12th ,13th & 14th Class

Statistical Inference

👉 **Meaning:**
Statistical inference means making conclusions about a **population** by using information from a **sample**.

It has two main parts:

1. **Estimation**
2. **Test of Hypothesis**

A. Estimation

Estimation means **guessing the value of an unknown population parameter** (like mean, variance, or proportion) using sample data.

1. Point Estimation

- We estimate a parameter by giving a **single value**.
- Example:
    - Population mean (μ) is unknown.
    - We take a sample and calculate sample mean ($\bar{x}$).
    - Here, $\bar{x}$ is a **point estimate** of μ.

2. Interval Estimation

- Instead of giving one value, we give a **range of values (interval)** that is likely to contain the true parameter.
- This interval is called a **Confidence Interval**.

- Example: “μ lies between 48 and 52 with 95% confidence.”

Properties of a Good Estimator

A good estimator should have these 4 properties:

1. **Unbiasedness:**
    - On average, the estimator should equal the true parameter.
    - Example: The expected value of sample mean ($\bar{x}$) = population mean (μ).
2. **Consistency:**
    - As sample size increases, the estimator gets closer to the true parameter.
3. **Sufficiency:**
    - The estimator should use **all the information** from the sample.
4. **Efficiency:**
    - Among all unbiased estimators, the best one is the one with **smallest variance** (least error).

B. Test of Hypothesis

Already explained in detail earlier. In short:

- It is a **procedure to decide** whether a population assumption (hypothesis) is true or false using sample data.
- Example: Testing whether the average height of students = 160 cm or not.

Types of Tests

1. Parametric Tests

- Assume that data follows a **specific distribution** (usually normal).
- Used when population parameters (μ, σ², etc.) are involved.
- Examples:
    - **Z-test**
    - **t-test**
    - **F-test**
    - **Chi-square (χ²) test**

2. Non-Parametric Tests

- Do **not assume a specific distribution**.
- Used when data is ordinal, ranked, or does not meet parametric test assumptions.
- Examples:
    - Sign Test
    - Wilcoxon Signed-Rank Test
    - Mann-Whitney U Test
    - Kruskal-Wallis Test
    - Spearman's Rank Correlation
    - Runs Test
    - χ² test (also works here)

Overview of Test of Hypothesis

1. Hypothesis

- A **hypothesis** is an assumption or guess about some characteristics of a population.
- It expresses an **expected relationship** between variables (e.g., average marks of students > 60).
- It is not just opinion—it's based on **facts, logic, or observation**.
- It is developed **before research**, and research is done to test whether the hypothesis is true or false.

👉 **Statistical Hypothesis**:
A statement about population **parameters** (like mean μ, variance σ^2, proportion p) or distribution, tested using **sample data**.

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2. Null & Alternative Hypothesis, Simple & Composite

- **Null Hypothesis (H_0):**
  - Neutral assumption.
  - No effect, no difference, no change.
  - Example: H_0: $\mu = 50$.
- **Alternative Hypothesis (H_1 or Ha):**
  - Opposite of H_0.
  - Claims there is an effect, difference, or change.
  - Example: H_1: $\mu \neq 50$.

👉 **Types:**

- **Simple Hypothesis:** Specifies the value of all parameters.
  Example: H_0: $\mu = 50$, $\sigma^2 = 4$.

- **Composite Hypothesis:** Specifies only part of the parameters.
  Example: H_0: $\mu = 50$ (σ^2 unknown).

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3. One-tailed & Two-tailed Test

- **One-tailed test:** Checks only one direction (greater or smaller).
  Example: H_1: $\mu > 50$.

- **Two-tailed test:** Checks both directions (not equal).
  Example: H_1: $\mu \neq 50$.

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4. Critical Value (Tabulated Value)

- A value taken from statistical tables (Z, t, χ^2, F tables).

- It divides the **acceptance region** and **rejection region**.

- If the test statistic > critical value → Reject H_0.

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5. Acceptance Region & Critical (Rejection) Region

- **Acceptance Region:** Range where we accept H_0.

- **Critical Region (Rejection Region):** Range where we reject H_0.

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6. Errors in Test of Hypothesis

When we take decisions, errors may occur:

Decision	H_0 True	H_0 False

Accept H_0	✅ No Error	❌ Type II Error (accepting false H_0)
Reject H_0	❌ Type I Error (rejecting true H_0)	✅ No Error

- **Type I Error (α):** Rejecting a true H_0 → "Producer's risk."
- **Type II Error (β):** Accepting a false H_0 → "Consumer's risk."

