6 Source of the problem.

- Expertise in the field of research.
- Reading professional literature/ journals.
- One's own personal experience. consultation with others.
- Extension of some already completed projects.
- School practices/ classroom practices. Community.
- Technological changes & curricular developments.
- Social changes.

7 Criteria for selection of research topic.

- Is the topic interesting?
- Is the topic sufficiently original?
- Is the topic amenable to research (researchability).
- Is the problem significant?
- Is the problem feasible?

8 .Steps in the formulation of research problems.

- **Identify a broad area.**
- **Dissect the broad areas and subareas. Select what is most interesting to you .**
- **Raise research questions.**
- **Formulate objectives (main and sub Objectives)**
- **Assess your objectives.**
- **Double check.**

Review of related literature

- Review of related literature is mostly known as the second chapter in almost every empirical thesis.
- it is the very first step to know, to explore and to understand the area of interest, moreover to select the variables and finalise the topic for the study.
- It also plays a major role in the discussion section of the thesis. In fact, review of related literature is required in every chapter of the thesis.
- It helps in defining your problem, identifying variables, framing objectives and hypotheses, linking it with the methodology, formulation of Data Collection tool and selecting appropriate statistical techniques, discussion on your findings and giving suggestions.
- Within the report there should be an adequate review of the relevant literature.
- The literature selected should be sufficiently contemporary to demonstrate the way in which the report is building upon recent research.
- For writing literature review you need to follow certain rules, e.g. chronological order, style of quoting the authors with year, paraphrasing the desired content and writing in your words.

Types of reviews

- Self- study reviews
- Context reviews
- Historical review
- Theoretical reviews
- Integrative review
- Methodological reviews

Primary sources

- Used broadly to embody all sources that are original.
- Provide first hand information that is closest to the object of study.
- Primary sources vary by discipline.
- Academic journals detailing the methodology used in the research, in depth descriptions and discussions of the findings are considered primary sources of information.
- Primary sources include speeches, letters, diaries, autobiographies, interviews, official reports, Court records, artifacts, photographs and drawings.

Secondary source

- A source that provides non original on second hand data or information.
- Written about primary sources
- Research summaries reported in test books, magazines, and newspapers are considered secondary sources.

Literature search

- Manual
- Books, news papers, journals,encyclopaedias etc….

Databases

- Google scholar
- Inflibnet
- STOR (digital library founded in 1995 in New York City- journal storage)
- Science direct.

Reference style

- There are a set of rules on how to cite sources in academic writing.
- Preferred by particular academic disciplines because they work better with the kind of tens that are most commonly used in that discipline
- Different styles of referencing: APA, MLA, Oxford, Harvard, Chicago

APA

- The American psychological Association is an organisation created for individuals in the psychology field.
- With close to 121,000 numbers, they provide educational opportunities, finding guidance and research information for everything psychology related.
- They also have numerous high-quality databases Peer reviewed journals and books that revolve around mental health.
- The APA is also created with creating their own specific citation and reference style.
- Education, economics, business and social sciences also use APA style quite frequently.

APA style referencing

- Standardised by American psychological Association.
- Uses the author/date method of citation in which the author's last name and the year of publication are inserted in the text of the paper.
- Use only the surname of the author followed by a comma and the year of publication.
- References must be listed in an alphabetical order by author,and then chronologically.

MLA (modern language Association)

- Developed by modern language Association
- Used in discipline in Humanities.
- Uses the author- page number style for in text citation
- Consists of two parts a brief in - text citations in the body of the essay and a detailed list of the "works cited".

Oxford style referencing

- A superscript (raised) number in the body of the text that refers to a foot notes of the bottom of the page.
- Footnotes provide the bibliographic details of a source and are numbered consecutively throughout a paper or chapter.
- Do not use Latin abbreviations such as ibid.and op.cit. in Oxford style.

Hypothesis

What is hypothesis?

Hypothesis is an assumption that is made on the basis of some evidence. This is the initial point of any investigation that translates the research questions in to a prediction.It includes components like variables, population and the relation between the variables.A research hypothesis is a hypothesis that is used to test the relationship between two or more variables.

Following are the characteristics of hypothesis.

- The hypothesis should be clear and precise to consider it to be reliable.
- if the hypothesis is a relational hypothesis, then it should be stating in the relations between variables.
- The hypothesis must be specific and should have scope for conducting more tests.
- The way of explanation of the hypothesis must be very simple and it should also be understood that the simplicity of the hypothesis is not related to its significance.

Sources of Hypothesis

Following are the sources of hypothesis:

- The resemblance between the phenomenon.
- Observations from past studies, present-day experiences and from the competitors.
- Scientific theories.
- General patterns that influence the thinking process of people.

Types of Hypothesis

There are six forms of hypothesis and they are:

- Simple hypothesis
- Complex hypothesis
- Directional hypothesis
- Non-directional hypothesis
- Null hypothesis
- Associative and causal hypothesis

Simple Hypothesis

It shows a relationship between one dependent variable and a single independent variable. For example – If you eat more vegetables, you will lose weight faster. Here, eating more vegetables is an independent variable, while losing weight is the dependent variable.

Complex Hypothesis

It shows the relationship between two or more dependent variables and two or more independent variables. Eating more vegetables and fruits leads to weight loss, glowing skin, reduces the risk of many diseases such as heart disease, high blood pressure and some cancers.

Directional Hypothesis

It shows how a researcher is intellectual and committed to a particular outcome. The relationship between the variables can also predict its nature. For example- children aged four years eating proper food over a five-year period are having higher IQ levels than children not having a proper meal. This shows the effect and direction of effect.

