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UNIT II

Research Methodology

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UNIT II

Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.



RESEARCH FORMULATION



What is Research Formulation?

Research formulation is the process of clearly defining and structuring a research problem. It involves narrowing down a broad topic into a specific, manageable, and researchable problem statement that guides the entire study.



Steps in Research Formulation:

Identify a broad area of interest

► Example: Online learning

Review existing literature

► Understand what's already known and where the gaps are

Narrow down to a specific issue or gap

► Example: Lack of motivation among students in online classes

Define the research problem clearly

► Example: “Why do undergraduate students show low motivation during online learning sessions?”



Set clear objectives or research questions

► Example:

What factors affect student motivation in online classes?

Does teacher interaction improve motivation?

Formulate a hypothesis (if applicable)

► Example: “Increased teacher-student interaction improves online learning motivation.”



DEFINING THE RESEARCH PROBLEM



Defining the Research Problem

In research process, the first and foremost step happens to be that of selecting and properly defining a research problem.

The researcher should define the problem **clearly and specifically** so that it can be **investigated or studied effectively**.

Like a medical doctor, a researcher must examine all the symptoms (presented to him or observed by him) concerning a problem before he can diagnose correctly. To define a problem correctly, a researcher must know: what a problem is?



Problem Owner (I):

Zomato – A leading food delivery company in India

Environment (N):

Post-COVID urban economy, where consumer behavior has shifted dramatically

Uncontrolled Variables (Y_j):

Rising food prices

Changing customer eating habits

Government restrictions on late-night delivery

Fuel price fluctuations

Increase in home cooking trends

Resulting Research Problem:

"How can Zomato optimize its delivery strategy to retain customers amid rising food costs and changes in post-COVID consumer behavior?"



(ii) There Must Be Multiple Courses of Action (C₁, C₂, ...)

The problem must involve at least two possible actions or strategies that can be taken.

Each course of action (C_j) is based on one or more controlled variables, which are factors the decision-maker can change.

Example: C₁ = launching a product in January; C₂ = launching it in March.
The launch time is a controlled variable.

Which launch time will yield better sales and brand visibility?"

Company: Flipkart

Decision Point:

C₁ = Launch a mega sale in July

C₂ = Launch it in October (during festive season)

Research Question:

Which timing will result in higher customer engagement and revenue, considering consumer behavior and competition?



(iii) There Must Be Different Outcomes (O₁, O₂, ...)

Each course of action should lead to at least two possible outcomes.

One outcome must be more desirable or preferable than the other(s), representing the researcher's objective.

Example:

O₁ = high sales (preferred)

O₂ = low sales

The researcher wants to identify which action is more likely to achieve O₁.

Company: Amazon

Situation: Choosing between two packaging options for faster delivery.

C₁ = Use eco-friendly packaging (takes slightly longer to pack)

C₂ = Use regular packaging (faster packing)

Possible Outcomes:

O₁ = Improved customer satisfaction due to eco-awareness (preferred)

O₂ = Customer complaints due to delayed delivery

Research Question:

Which packaging method results in better overall customer satisfaction?



(iv) Outcomes Must Have Different Probabilities

Each course of action must have a different likelihood of achieving the desired outcome.

In other words, if all options lead to the same result, there's no real “problem” to investigate.

This is represented by:

$$P(O_1 | I, C_1, N) \neq P(O_1 | I, C_2, N)$$

Where:

- $P(O_j | I, C_j, N)$: Probability that outcome O_j will happen when individual I chooses action C_j in environment N .



Example:

Scenario: A college wants to improve student attendance.

Courses of Action:

C1 = Send attendance reminders via email

C2 = Send attendance reminders via WhatsApp

Desired Outcome:

O1 = Higher student attendance (preferred)

Measured Probabilities (based on past data or pilot testing):

- $P(O_1 | I, C_1, N) = 0.45$ (Email reminders)
- $P(O_1 | I, C_2, N) = 0.75$ (WhatsApp reminders)

These values are not equal, so a research problem exists:

"Which communication method is more effective in improving student attendance?"



Over and above these conditions, the individual or the organisation can be said to have the problem only if 'I' does not know what course of action is best, i.e., 'I', must be in doubt about the solution.