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7. Level of Significance (α)

- Probability of Type I error.
- Common values: **0.01, 0.05, 0.10**.
- Example: α = 0.05 → 5% risk of rejecting a true H_0.

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8. Degrees of Freedom (df)

- Number of independent observations available for calculation.
- Formula: df = n – 1 (for many tests).
- Needed in **t, χ^2, F tests**.

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9. Steps in Test of Hypothesis

1. State **H_0 and H_1**.
2. Choose **level of significance (α)**.
3. Select the **appropriate test statistic** (Z, t, F, χ^2).

4. Find the **critical value** from table.
5. Calculate the **test statistic** from sample.
6. Compare with critical value.
    - If test statistic falls in rejection region → Reject H_0.
    - Else → Accept H_0.

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10. Different Tests

- **Parametric Tests (need distribution assumption, like normality):**
    - Z-test
    - t-test
    - F-test
    - χ^2-test
- **Non-Parametric Tests (no strict distribution assumption):**
    - Sign test (1-sample, 2-sample)
    - Fisher-Irwin test
    - McNemar test
    - Wilcoxon signed-rank test
    - Mann-Whitney U test
    - Kruskal-Wallis H test
    - Spearman rank correlation
    - Kendall’s coefficient of concordance

- Runs test
- χ^2 test (also used here)

How to Develop Research Hypothesis?

A **research hypothesis** is a clear, testable statement about what you expect to find in your study. To develop it:

1. **Define or state the problem in a general area**
    - Start with the broad issue you want to study.
    - Example: Students' study habits and exam performance.
2. **Narrow down the area into a more specific focus**
    - Focus on a smaller, researchable question.
    - Example: Effect of daily study time on exam results.
3. **Make sure the hypothesis clearly defines the topic and focus**
    - Your hypothesis should not be vague.
    - Example: "More study time improves exam scores."
4. **Write the hypothesis properly with research objective**
    - Link it to what you want to achieve.
    - Example Objective: "To test whether daily study time affects exam scores."
    - Hypothesis: H_0: Daily study time has no effect on exam scores.
      H_1: Daily study time improves exam scores.
5. **Define the variables**
    - Independent variable (cause): Study time.
    - Dependent variable (effect): Exam scores.

6. **Examine the hypothesis**
    - Make sure it is testable with data.

Steps of Test of Hypothesis

1. **State Null and Alternative Hypothesis**
    - Example:
      H_0: $\mu = \mu_0$ (mean equals a specific value)
      H_1: $\mu \neq \mu_0$ (mean is not equal to that value).
2. **Select sample size (n)**
    - Decide how many data points you will collect.
3. **Choose the appropriate test statistic**
    - Depends on sample size and whether variance is known or unknown.
    - Example: Z-test, t-test, etc.
4. **Choose the level of significance (α)**
    - Usually 0.05 (5%), 0.01 (1%), or 0.10 (10%).
5. **Define Degrees of Freedom (df)** (if needed)
    - Usually df = n – 1.
6. **Find the critical/tabulated value (Ttab)**
    - Look it up in statistical tables (Z, t, χ^2, F) using α and df.
7. **Calculate the test statistic (Tcal)**
    - Use formula depending on the test chosen.
8. **Decision Rule**

- If Tcal > Ttab → Reject H_0.
- If Tcal ≤ Ttab → Accept H_0.

👉 **Alternative method (using software / p-value):**

- If **p-value < α** → Reject H_0.
- If **p-value ≥ α** → Accept H_0.

What is Confidence Interval (CI)?

- A **confidence interval** gives a **range of values** that is likely to contain the true population parameter (like mean).
- Example: Instead of saying “average weight = 86 kg,” we say “average weight is between 84 kg and 88 kg (95% confidence).”

👉 **Interpretation:**
If we repeat the sampling 100 times, about 95 of the intervals will contain the true population mean.

👉 **Common confidence levels:** 90%, 95%, 99%.