Non directional Hypothesis

It is used when there is no theory involved. It is a statement that a relationship exists between two variables, without predicting the exact nature (direction) of the relations

Null Hypothesis

It provides the statement which is contrary to the hypothesis. It's a negative statement, and there is no relationship between independent and dependent variables. The symbol is denoted by "HO".

Associative and Causal Hypothesis

Associative hypothesis occurs when there is a change in one variable resulting in a change in the other variable. Whereas, causal hypothesis proposes a cause and effect interaction between two or more variables.

Examples of Hypothesis

Following are the examples of hypothesis based on their types:

- Consumption of sugary drinks every day leads to obesity is an example of a simple hypothesis.
- All lilies have the same number of petals is an example of a null hypothesis.
- If a person gets 7 hours of sleep, then he will feel less fatigue than if he sleeps less.

Functions of Hypothesis

Following are the functions performed by the hypothesis:

- Hypothesis helps in making an observation and experiments possible.
- It becomes the start point for the investigation.
- Hypothesis helps in verifying the observations.
- It helps in directing the inquiries in the right directions.

Researchers use hypotheses to put down their thoughts directing how the experiment would take place. Following are the steps that are involved in the scientific method:

- **Formation of question**
- **Doing background research**
- **Creation of hypothesis**
- **Designing an experiment**
- **Collection of data**
- **Result analysis**
- **Summarizing the experiment**
- **Communicating the results**

Formulating a Hypothesis

- In many cases, researchers might draw a hypothesis from a specific theory or build on previous research.
- For example, prior research has shown that stress can impact the immune system.
- So a researcher might hypothesize: "People with high-stress levels will be more likely to contract a common cold after being exposed to the virus than people who have low-stress levels."

- . "Birds of a feather flock together" is one example of folk wisdom that a psychologist might try to investigate.
- The researcher might pose a specific hypothesis that "People tend to select romantic partners who are similar to them in interests and educational level"

Elements of a Good Hypothesis

When trying to come up with a good hypothesis for your own research or experiments, ask yourself the following questions:

- Is your hypothesis based on your research on a topic?
- Can your hypothesis be tested?
- Does your hypothesis include independent and dependent variables?

Before you come up with a specific hypothesis, spend some time doing background research. Once you have completed a literature review, start thinking about potential questions you still have.

Variables

- **A variable is ,as the name applies, something that varies.**
- **Age, sex, export, income, and expenses, family size, class grades, blood pressure readings, eye colour, and vehicle type are all examples of variables because each of these properties varies or differs from one individual to another.**

Variable definition in research

- **A variable is any property, a characteristic, a number, or a quantity that increases or decreases over time or can take on different values in different situations.**

Types of variables

Qualitative variables

Qualitative variables are those that express a qualitative attribute such as hair colour, religion, race, gender, social status,method of payment, and so on. The values of a qualitative variable do not imply a meaningful numerical ordering.

The value of the variable religion (muslim, hindu,... Etc) differs qualitatively;no ordering of religion is implied.qualitative variables are sometimes referred to as categorical variables.

Nominal and ordinal variables

Categorical variables may again be described as nominal and ordinal.

- Ordinal variables are those which can be logically ordered or ranked higher or lower than another but do not necessarily establish a numeric difference between each category, such as examination grades , clothing size(large, medium, small)
- Nominal variables are those who can neither be ranked nor logically ordered, such as religion sex etc.

Quantitative variables

Quantitative variables, also called numeric variables, are those variables that are measured in terms of numbers. A simple example of a quantitative variable is a person's age.
The age can take on different values because a person can be 20 years old, 35 years old, and so on.
Likewise, family size is a quantitative
Variable, because a family might be comprised of one, two, three members and so on.

Discrete and continuous variables

Quantitative variable are again of two types:

Discrete and continuous.

- Discrete variable:a discrete variable, restricted to certain values, usually(but not necessarily)consists of whole numbers, such as the family size, number of defective items in a box. They are often the results of enumeration or counting.

eg:the number of accidents in the twelve month.
The number of mobile cards sold in a store within seven days.

- Continuous variable:A continuous variable is one that may take on an infinite number of intermediate values along a specified interval.

eg: the sugar level in the human body.
Blood pressure reading
Temperature
Height or weight of the human body.

Independent variable

The variable that is used to describe or measure the factor that is assumed to cause or at least to influence the problem or outcome is called an independent variable.

The definition implies that the experimenter uses the independent variable to describe or explain the influence or effect of it on the dependent variable.

dependent variable

The variable that is used time describe or measure the problem or outcome under study is called a dependent variable.

In a causal relationship, the cause is the independent variable, and the effect is the dependent variable.

The dependent variable usually is the variable the researcher is interested in understanding , explaining, or predicting.

background variable

In almost every study , we collect information such as age, sex, educational attainment, socioeconomic status, marital status, religion, place of birth and the like. These variables are referred to as background variables.

moderating variables

moderation occurs when the relationship between two variables depends on a third variable. The third variable is referred to as the moderator variable or simply the moderator.

If you are focusing on the relationship between the age of the trainees and work performance, you might use 'type of training ' as a moderating variable.

Extraneous variables

Most studies concern the identification of a single independent variable and the measurement of its effect on the dependent variable.

But still, several variables might conceivably affect our hypothesized independent dependent variable relationship there by distorting the study. These variables are referred to as extraneous variables.