Thus, an individual or a group of persons can be said to have a problem which can be technically described as a research problem, if they (individual or the group), having one or more desired outcomes, are confronted with two or more courses of action that have some but not equal efficiency for the desired objective(s) and are in doubt about which course of action is best.



Thus, state the components of a research problem as under:

- (i) There must be an individual or a group which has some difficulty or the problem.
- (ii) There must be some objective(s) to be attained at. If one wants nothing, one cannot have a problem.
- (iii) There must be alternative means (or the courses of action) for obtaining the objective(s) one wishes to attain. This means that there must be at least two means available to a researcher for if he has no choice of means, he cannot have a problem.
- (iv) There must remain some doubt in the mind of a researcher with regard to the selection of alternatives. This means that research must answer the question concerning the relative efficiency of the possible alternatives.
- (v) There must be some environment(s) to which the difficulty pertains.



Thus, a research problem is one which requires a researcher to find out the best solution for the given problem.

to find out by which course of action the objective can be attained optimally in the context of a given environment.



SELECTING THE PROBLEM



SELECTING THE PROBLEM

- Selecting a research problem is a critical and challenging task,
- Guidance from a research supervisor can be helpful, the ultimate responsibility lies with the researcher.
- A researcher must actively engage in identifying a problem that genuinely interests and motivates
- A guide can assist in shaping or refining the topic, but the core idea must come from the researcher themselves.

The following points may be observed by a researcher in selecting a research problem or a subject for research:

- (i) Subject which is overdone should not be normally chosen, for it will be a difficult task to throw any new light in such a case.
- (ii) Controversial subject should not become the choice of an average researcher
- (iii) Too narrow or too vague problems should be avoided.



- The subject selected for research should be **familiar and feasible** so that the related **research material or sources of research** are within one's reach. Even then it is quite difficult to supply definitive ideas concerning how a researcher should obtain ideas for his research. For this purpose, a researcher should contact an **expert or a professor** in the University who is already engaged in research. He may as **well-read articles published in current literature** available on the subject and may think how the techniques and ideas discussed therein might be applied to the solution of other problems. He may discuss with others what he has in **mind concerning a problem**. In this way he should make all possible efforts in selecting a problem.



- The importance of **the subject, the qualifications and the training** of a researcher, the costs involved, the time factor are few other criteria that must also be considered in selecting a problem.

In other words, before the final selection of a problem is done, a researcher must ask himself the following questions:

- (a) Whether he is well equipped in terms of his background to carry out the research?
- (b) Whether the study falls within the budget he can afford?
- (c) Whether the necessary cooperation can be obtained from those who must participate in research as subjects?

If the answers to all these questions are in the affirmative, one may become sure so far as the practicability of the study is concerned.



Before choosing a research problem, it is important to do an initial or **background study** to understand the topic better.

This may not be needed if you're **working on a problem** that is **very similar** to one already researched and where methods are already established.

However, if the topic is new and lacks clear methods or tools, then a small preliminary study (called a feasibility study) is essential to see if the research is practical and manageable.

Subject for research is selected properly by observing the above mentioned points



NECESSITY OF DEFINING THE PROBLEM



NECESSITY OF DEFINING THE PROBLEM

Quite often we all hear that a **problem clearly stated** is a **problem half solved**.

This statement signifies the **need for defining a research problem**.

The problem to be investigated must be defined **unambiguously** for that will help to discriminate relevant data from the irrelevant ones.

A proper definition of research problem will enable the researcher to be on the track whereas an ill-defined problem may create hurdles.

Questions like:

What data are to be collected?

What characteristics of data are relevant and need to be studied?



What relations are to be explored.

What techniques are to be used for the purpose?

and similar other questions crop up in the mind of the researcher who can well plan his strategy and find **answers to all such questions** only when the research problem has been well defined.

Thus, defining a research problem properly is a prerequisite for any study and is a step of the highest importance.

In fact, formulation of a problem is often more essential than its solution.

It is only on careful detailing the research problem that we can work out the research design and can smoothly carry on all the consequential steps involved while doing research.



IMPORTANCE OF LITERATURE REVIEW IN DEFINING A PROBLEM



IMPORTANCE OF LITERATURE REVIEW IN DEFINING A PROBLEM

A new research depends on the past knowledge, and not includes a part of knowledge.

A literature review is an account of what has been published in books, journals and internet on a topic by accredited scholars and researchers.