Formula for 95% Confidence Interval for Population Mean

CI=x¯±Z×SnCI = \bar{x} \pm Z \times \frac{S}{\sqrt{n}}CI=x¯±Z×nS

Where:

- x¯\bar{x}x¯ = Sample mean
- ZZZ = Z-value for confidence level (for 95%, Z = 1.96)

- SSS = Sample standard deviation
- nnn = Sample size

Example

Construct a 95% CI for the following:

- Sample mean ($\bar{x}$) = 86 kg
- Sample standard deviation (S) = 6.2 kg
- Sample size (n) = 46

Step 1: Write formula

$CI = \bar{x} \pm Z \times \frac{S}{\sqrt{n}}$

Step 2: Plug in values

- $\bar{x} = 86$
- $Z = 1.96$ (for 95% confidence)
- $S = 6.2$
- $n = 46$, so $\sqrt{n} = \sqrt{46} \approx 6.78$

$CI = 86 \pm 1.96 \times \frac{6.2}{6.78}$

Step 3: Simplify

$CI = 86 \pm 1.96 \times 0.914$ $CI = 86 \pm 1.79$

Step 4: Final Answer

$CI = (84.21, 87.79)$

👉 Interpretation: We are 95% confident that the **true population mean weight** lies between **84.21 kg and 87.79 kg**.

The Questionnaire

👉 A **questionnaire** is a written list of questions given to people (respondents) to answer.

- People read the questions, understand what is asked, and **write their answers**.
- The main difference between:
    - **Questionnaire** → Respondent fills in the answers themselves.
    - **Interview schedule** → Interviewer asks the questions, explains if needed, and records the answers.

Types of Questions

1. **Open-ended Questions**
    - No fixed answers are given.
    - Respondents write their own answers in their own words.
    - Example: *“What do you think about online classes?”*
2. **Closed Questions**
    - Answer choices are already given.
    - Respondents just **tick or choose** the option that fits.
    - Example: *“Do you like online classes? (a) Yes (b) No (c) Not sure”*

Focus Group Interview

- Similar to an interview but with a **group instead of one person**.

- Used to explore people's **experiences, opinions, and understandings** about a common issue.
- Example topics: domestic violence, disability, refugee experiences.

👉 **How it works:**

- Researcher prepares some **broad discussion topics** beforehand.
- The group then discusses, and **specific points come out naturally** during the talk.
- Each member of the group shares their views and experiences.

Characteristics of a Good Questionnaire

A good questionnaire should be:

1. **Valid** – It measures what it is supposed to measure.
2. **Reliable** – If repeated, it gives similar results.
3. **Clear** – Easy to understand, no confusing words.
4. **Concise** – Short and to the point (not too long).
5. **Sequential** – Questions should follow a logical order.
6. **Interesting** – Should engage respondents so they don't lose interest.

👉 **Extra tips for designing a good questionnaire:**

- Base it on a **conceptual framework** (your research plan).
- Check each question for **relevance and clarity**.
- Think about how you will **analyze the data later**.
- Do a **pilot test** (try it with a small group first) and improve it.

15th & 16th Class

Data Collection – Easy Notes

1. What is Data?

- **Data** = collection of information.
- **Datum** = a single piece of information.
- Data = observations, facts, or evidence collected for research.
- Data can be **qualitative** (descriptive, like honesty, confidence) or **quantitative** (numbers, like height, weight).
- In research, data is like the **raw material** used to find answers.

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2. Needs of Data

Why do we need data in research?

1. Data gives a strong **foundation** for research.
2. Like raw material for production – **quality of data = quality of research**.
3. Data provides **clear answers** to research questions.
4. Helps to **support arguments** in research findings.
5. Used to **test hypotheses**.
6. Used for:
    - Estimating population values.
    - Testing assumptions.

7. Qualitative data → finds facts.
   Quantitative data → helps create new theories.

8. Checks if a new tool/device works in real life.

9. Helps to **solve the problem**.

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3. Types of Data

Data can be divided into:

1. **Qualitative Data (Attributes)**
    - Cannot be measured in numbers.
    - Examples: honesty, motivation, confidence.
2. **Quantitative Data (Variables)**
    - Can be measured in numbers.
    - Examples: height, weight, age, price.

👉 Both qualitative and quantitative data can be:

- **Primary Data** – collected for the **first time**, original and fresh.
- **Secondary Data** – already collected by someone else and available.

Difference:

- Primary = new/original.
- Secondary = already existing, compiled.

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4. Data Collection Methods

The two main tools are:

- **Interview**
- **Questionnaire**

A. Interview

- **Interview =** person-to-person interaction to collect information.
- Can be **face-to-face, phone, or online**.