Intervening variable

Often an apparent relationship between two variables is caused by a third variable. For example variables X and Y may be highly correlated, but only because X causes the third variable, Z which in turn causes Y. In this case, Z is the intervening variable. An intervening variable theoretically affects the observed phenomena but cannot be seen, measured, or manipulated directly;its effects can only be inferred from the effects of the independent and moderating variables on the observed phenomena.

suppressor variable

In many cases,we have good reasons to believe that the variables of interest have a relationship within themselves, but our data fail to establish any such relationship. Some hidden factors may be suppressing the true relationship between the two original variables.

Such a factor is referred to as a suppressor variable because it suppresses the actual relationship between the other two variables.

Module 3
sampling

What is sampling?

Sampling is a technique of selecting individual members or a subset of the population to make statistical inferences from them and estimate characteristics of the whole population. Different sampling methods are widely used by researchers in market research so that they do not need to research the entire population to collect actionable insights.

It is also a time-convenient and a cost-effective method and hence forms the basis of any research design. Sampling techniques can be used in a research survey software for optimum derivation.

Population vs Sampling

- Collection of all individuals, fomilier, group, organization, communities, events etc.
- May be finite or not so well defined.
- Sample is a subject of population. It should be a true representative of the population.

Sampling design - Reasons:

- Random sample
- Simple random sampling cannot be conducted
- Population being diverse
- Population whose members are grouped

Good sampling design - Requirements

- Goal orientation
- Measurability
- Practicability
- Economy

Types of sampling: sampling methods

Sampling in market research is of two types – probability sampling and non-probability sampling.

Probability sampling: Probability sampling is a sampling technique where a researcher sets a selection of a few criteria and chooses members of a population randomly. All the members have an equal opportunity to be a part of the sample with this selection parameter.

Non-probability sampling: In non-probability sampling, the researcher chooses members for research at random. This sampling method is not a fixed or predefined selection process. This makes it difficult for all elements of a population to have equal opportunities to be included in a sample.

Types of probability sampling

Probability sampling is a sampling technique in which researchers choose samples from a larger population using a method based on the theory of probability. This sampling method considers every member of the population and forms samples based on a fixed process.

There are four types of probability sampling techniques:

Simple random sampling: One of the best probability sampling techniques that helps in saving time and resources, is the Simple Random Sampling method. It is a reliable method of obtaining information where every single member of a population is chosen randomly, merely by chance. Each individual has the same probability of being chosen to be a part of a sample.

Cluster sampling: Cluster sampling is a method where the researchers divide the entire population into sections or clusters that represent a population. Clusters are identified and included in a sample based on demographic parameters like age, sex, location, etc. This makes it very simple for a survey creator to derive effective inference from the feedback.

Systematic sampling: Researchers use the systematic sampling method to choose the sample members of a population at regular intervals. It requires the selection of a starting point for the sample and sample size that can be repeated at regular intervals. This type of sampling method has a predefined range, and hence this sampling technique is the least time-consuming.

Stratified random sampling: Stratified random sampling is a method in which the researcher divides the population into smaller groups that don’t overlap but represent the entire population. While sampling, these groups can be organized and then draw a sample from each group separately.

There are multiple uses of probability sampling:

Reduce Sample Bias: The selection of the sample mainly depicts the understanding and the inference of the researcher. Probability sampling leads to higher quality data collection as the sample appropriately represents the population.

Diverse Population: When the population is vast and diverse, it is essential to have adequate representation so that the data is not skewed towards one demographic.

Types of non-probability sampling with examples

The non-probability method is a sampling method that involves a collection of feedback based on a researcher or statistician’s sample selection capabilities and not on a fixed selection process.

Four types of non-probability sampling

Convenience sampling: This method is dependent on the ease of access to subjects such as surveying customers at a mall or passers-by on a busy street. It is usually termed as convenience sampling, because of the researcher's ease of carrying it out and getting in touch with the subjects. Researchers have nearly no authority to select the sample elements, and it's purely done based on proximity and not representativeness.

Judgmental or purposive sampling: Judgemental or purposive samples are formed by the discretion of the researcher. Researchers purely consider the purpose of the study, along with the understanding of the target audience.

Snowball sampling: Snowball sampling is a sampling method that researchers apply when the subjects are difficult to trace. For example, it will be extremely challenging to survey shelterless people or illegal immigrants. In such cases, using the snowball theory, researchers can track a few categories to interview and derive results.

Quota sampling: In Quota sampling, the selection of members in this sampling technique happens based on a pre-set standard. In this case, as a sample is formed based on specific attributes, the created sample will have the same qualities found in the total population. It is a rapid method of collecting samples.

Uses of non-probability sampling

Non-probability sampling is used for the following:

Create a hypothesis: Researchers use the non-probability sampling method to create an assumption when limited to no prior information is available. This method helps with the immediate return of data and builds a base for further research.

Exploratory research: Researchers use this sampling technique widely when conducting qualitative research, pilot studies, or exploratory research.

Budget and time constraints: The non-probability method when there are budget and time constraints, and some preliminary data must be collected. Since the survey design is not rigid, it is easier to pick respondents at random and have them take the survey or questionnaire

STATISTICS
MODULE 1
DESCRIPTIVE ANALYSIS OF DATA

1)Basic concepts of statistics: Need of statistics in Educational Research

Statistics is the science of collection, classification, organization, presentation, analysis and interpretation of numerical data. In quantitative research, statistics is a major tool for collecting relevant data, its organization, presentation, analysis and interpretation of the results. Research is the systematic observation and description of characteristics of objects/events in order to explore relationship between variables.