In general, the literature review should:

- ✓ Literature review is most important to identify the **problem of the study**. It can be solved by collection of data. It is very important to know that the work is doing by researcher in a research **should not be repeated again** (or if it is repeated, that it is marked as a "replication study").
- ✓ It also helps to **avoid the mistakes**, which already done by another one.



- ✓ New research depends on **past knowledge**, but it does not merely repeat or copy it—it builds upon it to **generate new understanding**.
- ✓ It verifies that it has not been already done (outline gaps in previous research).
- ✓ Literature review is important to judge research question and to provide latest research material for the readers.
- ✓ Help refine, refocus or even change the topic



Why is a literature review necessary?

The literature review performs a number of important functions:

- ✓ It demonstrates to a Ph.D. committee that the student has **read a large amount of statistical literature** to prove that the student is **aware of the wide range of research in theory and methodology** related to the proposed research topic.
- ✓ It provides proof to a Ph.D. committee that the student has a **deep understanding of the published statistical research related to the topic** of the dissertation.
- ✓ It should convince the Ph.D. committee that the student can communicate this understanding of the statistical literature and its relationship to the proposed research.



- ✓ It should support the **originality and relevance** for the Ph. D. research problem.
 - i. This is done by **identifying specific gaps** in the statistical literature. That is, the student identifies statistical questions that have not been answered and problems that have not been solved.
 - ii. By identifying gaps in the statistical literature, the student can justify the **originality of the proposed dissertation research**. The originality can be an extension of research that has been published or a modification of existing methodology or theory that can be used to perform the Ph.D. research.



- ✓ In the proposal the student **emphasizes or stresses the originality** of the dissertation. **Without a good literature review**, the student cannot convince the committee that that the proposed research is original.
- ✓ A dissertation may be **unacceptable** because the Ph. D. student does not clearly show that the research problem is original due to a poor literature review.
- ✓ Remember: the Literature Review is more **summary of publications**. It provides evidence that your research will be an original and relevant contribution than a to statistics.



LITERATURE REVIEW



Literature Survey:

After defining a problem, the researcher has to do literature survey connected with the problem.

Literature survey is a collection of research publications, books and other documents related to the defined problem.

It is very essential to know whether the defined problem has already been solved, status of the problem, techniques that are useful to investigate the problem and other related details.



One can survey

- ✓ The journals which publish abstracts of papers published in various journals,
- ✓ Review articles related to the topic chosen,
- ✓ Journals which publish research articles,
- ✓ Advanced level books on the chosen topic,
- ✓ Proceedings of conferences, workshops, etc., reprint/preprint
- ✓ collections available with the supervisor and nearby experts working on the topic chosen and Internet.

[A free e-print service provider for physics, mathematics, nonlinear science, computer science and biology is <http://www.arXiv.org>]



- ✓ Other sources are the Education Index and the Educational Resources information centers (ERIC).
- ✓ Computer-assisted searchers of literature have become very common today.
- ✓ They have the advantage of comprehensiveness and speed.
- ✓ They are also very cost-effective in terms of time and effort although access to some of the databases requires payment.
- ✓ Irrespective of the sources of the literature, ethics of research require that the source is acknowledged through a clear system of referencing.



PRIMARY AND SECONDARY SOURCES



PRIMARY AND SECONDARY SOURCES

For some research projects you may be required to use primary sources.

How can you identify these?

Primary sources are the surviving original records of a period, eyewitness accounts and **first published documentation of new information.**



Primary Sources :

- ✓ A primary source provides direct **or firsthand evidence** about an event, object, person, or work of art.
- ✓ Primary sources include historical and legal documents, eyewitness accounts, and results of experiments, statistical data, pieces of creative writing, audio and video recordings, speeches, and art objects.
- ✓ Interviews, surveys, fieldwork, and Internet communications via email, blogs, listservs, and newsgroups are also primary sources.
- ✓ In the natural and social sciences, primary sources are often empirical studies—research where an experiment was performed or a direct observation was made.
- ✓ The results of empirical studies are typically found in scholarly articles or papers delivered at conferences.



Secondary Sources

- ✓ A **secondary source** is a document or recording that **interprets, analyzes, or comments on** information originally presented elsewhere.
- ✓ It is second-hand information.
- ✓ It is not original research or firsthand evidence, but it is based on or about primary sources.
- ✓ It is created after the fact, often by someone who was not directly involved in the event or original research.