Types of Interview:

1. **Unstructured Interview (Flexible)**
    - No fixed format.
    - Questions can be changed or added during the interview.
    - Mostly used in **qualitative research**.
    - Examples:
        - In-depth Interviews
        - Focus Group Discussions (FGD)
        - Narratives (personal experiences)
        - Oral Histories (past events)
2. **Structured Interview (Rigid)**
    - Fixed set of questions, same order, same wording.
    - Uses an **interview schedule** (written list of questions).
    - Easier to compare results because everyone answers the same.
    - Needs less skill than unstructured interviews.

B. Questionnaire

- A **questionnaire** = written list of questions filled out by respondents themselves.
- Difference from interview: In an interview, the researcher asks; in a questionnaire, the person writes answers directly.

Things to remember when making a questionnaire:

- Questions must be **clear and simple**.
- Layout should be **easy to read and attractive**.
- Order of questions should be **logical**.
- Should feel **interactive**, like someone is talking.
- Sensitive questions should be explained first with a short statement.

Covering Letter (with mailed questionnaire) must include:

1. Who you are + your institution.
2. Main objectives of the study.
3. Why the study is important.
4. General instructions.
5. Participation is **voluntary**.
6. Answers are **confidential**.
7. Contact information.
8. Return address + deadline.
9. Thanking the participant.

Editing of Data

- **Meaning:**
  Editing means carefully checking the collected data (from questionnaires or surveys) to find and correct mistakes, missing answers, or unclear writing.

- **Purpose:**
  To make sure data is:

    1. **Accurate** – no wrong entries
    2. **Consistent** – matches with other facts collected
    3. **Uniform** – written in the same way everywhere
    4. **Complete** – no missing information
    5. **Organized** – arranged properly for **coding** and **tabulation** later

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Types of Editing

1. **Field Editing**
    - Done by the investigator (researcher) soon after the interview.
    - Purpose: To make the notes neat, complete, and readable.
    - **Important Rule:** The investigator should not guess or fill in missing answers by imagination.
2. **Central Editing**
    - Done later (by specially trained editors) when questionnaires come back from the field.
    - Purpose: To check for incomplete, unclear, or abbreviated answers (sometimes handwriting is hard to read).
    - Best time: As soon as possible—on the same day or next day.

Points Editors Must Remember

While editing, editors should:
(a) Know the instructions given to interviewers, coders, and editors.
(b) If they cut out an entry, they should use a **single line** so the old entry is still visible.
(c) Add new entries (if needed) using a **different color** and a **standard format**.
(d) Put their **initials** on any changes they make.
(e) Write their **initials + date** on every completed form/schedule.

Coding

- **Meaning:**
  Coding means giving numbers or symbols to answers so they can be grouped into categories.
  Example:

- Gender → Male = 1, Female = 2

- Education Level → Primary = 1, Secondary = 2, Higher = 3

- **Purpose:** To make data easier to classify, count, and analyze using statistics.

- **Good Coding Rules:**

1. **Exhaustiveness** – Every answer must fit into some category (no answer left out).

2. **Mutual Exclusiveness** – One answer should go to only one category (no overlap).

3. **Unidimensionality** – Each category should represent only one idea/concept.

✅ In short:

- **Editing = Cleaning the data** (checking for mistakes, missing info, and clarity).

- **Coding = Organizing the data** (putting responses into number-based categories for analysis).

17th Class

🎯 Training of Fieldworkers

- **Objective of training:**
    - To make sure all data collectors (fieldworkers/interviewers) use the questionnaire in the **same way**.
    - Every respondent should get the **same information** and be treated in the **same manner**.
    - If data is collected uniformly from everyone → training was successful.

Supervision of Field Work means guiding, monitoring, and controlling the activities of fieldworkers (interviewers/data collectors) while they are collecting information. The main goal is to make sure that data is gathered correctly, honestly, and in the same way by everyone.

When fieldwork is going on, supervisors check whether interviewers are following the instructions properly, asking questions exactly as written, recording responses accurately, and treating all respondents politely. Supervisors may also re-contact some respondents to verify the answers and ensure there is no carelessness or cheating.

Good supervision ensures that:

- Data is accurate, complete, and reliable.
- Interviewers work uniformly and honestly.
- Mistakes, misunderstandings, or biases are corrected quickly.
- The overall quality of research is maintained.