2) Data types

Nominal scale

In statistics, nominal data (also known as nominal scale) is a type of data that is used to label variables without providing any quantitative value. It is the simplest form of a scale of measurement scales.

Ordinal

Ordinal Scale is defined as a variable measurement scale used to simply depict the order of variables and not the difference between each of the variables. These scales are generally used to depict non-mathematical ideas such as frequency, satisfaction, happiness, a degree of pain, etc.

Interval Scale

Interval Scale is defined as a numerical scale where the order of the variables is known as well as the difference between these variables. Variables that have familiar, constant, and computable differences are classified using the Interval scale. It is easy to remember the primary role of this scale too, ‘Interval’ indicates ‘distance between two entities’, which is what Interval scale helps in achieving.

Ratio Scale

Ratio Scale is defined as a variable measurement scale that not only produces the order of variables but also makes the difference between variables known along with information on the value of true zero. It is calculated by assuming that the variables have an option for zero, the difference between the two variables is the same and there is a specific order between the options.

4) Graphical And Diagramatical Reprsentation Of Data

1. when data is quantitatively represented through chart and diagrams.
2. to show the relative position of different subdivision/sub-data.

Advantages

- Easily understood, easy interpretation.
- More attractive.
- Useful in comparing relationship between two or more sets of figures.
- Enable statistical problems in a visual form.

Types

- Line diagram/graph
- Bar diagram
- Pie chart
- Histogram
- Frequency polygon
- Ogive/cumilative frequency polygon.

Graphical representation of ungrouped data

can be represented by using

1.Line graph.

2. Bar graph/bar diagram

3. Circle graph/pie diagrams

4. pictograms

Line graph/graph

- Most common graphical representation
- By plotting X axis on horizontally while Y axis vertically.
- Find out the intersecting point or origin and join all intersections.
- Example: cricket score in each over.

Measures of Central Tendency: Mean, Median, and Mode

A measure of central tendency is a summary statistic that represents the center point or typical value of a dataset. These measures indicate where most values in a distribution fall and are also referred to as the central location of a distribution. In statistics, the three most common measures of central tendency are the mean, median, and mode. Each of these measures calculates the location of the central point using a different method.

Mean, Median, and Mode

Mean:

The mean is the arithmetic average, and it is probably the measure of central tendency that you are most familiar. Calculating the mean is very simple

Median

The median is the middle value. It is the value that splits the dataset in half. To find the median, order your data from smallest to largest, and then find the data point that has an equal amount of values above it and below it. The method for locating the median varies slightly depending on whether your dataset has an even or odd number of values.

Mode

The mode is the value that occurs the most frequently in your data set.

Median

Advantages

* It is simple to understand
* It is easy to calculate
* Not affected by extreme values.

Disadvantages

* it does not consider all variables
* it is not stable
* it is not rigidly defined.

Mode

Advantages

* it is the simplest method of central tendency.

* It is not affected by extreme values.
* it can be calculated open ended classes.

Disadvantages

* mode is not stable.
* mode is not rigidly designed.
* mode cannot be used further calculations

6)Measures of Dispersion

In statistics, the measures of dispersion help to interpret the variability of data i.e. to know how much homogeneous or heterogeneous the data is. In simple terms, it shows how squeezed or scattered the variable is.
It includes range, standard deviation, quartile deviation, mean deviation.

Range:

It is simply the difference between the maximum value and the minimum value given in a data set.

Standard Deviation:

The square root of the variance is known as the standard deviation i.e. S.D. = $\sqrt{\sigma}$.

Quartiles and Quartile Deviation:

The quartiles are values that divide a list of numbers into quarters. The quartile deviation is half of the distance between the third and the first quartile.

Mean and Mean Deviation:

The average of numbers is known as the mean and the arithmetic mean of the absolute deviations of the observations from a measure of central tendency is known as the mean deviation.

Range

Advantages

* it can be easily calculated and understood.

Disadvantages

It helps us to make only a rough comparison of two or more groups with respect to the variability of the scores concerned.

* It is very greatly affected by fluctuations in sampling.

* it's value is never stable.

Standard deviation

Advantages

* it is well defined and it's value is always definite.

* it is based on all the scores in the data.
* it is less affected by fluctuations in sampling than most other measures of variability.

Disadvantages

* statistical interpretation using standard deviation is comparatively difficult.

* it gives more weight to extreme scores and less to those which are near the mean, because the squares of the deviations are taken. These squares will become very large as the deviations increase.

Quartile deviation

Advantages

* it is more representative and trustworthy measure of variability than the range.

* it is a good index of scores density at the middle of the distribution.

* It is useful in indicating the skewness of a distribution.

Disadvantages

* it is not capable of further algibriac treatment.

* it is unduly affected by a considerable clustering of scores at anyone end of a distribution.

Mean deviation

Advantages

* it is easily understood.
* it is based on all the scores.
* it is not affected very much by the values of the extreme items.

Disadvantages

* it ignores the algebraic signs of the deviations and as such it is not capable of further mathematical treatment.

7) Percentiles and Percentile Ranks:

As classified earlier ‘Percentile Rank’ is also a derived score. Through Percentile Rank we can know the relative standing (position) of the individual in a group. Before discussing about percentile ranks we must have some idea of Percentiles.

Percentile

In case of median, total frequency is divided into two equal parts; in case of quartiles, total frequency is divided into four equal parts; similarly in case of percentiles, total frequency is divided into 100 equal parts. We have learned that the median is that point in a frequency distribution below which lie 50% of the measures or scores; and that Q_1 and Q_3 mark points in the distribution below which lie, respectively, 25% and 75% of the measures or scores.