- ✓ Secondary source materials can be articles in newspapers or popular magazines, book or movie reviews, Web pages or articles found in scholarly journals that discuss or evaluate someone else's original research.



REVIEWS



What are Reviews in Research?

- ✓ Reviews are critical evaluations of existing published research.
- ✓ They do not produce new data but help in understanding what is already known in a research area.

Importance of Reviews:

Summarize existing research

Identify trends, gaps, and inconsistencies

Help researchers form new questions or hypotheses

Guide future research and practice



TREATISES



Treatises:

A **treatise** is a **comprehensive and authoritative written work** that discusses a specific subject in great depth.

- In-depth exploration: Covers a subject thoroughly, often from all angles (historical, theoretical, practical).
- Often multi-volume: Some treatises are published in multiple volumes due to their detailed nature.
- Expert authorship: Usually written by scholars or specialists with deep knowledge of the subject.
- Formal structure: Organized systematically with chapters, subtopics, references, and indexes.



Importance of Treatises:

Provide foundational knowledge: Great for understanding the background and theory behind a topic.

Used in research and academics: Help researchers, students, and professionals gain deep insights.

Cited in legal and scholarly work: Especially valuable in disciplines like law, philosophy, science, and history.



MONOGRAPHS



What is a Monograph?

A **monograph** is a **detailed, scholarly work** that focuses on a **single specialized subject or aspect of a subject**, often written by a single author.

Characteristics:

- ✓ In-depth exploration of one specific topic
- ✓ Written by experts or researchers
- ✓ Can be single-volume or multi-volume
- ✓ Focused scope—unlike textbooks, monographs do not cover broad topics
- ✓ May include original research, data, and theoretical analysis



Importance of Monographs:

- ✓ Provide a deep understanding of a subject
- ✓ Serve as a solid academic resource for advanced studies or research
- ✓ Help in developing theoretical foundations
- ✓ Often used in literature reviews to support background research



PATENT



What is a Patent?

A **patent** is a **legal document** granted by a government that gives an inventor the **exclusive right** to make, use, sell, or license an invention for a certain period (usually 20 years)

Characteristics:

- ✓ Legal Protection for inventions (processes, machines, devices, compositions, etc.)
- ✓ Issued by patent offices (e.g., USPTO, Indian Patent Office)
- ✓ Time-limited (typically 20 years from the filing date)
- ✓ Based on novelty, usefulness, and non-obviousness
- ✓ Contains technical drawings, claims, and descriptions of how the invention works



Importance in Research:

- **Shows innovation and originality**
- Acts as a **primary source** — contains **firsthand technical information**
- Used in **literature review** to:
 - Identify existing inventions
 - Avoid duplication
 - Understand current trends in technology



WEB AS A SOURCE & SEARCHING OF WEB



THE WEB AS A SOURCE FOR LITERATURE REVIEW—"HARNESSING THE WEB FOR RESEARCH"

The **Web** (World Wide Web) is a vast digital platform containing information from diverse domains—published by individuals, organizations, academic institutions, governments, and more.

Types of web sources:

- Academic databases (e.g., JSTOR, ScienceDirect)
- Open access journals
- Institutional repositories
- Preprint servers (e.g., arXiv)
- Government websites
- Professional organizations



1. Academic Databases

Examples: JSTOR, ScienceDirect, SpringerLink, IEEE Xplore

Use: Provide access to peer-reviewed journal articles, books, and conference papers.

Credibility: Very high — scholarly and subscription-based.

2. Open Access Journals

Examples: DOAJ (Directory of Open Access Journals), PLOS ONE, BioMed Central

Use: Free-to-read journals that publish peer-reviewed research.

Benefit: No paywall — accessible to all researchers and students.

3. Institutional Repositories

Examples: University digital libraries, Shodhganga (India), Harvard DASH

Use: Store theses, dissertations, research articles, and reports by affiliated scholars.

Content: Often includes unpublished or in-progress academic work.



4. Preprint Servers

Examples: arXiv (physics, math, CS), bioRxiv (biology), SSRN (social sciences)

Use: Share research papers before peer review.

Note: Good for current trends, but not peer-reviewed yet.

5. Government Websites

Examples: india.gov.in, census.gov, who.int, data.gov.in

Use: Provide official data, statistics, policies, and public reports.