📌 Points for Training Program for Interviewers

1. How to make **initial contact** with the respondent and secure the interview.
2. How to **ask survey questions**.
3. How to **probe** (encourage/respondent to explain better).
4. How to **record responses**.
5. How to **end the interview** properly.

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1. Making Initial Contact and Securing the Interview

- **Face-to-face contact:**
  "Good morning/Salam/Adab, my name is …… and I'm from a national survey research company.
  We are conducting a survey about ……
  I'd like to ask a few questions and get your opinions, please."

- **Telephone contact:**
  "Good evening/Salam/Adab, my name is …… I am calling from the CSE department, Leading University, Sylhet.
  We are collecting some information for our research work, and I'd like your help, please."

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2. Five Principles of Asking Questions

1. Ask the question **exactly** as written in the questionnaire.
2. Read each question **slowly**.
3. Ask questions in the **same order** as they appear.
4. Ask **every question** in the questionnaire (do not skip).
5. Repeat the question if the respondent **doesn't understand**.

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3. What is Probing?

- **Probing = Encouraging the respondent to give more explanation, details, or clarify their answer.**
- Example: If respondent says, “I don’t know,” you can politely say:
    - “Could you think about it a little more?”
    - “Can you explain what you mean?”

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4. Basics of Good Interviewing

1. Be **honest** and show integrity.
2. Be **patient, polite, and respectful**.
3. Be careful about **accuracy and details**.
4. Show interest in the survey but **do not share your own opinions**.
5. Be a **good listener**.
6. Keep all information **confidential**.
7. **Respect respondents’ rights**.

📝 Editing

- **Meaning:** Checking and preparing data for coding and storage.
- **Purpose:** To make sure data is **complete, consistent, and reliable**.
- Editing includes:

- Checking for **missing answers**
- Checking if handwriting is **readable**
- Checking for **logical consistency** (answers make sense)

Types of Editing

1. **Field Editing**
   - Done on the **same day** as the interview by a supervisor.
   - Purpose: Catch small mistakes, check handwriting clarity, and correct inconsistent responses.
2. **In-house Editing**
   - Done later in the **central office** by trained staff.
   - Purpose: More **detailed and rigorous** checking.

Mechanics of Editing

- Editors often use **colored pencils** (blue/green) for making corrections.
- **Red pencils** are usually used for **coding**.
- **Important Rule:** Original data should not be erased. Instead, just cross it once → so future editors can still see it.

🔢 Coding and Recoding

- **Coding:** Giving numbers/symbols to answers so they can be classified.
  - Example: Gender → Male = 1, Female = 2

- **Recoding:** Changing one set of codes into another for easier analysis.
    - Example: `var1 = var2 - 8` or `total_new = total1 + total2`

✅ **In short:**

- **Training** = Make sure all interviewers collect data in the same way.
- **Interviewing** = Contact properly, ask correctly, probe if needed, record carefully, and end politely.
- **Editing** = Clean the data (field + in-house).
- **Coding/Recoding** = Turn answers into numbers for analysis.

18th 19 20 Class

Data Processing – Easy Notes

What is Data Processing?

- **Data Processing** means collecting raw data and working on it to make it meaningful and useful.
- It is basically **changing data into information** that people can understand.
- It includes **selecting, organizing, and transforming raw data** into valuable information.
- Nowadays, the term *Data Processing* is often replaced by **Information Technology (IT)**.

Types of Data Processing

1. **Manual Data Processing**
    - Done by hand (no machines).
    - Example: Counting survey responses manually and writing them in a notebook.
2. **Automatic Data Processing**
    - Done by machines (like calculators, punch cards).
    - Example: Using a cash register machine.
3. **Computerized Data Processing**
    - Done by computers (fast and accurate).
    - Example: Using Excel or software to analyze survey results.

Steps of Data Processing

1. **Collection** – Gather data from different sources.
2. **Filtering** – Remove wrong or unnecessary data.
3. **Sorting** – Arrange data in order (e.g., A–Z, highest to lowest).
4. **Analysis** – Study the data to find results and patterns.

👉 These steps make raw data meaningful and accurate.

Data Tabulation

- **Tabulation** = arranging data properly in a **table** or summary format.
- It helps researchers **see data clearly**.

1. Simple / Marginal Tabulation

- Counting how many times each answer appears.
- Example:
  Question: Do you have a Samsung smartphone?