Using the same method by which the median and the quartiles were found, we may compute points below which lie 10%, 43%, 85%, or any percent of the scores. These points are called percentiles, and are designated, in general, by the symbol P_P, the p referring to the percentage of cases below the given value.

Percentile Rank (PR)

“percentile rank of an individual is his position on a scale of 100 indicating the percentage of N which lie below his score.”

Distinction between Percentile and Percentile Rank:

1. Percentiles are points in a continuous distribution below which lie given percentages of N. But percentile rank (PR) is the position on a scale of 100 to which the subject’s score entitles him.

2. In calculating percentiles, one starts with a certain per cent of N, say 15% or 60%, while in calculating PR one begins with an individual score and then determines the percentages of the scores which lie below it.

3. Procedure of computing PR is just reverse of computing percentile.

Calculating PR's from ordered data:

When individuals and things cannot be measured directly or conveniently, they can be put in 1-2-3 order with respect to some traits or characteristics.

The formula is:

Where R = Ranks in order of merit

and N = total number of cases.

Formula for a grouped data

Characteristics of PR:

(i) They present only a rank order of test results.

(ii) A single raw-score-difference near the mean may produce a change of several PR points, while a relatively large-score-difference at the extremes of the distribution may produce a very small PR difference. Therefore, the PR differences near the middle of the distribution must be interpreted with care and caution;

(iii) A PR indicates an individual's position with relation to the reference group, and is not a measure of growth.

Limitations of Percentiles and PR:

(i) PR are less reliable than z-scores and T-scores, for they are more affected by minor irregularities in the distribution of scores;

(ii) PR cannot, with strict validity, be averaged, added or subtracted.

(iii) The size of the percentile units is not constant in terms of raw score units. For example, if the distribution is normal, the raw score differences between the 90th and the 99th percentiles is much greater than the raw score difference between the 50th and the 59th percentiles. Thus, the differences in percentiles represent true differences at the extremes rather than at the middle of a normal distribution.

(iv) Percentiles are not well suited to the computation of means, correlations and other statistical measures.

(v) The mastery of an individual is not judged by the use of percentiles, as the same person in a poor group will show better rank and in an excellent group will show comparatively poorer rank. Also, as in case of simple ranks the difference in percentile ranks at different intervals are not equal.

(vi) The position of a student on total achievement cannot be calculated from percentiles given in several tests.

Ogive

The word Ogive is a term used in architecture to describe curves or curved shapes. Ogives are graphs that are used to estimate how many numbers lie below or above a particular variable or value in data. To construct an Ogive, firstly, the cumulative frequency of the variables is calculated using a frequency table. It is done by adding the frequencies of all the previous variables in the given data set. The result or the last number in the cumulative frequency table is always equal to the total frequencies of the variables.

Ogive Definition

The Ogive is defined as the frequency distribution graph of a series. The Ogive is a graph of a cumulative distribution, which explains data values on the horizontal plane axis and either the cumulative relative frequencies, the cumulative frequencies or cumulative per cent frequencies on the vertical axis.
Cumulative frequency is defined as the sum of all the previous frequencies up to the current point. To find the popularity of the given data or the likelihood of the data that fall within the certain frequency range, Ogive curve helps in finding those details accurately.

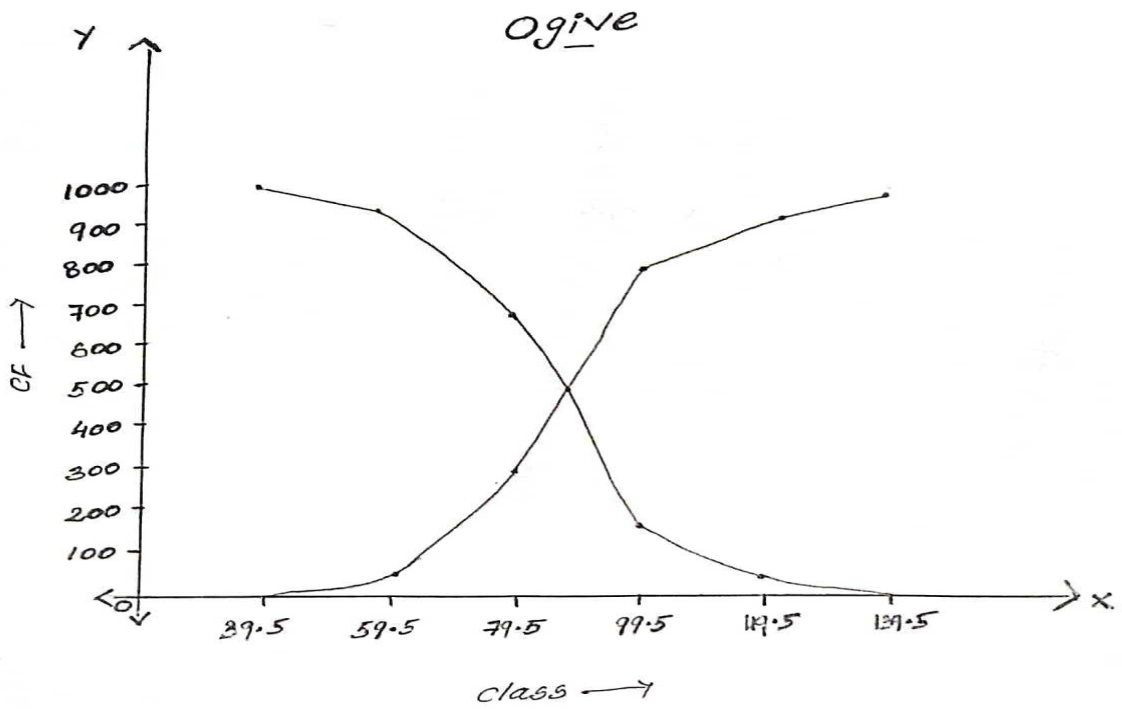
Create the Ogive by plotting the point corresponding to the cumulative frequency of each class interval. Most of the Statisticians use Ogive curve, to illustrate the data in the pictorial representation. It helps in estimating the number of observations which are less than or equal to the particular value.