Credibility: High — factual and current (but check for bias or political framing).

6. Professional Organizations

Examples: ACM (Association for Computing Machinery), AMA (American Medical Association), IEEE(Institute of Electrical and Electronics Engineers)

Use: Publish white papers, research guidelines, industry standards, and professional updates.

Benefit: Trusted sources for both practitioners and researchers.



Advantages:

Accessibility and Speed

- Information is available 24/7 from anywhere in the world.
- Quick access to data, articles, and opinions.

Wide Range of Perspectives

- Content from diverse authors: professionals, academics, citizens, institutions.
- Allows comparison of views and global understanding.

Up-to-Date Information

- Real-time updates on current events, scientific breakthroughs, and trends.
- Ideal for topics that change rapidly (e.g., technology, health, politics).



Challenges:

Quality Control

- Not all websites go through peer review or editorial screening.
- Risk of encountering false, outdated, or misleading information.

Information Overload

- Huge volume of content can make it hard to filter useful data.
- Time-consuming to verify and select reliable sources.

Potential Bias

- Some sources may have political, commercial, or personal agendas.
- Need to evaluate the objectivity and purpose of the source.



EFFECTIVE WEB SEARCH STRATEGIES

- Use of Boolean operators (AND, OR, NOT)
- Phrase searching with quotation marks
- Wildcard and truncation symbols (* and ?)
- Advanced search features:
 - Site-specific searches (site:edu)
 - File type specification (filetype:pdf)
- Utilizing search filters:
 - Date range
 - Language
 - Geographic region
- Importance of keyword selection and variation



EVALUATING WEB SOURCES

Key evaluation criteria:

- Authority: Who is the author/publisher?
- Accuracy: Is the information supported by evidence?
- Objectivity: Is there bias?
- Currency: When was it published/updated?
- Coverage: How in-depth is the information?

Red flags:

- Lack of citations • Poor writing quality • Outdated information • Extreme bias

Tools for evaluation:

- Domain analysis (.edu, .gov, etc.) • Cross-referencing with other sources • Checking author credentials



ACADEMIC SEARCH ENGINES AND DATABASES—"SPECIALIZED TOOLS FOR SCHOLARLY RESEARCH"

1. General academic search engines: • Google Scholar • Microsoft Academic
• Semantic Scholar
2. Subject-specific databases: • PubMed (medicine) • IEEE Xplore
(engineering) • ERIC (education)
3. Features to leverage: • Citation tracking • Author profiles • Related article suggestions
4. Access considerations: • Institutional subscriptions • Open access options



ORGANIZING AND MANAGING WEB SOURCES-FROM SEARCH TO SYNTHESIS"

Reference management tools:

- Zotero
- Mendeley
- EndNote

Features:

- Automatic citation capture
- PDF annotation
- Bibliography generation

Organizing strategies:

- Tagging and categorizing sources
- Creating thematic folders
- Maintaining research notes

Best practices:

- Regular backups
- Consistent naming conventions
- Proper attribution and citation



CRITICAL LITERATURE REVIEW



CRITICAL LITERATURE REVIEW

- 1. Purpose of the Review:** Clearly state the goal of the literature review. For example: "The purpose of this review is to synthesize existing research on [specific topic] to identify key themes, trends, and gaps in the literature."
- 2. Significance of the Topic:** Explain why this topic is important within its field. Consider questions like:
 - How does this topic contribute to the broader field of study?
 - Why is it relevant to current research or practical applications?
 - Are there any recent developments or controversies that make this topic particularly significant?



METHODOLOGIES AND APPROACHES

1. Common Research Methods:

List and briefly describe the methodologies commonly used in the literature.

2. Strengths and Weaknesses:

Discuss the strengths and weaknesses of these approaches.

3. Innovative Approaches:

Highlight any innovative methods or approaches found in the literature.



1. Scope:

Time Frame:

Define the period covered by the literature. For example: "This review focuses on research published from 2010 to 2024."

Geographical Location:

Specify if the review targets studies from particular regions or countries. For example: "The literature reviewed is primarily from North America and Europe."

Specific Aspects of the Topic:

Clarify what aspects of the topic are covered and what are excluded. For example: "This review focuses on the social and economic impacts of [specific topic], excluding technical and engineering aspects."