Response	Frequency
Yes	330
No	70
Total	**400**

👉 This shows how often each response occurs.

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2. Cross Tabulation

- Organizing data into **groups or categories** to compare them.
- Example: Cross-tab of **Subjects** and **Grades**:

Subject	A	B	C	Total
Mathematics	50	60	25	135
Statistics	55	50	15	120
Basic Computer	45	40	10	95
Total	150	140	50	340

👉 Helps compare results across subjects.

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3. Contingency Table

- A **special type of cross-tab** for two **qualitative variables**.
- Example: *Did you take makeup exam?* (Male/Female)

Student Type	Yes	No	Total
Male	15	5	20
Female	18	2	20
Total	33	7	40

👉 Shows the relationship between two categories (Gender vs Exam).

Data Transformation

- **Changing data** into a new form that is better for analysis.
- Also called **Data Conversion**.
- Sometimes new variables are created.

Example:

```
New_Sum = var1 + var2 + var3
```

👉 Here, a new variable is made by adding three variables.

Interpretation

- After processing and analyzing, the final step is **Interpretation**.
- It means:
    - Explaining what the results mean.
    - Drawing conclusions.
    - Understanding the implications of the research.

👉 Example: If most students answered “Yes” to using Samsung phones, the conclusion is that **Samsung is popular among students**.

Data Analysis and Interpretation

What is Data Analysis?

- Data analysis means different activities we do to **get useful results from data**.
- Descriptive analysis = changing raw data into a simple form so it can be described, understood, and interpreted.
- The first step in analysis is usually **describing the responses or observations**.

Tools of Descriptive Analysis

1. **Tabular Presentation** → Putting data in tables.
2. **Graphical Presentation** → Using graphs, charts, diagrams.
3. **Measures of Central Tendency** → Mean, Median, Mode.
4. **Measures of Dispersion** → How spread out the data is.
5. **Correlation & Regression Analysis** → Finding relationships between variables.

Measures of Central Tendency

These tell us the **center point** of data.

1. **Mean (Average)**
    - **Arithmetic Mean (AM):** For all values.
    - **Geometric Mean (GM):** For positive values (used for rates, ratios, percentages).
    - **Harmonic Mean (HM):** Used in speed, rate problems (not for zero values).
2. **Median** → The middle value when data is arranged.
3. **Mode** → The most frequent value.
4. **Quantiles** → Dividing data into parts.
    - Quartiles (4 parts), Deciles (10 parts), Percentiles (100 parts).

Relation among AM, GM, HM:

- For positive values: **AM ≥ GM ≥ HM**
- For two values: **$AH = G^2$** (A = Arithmetic mean, G = Geometric mean, H = Harmonic mean).

Measures of Dispersion (Spread of Data)

Dispersion = how much data values vary or scatter.

There are **two types**:

1. **Absolute Measures (have same unit as data)**
    - **Range (R):** Highest – Lowest.
    - **Quartile Deviation (QD):** Spread around the median.
    - **Mean Deviation (MD):** Average of differences from mean.

    - **Standard Deviation (SD):** Square root of variance; most common measure.

2. **Relative Measures (no unit)**
    - Coefficient of Range.
    - Coefficient of Quartile Deviation (CQD).
    - Coefficient of Mean Deviation (CMD).
    - Coefficient of Variation (CV) = (SD ÷ Mean) × 100%.

👉 **Relative measures are used** when comparing data with different units (kg vs inch) or with very different means.

Correlation

- Shows the **relationship** between two variables.
- If one changes, does the other change too?
- Coefficient of correlation is **r**.

Values of r:

- r = +1 → Perfect positive relationship.
- r = -1 → Perfect negative relationship.
- r between +0.5 and +1 → Strong positive relation.
- r between -0.5 and -1 → Strong negative relation.
- Example: r = 0.78 → fertilizer & production strongly positively related.
- Example: r = -0.35 → temperature & production weak negative relation.

Regression

- Regression shows **average dependence** of one variable (Y = dependent) on another (X = independent).
- It also helps to **predict Y** if X is known.
- Equation: **Y = a + bX + e** (a = constant, b = slope, e = error).

Interpretation

- Interpretation = explaining the meaning of results.
- It means drawing conclusions from the analysis, in a **clear, logical, and simple way**.
- Should also link with valid references or research background.