Ogive Graph

The graphs of the frequency distribution are frequency graphs that are used to exhibit the characteristics of discrete and continuous data. Such figures are more appealing to the eye than the tabulated data. It helps us to facilitate the comparative study of two or more frequency distributions. We can relate the shape and pattern of the two frequency distributions.

The two methods of Ogives are:

- Less than Ogive
- Greater than or more than Ogive



The graph given above represents less than and the greater than Ogive curve.

Less than Ogive

The frequencies of all preceding classes are added to the frequency of a class. This series is called the less than cumulative series. It is constructed by adding the first-class frequency to the second-class frequency and then to the third class frequency and so on. The downward cumulation results in the less than cumulative series.

Greater than or More than Ogive

The frequencies of the succeeding classes are added to the frequency of a class. This series is called the more than or greater than cumulative series. It is constructed by subtracting the first class, second class frequency from the total, third class frequency from that and so on. The upward cumulation result is greater than or more than the cumulative series.

Ogive Chart

An Ogive Chart is a curve of the cumulative frequency distribution or cumulative relative frequency distribution. For drawing such a curve, the frequencies must be expressed as a percentage of the total frequency. Then, such percentages are cumulated and plotted, as in the case of an Ogive. Below are the steps to construct the less than and greater than Ogive.

How to Draw Less Than Ogive Curve?

- Draw and mark the horizontal and vertical axes.
- Take the cumulative frequencies along the y-axis (vertical axis) and the upper-class limits on the x-axis (horizontal axis).
- Against each upper-class limit, plot the cumulative frequencies.
- Connect the points with a continuous curve.

How to Draw Greater than or More than Ogive Curve?

- Draw and mark the horizontal and vertical axes.
- Take the cumulative frequencies along the y-axis (vertical axis) and the lower-class limits on the x-axis (horizontal axis).
- Against each lower-class limit, plot the cumulative frequencies.
- Connect the points with a continuous curve.

Uses of Ogive Curve

Ogive Graph or the cumulative frequency graphs are used to find the median of the given set of data. If both, less than and greater than, cumulative frequency curve is drawn on the same graph, we can easily find the median value. The point in which, both the curve intersects, corresponding to the x-axis, gives the median value. Apart from finding the medians, Ogives are used in computing the percentiles of the data set values.

8) Derived Score:

In order to interpret the scores properly or to make them comparable we convert the raw scores into derived scores. The derived scores help us to know the position of an individual in his group and we can compare the performance with others. **“A derived score is a numerical description of an individual’s performance in terms of norms.”**

Standard Scores or z-Score (Small z Score) or a-Score (Sigma Score)

- Standard scores also indicate the relative position of a pupil in a group by showing how far the raw score is above or below average. The standard scores express the performance of pupils in standard deviation unit.
- **This gives us a standard score, usually denoted by a-score, (read as sigma-'z') is obtained by the formula:**
- z(or, σ-score) = X – M/SD
- where X = score of the individual
- M = Mean of the group
- The standard scores represent 'measurements' from the mean in S.D. units. The standard score indicates how far a particular score is removed from the mean of the distribution in terms of S.D. of the distribution. Standard scores conform to the concept of the normal distribution. In case of standard scores, the difference between score units are hypothesized to be equal.

Properties of the standard score or z-score:

A score becomes significant only when it is comparable with other scores. Raw scores become meaningful when they are converted into derived scores' or z-scores.

(i) Z-score:

The standard scores or z-scores involve decimals and directional signs. To avoid this the z-value is multiplied by' 10 and then 50 is added to it. The new score is called Z-score. Thus, Z-score is a standard score on the scale with a mean of 50 and SD of 10.

The formula for computing Z-score is:

$$\text{Z-score} = 50 + 10z$$

Where $z = \frac{X - M}{S.D}$ ss or, we may express the formula as.
(small z score)

$$\underset{\text{(capital Z-score)}}{\text{Z-score}} = 50 + 10\left[\frac{X - M}{S.D.}\right]$$

The derived scores properties:

1. A z-score has a mean of 0 and standard deviation of 1.

2. We can know the relative position of an individual in the whole group by expressing the raw score in terms of a distances above or below the mean.

3. Standard score differences are proportional to raw score differences.

4. Standard scores on different tests are directly comparable.

5. One type of standard score can be converted into another type of standard score.

6. From the formula, z-score = raw score – mean/standard deviation = X-M/SD,

it can be derived that:

(i) If the raw score = mean, z-score is Zero;

(ii) If the raw score > mean, z-score is positive;

(iii) If the raw score < mean, z-score is negative.

Advantages of z-scores:

(i) They permit us to convert raw scores into a common scale which has equal units and which can be readily interpreted.

(ii) They give us an idea of how well a teacher-made test is. A good teacher- made test designed to discriminate among students will generally have a range between 4 and 5 SDs, i.e., 2.0 to 2.5 SDs on either side of the mean.

Limitations:

They involve the use of decimals and negative numbers.

T-score (Mc Call's score)

Mc Call suggested a scale with a mean of 50 and a SD of 10 to be used when the distribution is normal. T-score enjoys advantage over standard scores as in it the negative or fractional standard scores can be avoided. (T-score is named after Thorndike and Terman).

T-score = 50 + 10z

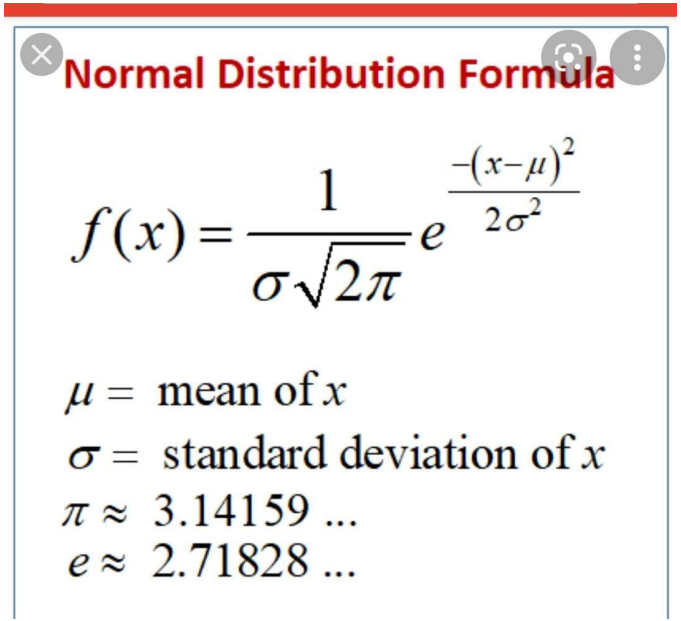
Here, in the T-scale it is assumed that the distribution is normal. This is why T-score is called a "normalized standard score."

MODULE 2
NORMAL DISTRIBUTION

Normal distribution

It is a non skewed mesokurtic distribution that is symmetrical about the ordinate at the mean.

The equation for the normal curve is non skewed mesokurtic distribution



Properties of normal probability curve

- Symmetrical about the ordinate of the central point of the curve. It implies that the size, shape and slope of the curve on one side of the curve is identical to that of the other.
- Skewness=0
- Kurtosis=0.263
- maximum ordinate occurs at the centre:
- The maximum height of the ordinate always occurs at the central point of the curve, that is, at the midpoint. In the unit normal curve, it is equal to 0=3989.
- The normal curve is asymptotic to the X-axis: The curve continues to decrease in height on both ends away from the middle point; It extends infinitely in both directions.

- The total area under the curve is N. For practical purposes, it is treated as 1 .
- The area under the curve between the two turning points $x+\sigma$ and $x-\sigma$ are 68.26% or 0.6826

- The area under the curve between the two turning points $x+2\sigma$ and $x-2\sigma$ are 95.44% or 0.9544

- The area under the curve between the two turning points $x+3\sigma$ and $x-3\sigma$ are 99.73% or 0.9973

Applications

- To determine the percentage of cases in a normal distribution within the given limit of scores.
- To determine the percentage of cases like above or below a given score
- To determine to the limits of scores which includes a given percentage of cases
- To determine the percentile rank
- To compare the two distributions in terms of overlapping.
- Dividing a group into sub-groups according to certain ability and assigning the grades
- Determining percentage of cases
- Determination of limits

Overlapping

- When two probability distributions overlap, statistical interference exists.
- Knowledge of the distributions can be used to determine the likelihood that one parameter exceeds another, and by how much.

Overlapping can be defined as the area intersected by two or more probability density functions and offers a simple way to quantify the similarity (or difference) among samples or populations which are described in terms of distributions

Relative difficulty

- Developed as an index of test or item difficulty for use in situations in which raw score means not directly comparable because of chance score differences.
- Computational RD are described. Data from the literature are used to illustrate applications of the RD at both the test and item level.

Separation into given groups

- When a certain trait is distributed normally, we can divide a group into subgroups according to capacity. Since most of the area (99.73 percent) lies between -3 and +3.
- This total range of six may be allotted to different groups according to the given capacity, and then the number of individuals can be found out according to the area bounded by the coordinates at this point.

Division from normality

Skewness

- Distortion or asymmetry that deviates from the symmetrical bell curve, or normal distribution, in a set of data.
- If the curve is shifted to the left or to the right, it is said to be skewed.
- Skewness can be quantified as a representation of the extent to which a given distribution varies from a normal distribution.
- A normal distribution has a skew of zero, while a lognormal distribution for example, would exhibit some degree of right-skew.

- Distributions can also be said to have zero or undefined skew.
- In the curve of a distribution, the data on the right side of the curve may taper differently from the data on the left side -"tails."
- Negative skew refers to a longer or fatter tail on the left side of the distribution, while positive skew refers to a longer or fatter tail on the right.
- The mean of positively skewed data will be greater than the median.
- In a distribution that is negatively skewed, the mean of negatively skewed data will be less than the median.
- If the data graphs symmetrically, the distribution has zero skewness, regardless of how long or fat the tails are.
- The three probability distributions depicted below are positively-skewed (or right-skewed) to an increasing degree.
- Negatively-skewed distributions are also known as left-skewed distributions.