Types of Data Analysis

1. **Univariate Data Analysis**
    - "Uni" = one → only one variable.
    - Example: heights of students, salaries of workers.
    - Can be numerical (height, weight) or categorical (eye color).
    - Tools: graphs, averages, dispersion, z-test, t-test.
2. **Bivariate Data Analysis**
    - "Bi" = two → data about two variables at the same time.
    - Example: Height & Weight of students; Price & Sales of laptops.
    - Can find relationships between them (correlation, regression, Chi-square test).

3. **Multivariate Data Analysis**
    - "Multi" = more than two variables.
    - Example: Studying height, weight, and age together.
    - Used to see how many variables affect or relate with each other.
    - Tools: regression, PCA, MANOVA, factor analysis, cluster analysis, etc.

Difference between Univariate, Bivariate and Multivariate data

Lets see a tabular difference between each of them for better understanding.

Univariate	Bivariate	Multivariate
It summarizes a single variable.	It summarizes two variables.	It summarizes more than two variables.
Does not deal with causes or relationships.	Deals with relationships between two variables.	Analyzes complex relationships between multiple variables.
Does not contain any dependent variable.	Contains one dependent variable.	Contains multiple dependent variables.
The main purpose is to	The main purpose is to explain	The main purpose is to study the

Example: Height of students in a class.	Example: Temperature and ice cream sales in summer.	Example: Comparison of click rates for advertisements across different genders.

21st,22,23 Class

1. Meaning of Communication

In research, **communication** means sharing the findings of your research with others.
👉 Simply: **Researcher → shares results → audience → gets feedback.**

5 elements of communication:

1. **Communicator (Who?)** – The sender (researcher or report writer).
2. **Message (Says What?)** – The research findings or results.
3. **Medium (In What Way?)** – The method of communication (oral, written, poster).
4. **Audience (To Whom?)** – The people receiving it (managers, decision-makers, researchers, students).
5. **Feedback (With What Effect?)** – The reaction or response from the audience.

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2. Meaning of Research Report

A **Research Report** is a document or presentation that shows the findings of your research to a specific audience for a purpose.
👉 It can be **written** (book/report) or **oral** (presentation).
👉 Purpose: To share results, give recommendations, or help decision-making.

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3. Report Format

A research report has a **proper structure**. The main parts are:

Front Part

1. **Title Page** – Topic, researcher name, institution, date.
2. **Letter of Transmittal** – Letter from researcher → authority (explains purpose of the report).
3. **Letter of Authorization** – Approval letter from authority to conduct the research.
4. **Table of Contents** – List of sections with page numbers.
    - May also include **list of figures/tables**.

Summary Part (Executive Summary)

5. **Summary** (short overview of the whole research)
    - Objectives
    - Results
    - Conclusions
    - Recommendations

Main Body

6. **Body** (Detailed explanation)
    - **Introduction**
        - Background
        - Objectives
        - Significance of study
    - **Methodology** – How data was collected & analyzed.
    - **Results** – Findings of the research.
    - **Limitations** – Weakness or constraints of the study.

- **Conclusions & Recommendations** – Final comments and suggestions.

End Part

7. **Appendix** – Extra details.
    - Data collection forms
    - Calculations
    - Tables
    - References/Bibliography
    - Other supporting materials

Guidelines or Steps of Writing Research Report

A research report is not written in one day. It goes through **many careful steps**:

a) Logical Analysis of the Subject Matter

- First step: think and plan how you will present the subject.
- Two ways:
    1. **Logical Order** → from simple to complex ideas.
    2. **Chronological Order** → step-by-step in the order of time (what happened first, then next, etc.).

👉 Example: If you write about a new technology, you can explain logically (principles → functions → applications) or chronologically (history → development → current status).

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b) Preparation of the Final Outline

- Outline = **framework** of your report.
- It helps you **organize ideas** and **remember main points**.
  👉 Example: Title → Introduction → Methodology → Results → Conclusion.

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c) Preparation of the Rough Draft

- Start writing **based on your outline**.
- Write everything you did:
  - How you collected data.
  - What problems you faced.
  - What techniques you used to analyze.
  - What you found.

👉 Rough draft = "first version" (don't worry about mistakes yet).

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d) Rewriting and Polishing

- This step takes **most time**.
- Check:
  - Is the report clear, logical, and consistent?
  - Does it have unity (everything connected)?
  - Is grammar, spelling, sentence structure correct?
- Make it **simple, neat, and professional**.

👉 Example: Replace "It seems that…" with direct words like "The result shows that…".