Measuring Skewness

- Prson’s first and second coefficients of skewness

- Pearson’s first coefficient of skewness/ Pearson mode skewness, subtracts the mode from the mean and divides the difference by the standard deviation.
- useful if the data exhibit a strong mode

- Pearson’s second coefficient of skewness/Pearson median skewness, subtracts the median from the mean, multiplies the difference by three, and divides the product by the standard deviation.
- Preferable If the data have a weak mode or multiple modes, as it does not rely on mode as a measure of central tendency.

Kurtosis

- A statistical measure that is used to describe distribution which measures extreme values in either tail.
- Distributions with large kurtosis exhibit tail data exceeding the tails of the normal distribution (e.g., five or more standard deviations from the mean)
- Distributions with low kurtosis exhibit tail data that are generally less extreme than the tails of the normal distribution.
- For investors, high kurtosis of the return distribution implies the investor will experience occasional extreme returns (either positive or negative), more extreme than the usual + or - three standard deviations from the mean that is predicted by the normal distribution of returns.
- This phenomenon is known as kurtosis risk.

- Kurtosis is a measure of the combined weight of a distribution's tails relative to the center of the distribution.
- kurtosis is a measure that describes the shape of a distribution's tails in relation to its overall shape.
- A distribution can be infinitely peaked with low kurtosis, and a distribution can be perfectly flat-topped with infinite kurtosis. Thus, kurtosis measures "tailedness," not "peakedness."

There are three categories of kurtosis

- The first category of kurtosis is a mesokurtic distribution. This distribution has a kurtosis statistic similar to that of the normal distribution, meaning the extreme value characteristic of the distribution is similar to that of a normal distribution
- The second category is a leptokurtic distribution. Any distribution that is leptokurtic displays greater kurtosis than a mesokurtic distribution. Characteristics of this distribution is one with long tails (outliers.).
- Examples of leptokurtic distributions are the T-distributions with small degrees of freedom.

- The final type of distribution is a platykurtic distribution.
- These types of distributions have short tails (paucity of outliers.) The prefix of "platy-" means "broad," and it is meant to describe a short and broad-looking peak, but this is an historical error.
- Uniform distributions are platykurtic and have broad peaks.

MODULE 3
CORRELATION

Concept of correlation

Correlation is a statistical measure that expresses the extent to which two variables are linearly related (meaning they change together at a constant rate). It's a common tool for describing simple relationships without making a statement about cause and effect.

Types of Correlation

All correlations have two properties: strength and direction. The strength of a correlation is determined by its numerical value. The directionof the correlation is determined by whether the correlation is positive or negative.

1. Positive correlation:

Both variables move in the same direction. In other words, as one variable increases, the other variable also increases. As one variable decreases, the other variable also decreases.

Eg: Intelligence and achievement

2. Negative correlation:

The variables move in opposite directions. As one variable increases, the other variable decreases. As one variable decreases, the other variable increases.

Eg : Anxiety and Achievement

All positive correlations have scatterplots that move in the same direction as the positive correlation in the image above. All negative correlations have scatterplots that move in the same direction as the negative correlation in the image above.

3. No Correlations

It means that there is no apparent relationship between the two variables. For example, there is no correlation between shoe size and salary. This means that high scores on shoe size are just as likely to occur with high scores on salary as they are with low scores on salary.

If your line of best fit is horizontal or vertical like the scatterplots on the top row, or if you are unable to draw a line of best fit because there is no pattern in the data points, then there is little or noCorrelations.

Pearson's-Product moment coefficient of correlation

Pearson correlation coefficient or Pearson’s correlation coefficient or Pearson’s r is defined in statistics as the measurement of the strength of the relationship between two variables and their association with each other.

In simple words, Pearson’s correlation coefficient calculates the effect of change in one variable when the other variable changes.

The correlation coefficient formula finds out the relation between the variables. It returns the values between -1 and 1. Use the below Pearson coefficient correlation calculator to measure the strength of two variables.

Pearson correlation coefficient formula

Where:

N = the number of pairs of scores

Σxy = the sum of the products of paired scores

Σx = the sum of x scores

Σy = the sum of y scores

Σx2 = the sum of squared x scores

Σy2 = the sum of squared y scores

Spearman Rank Correlation (Spearman's Rho)

Spearman rank correlation is a non-parametric test that is used to measure the degree of association between two variables.

The following formula is used to calculate the Spearman rank correlation:

Where:

ρ= Spearman rank correlation

di = difference in paired ranks

n = number of cases

When the correlation is

* between 0 and ± 0.20 relationship is negligible
* between ± 0.20 and ± 0.40 relationship is low
* between ± 0.40 and ± 0.60 relationship is moderate
* between ± 0.60 and ± 0.80 relationship is substantial
* between ± 0.80 and ± 1 relationship is very high

1) Pearson's r

The two variables are continuous and quantitative with linear relationship.

2) Spearman's ρ

The two variables are in ordinal scale

3) Biserial correlation

One variable is continuous and quantitative and the second variable is dichotomized.

4) Tetra choric correlation

Both the variables are dichotomized.

5) Phi- coefficient

Both the variables are qualitative and dichotomous.

6) Point Biserial correlation

One variable is continuous and quantitative and the other is qualitative and dichotomous.

7) Contingency Coefficient

Both the variables are not continuous and at least one consists of three or more categories.

8) The correlation ratio

Two continuous and quantitative variables with curvy linear relationship.

9) Multiple correlation

To combine the predictor variables and to make a better prediction.