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e) Preparation of the Final Bibliography

- Bibliography = **list of all books, journals, and articles you used**.
- Two parts:
    1. **Books & pamphlets**.
    2. **Journals, magazines, newspapers**.

📌 **Order for Books**:

1. Author (last name first)
2. Title (italic/underlined)
3. Place, Publisher, Year
4. Edition (if any)
   👉 Example:
   Kothari, C.R., Quantitative Techniques, New Delhi, Vikas Publishing House Pvt. Ltd., 1978, 3rd Ed.

📌 **Order for Journals**:

1. Author (last name first)
2. Title of article (in quotation marks)
3. Journal name (italic/underlined)
4. Volume/Number
5. Date
6. Page number
   👉 Example:
   Robert V. Roosa, "Coping with Short-term International Money Flows," The Banker, London, September 1971, p. 995.

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f) Writing the Final Draft

- The final version must be:
    - **Concise** (short and clear).
    - **Objective** (facts, not personal opinion).
    - **Simple language** (avoid jargon and vague words like “maybe” or “it seems”).
    - Include **examples or illustrations** so people can understand easily.
- Must be **interesting, original, and engaging**.

Oral Presentation

- Speaking in front of an audience about your research.
- Used in **classrooms, seminars, workplaces, conferences**.
- Often uses **slides (PowerPoint)** as visual aids.

Purpose:

1. To Educate (teach audience something new).
2. To Inform (give updates, data, results).
3. To Entertain (make it interesting with stories).
4. To Persuade (convince audience to take action).

Key Elements:

1. **Verbal Communication** – Speak clearly, with proper tone & volume.

2. **Content** – Only relevant & well-researched info.
3. **Audience Engagement** – Ask questions, maintain eye contact.
4. **Visual Aids** – Slides, charts, graphs (support, not replace speech).
5. **Structure** – Clear beginning, middle, and end.
6. **Time Management** – Finish within allotted time.
7. **Practice** – Rehearse before presenting.

👉 **Forms:** Academic (seminars), Professional (meetings), General public speaking.

Poster Presentation

- A **visual display** of research (large chart/poster).
- Common in **conferences, exhibitions**.
- Allows one-on-one discussion with viewers.

Poster Components:

a) **Title** (big and clear).
b) **Authors & Affiliations** (who did it, where).
c) **Introduction/Background** (context).
d) **Objectives** (what you wanted to find).
e) **Methods** (how you researched).
f) **Results** (key findings with graphs/pictures).
g) **Conclusions/Discussion** (what the findings mean).

Referencing

- Giving credit to the sources you used.

- 4 systems (Butcher, 1981):

1. Short-title system (common in books).
2. Author–date system (science, social science).
3. Number system.
4. Author–number system.

👉 Use the system required by your university.

Bibliography Styles

Common styles:

1. Harvard
2. APA (American Psychological Association)
3. AMA (American Medical Association)
4. McGraw-Hill
5. MLA (Modern Language Association)
6. Footnote system

References vs. Bibliography

- **References** = Only the sources you **directly cited** in your text.
- **Bibliography** = All sources you **consulted**, even if not cited.

📌 Differences:

- References = selective, focused.
- Bibliography = broad, background reading.

How to Write a Research Title

- Should be:
    - **Concise** (short, under 16 words).
    - **Clear & Informative**.
    - **Specific** (reflects exact content).
    - **Contains Keywords**.
    - **No jargon or abbreviations**.
    - **No period (.) at the end**.

👉 Example:
❌ Bad title: “A Study of Something Interesting in Technology”
✅ Good title: “Machine Learning Approaches for Early Disease Detection”

Point of Difference	References	Bibliography
Meaning	List of sources directly cited in the text.	List of all sources consulted (cited + not cited).
Cited vs. Consulted	Only cited works.	All consulted works.
Purpose	To give evidence for specific points in the text.	To show background reading and extra sources.
Scope	Narrow and focused.	Broad and comprehensive.
Use	Common in APA, Harvard style.	Common in Chicago, MLA style.
Placement	Comes at the end of the document.	Also placed at the end of the document.
Reader's Help	Helps readers verify claims.	Helps readers explore further readings.
Content	Books, articles, or materials directly quoted/paraphrased.	Includes everything read, even if not quoted.
Nature	Mandatory for academic writing.	Optional, depends on style/teacher requirement.