2. Background Information:

1. Context:

Provide a brief background of the topic to set the stage for your review.
Include essential definitions, concepts, or historical context if necessary.

2. Research Questions:

List any research questions or hypotheses guiding the review, if applicable.



3. Visual Aids:

1. Consider including a graphic or diagram that illustrates the context or significance of the topic.
2. Use bullet points to make the slide easy to read and concise.

4. Speaker Notes:

1. Prepare notes that expand on each point for your verbal presentation, ensuring you provide depth and clarity to the audience.



IDENTIFYING GAP AREAS FROM LITERATURE REVIEW



IDENTIFYING GAP AREAS FROM LITERATURE REVIEW

Identifying gaps in the literature is a critical part of conducting a literature review, as it highlights areas that require further research and contributes to advancing the field

Definition of Research Gaps:

It Explains what constitutes a research gap. For example: "A research gap is an area or topic within a field that lacks sufficient or conclusive research and understanding."



1. Importance of Identifying Gaps:

1. Discuss why identifying gaps is crucial for advancing knowledge.

Consider points like:

- Guiding future research directions.**
- Highlighting opportunities for innovation.**
- Addressing overlooked or emerging issues.**

Objective of Gap Analysis:

State the purpose of your gap analysis in the context of the literature review.

For example: "This analysis aims to identify unaddressed areas in the current literature on [specific topic]."



COMMON TYPES OF RESEARCH GAPS

Knowledge Gaps:

1. Areas where information is incomplete or lacking. For example: "Limited understanding of [specific aspect]."

Methodological Gaps:

1. Flaws or limitations in existing research methods. For example: "Reliance on qualitative data without quantitative validation."

Theoretical Gaps:

1. Lack of comprehensive theories or models. For example: "Absence of a unified theory to explain [specific phenomenon]."



Population Gaps:

1. Underrepresentation of certain groups or demographics. For example: "Limited research on [specific group]."

Geographical Gaps:

1. Areas or regions that have been under-researched. For example: "Most studies focus on Western countries, neglecting Asia and Africa."



IDENTIFIED GAPS IN CURRENT LITERATURE

Summary of Key Gaps:

1. List specific gaps identified in your literature review. Use bullet points for clarity.

Example:

1. Lack of longitudinal studies on the long-term effects of [specific intervention].
2. Insufficient data on the impact of [topic] in developing countries.
3. Need for interdisciplinary approaches to studying [specific issue].

Visual Representation:

1. Include a chart or diagram highlighting where gaps are most prominent within the existing body of literature.



DEVELOPMENT OF WORKING HYPOTHESIS



DEVELOPMENT OF WORKING HYPOTHESIS.

Definition of a Working Hypothesis:

1. Explain what a working hypothesis is. For example: "A working hypothesis is a testable statement that predicts a possible outcome or explains a phenomenon based on existing knowledge."

Purpose and Importance:

Describe why a working hypothesis is essential in research:

1. Guides the research process by providing a clear focus.
2. Helps in formulating research questions and designing experiments.
3. Facilitates the interpretation of results



Characteristics of a Good Hypothesis:

State the key characteristics:

- 1. Testable:** Can be empirically tested using experiments or observations.
- 2. Specific:** Clearly defined and focused.
- 3. Falsifiable:** Can be proven false through evidence.



DEVELOPING A WORKING HYPOTHESIS

Step 1: Conduct a Literature Review:

1. Briefly explain the importance of reviewing existing literature to identify gaps and gather background information.

Step 2: Identify Key Variables:

1. Define the variables involved in the research. For example: "In a study on the effects of sleep on cognitive performance, the key variables might be sleep duration (independent variable) and test scores (dependent variable)."



Step 3: Formulate the Hypothesis:

1. Discuss how to articulate the hypothesis based on the literature review and identified variables.
2. Example of Hypothesis Structure: "If [independent variable], then [dependent variable], because [rationale based on literature]."



TYPES OF HYPOTHESES

Null Hypothesis (H₀):

1. Definition: A statement that there is no effect or no difference.
2. Example: "There is no significant difference in test scores between students who sleep 8 hours and those who sleep 6 hours."

Alternative Hypothesis (H₁):

1. Definition: A statement that indicates the presence of an effect or difference.
2. Example: "Students who sleep 8 hours score significantly higher on tests than those who sleep 6 hours."



Directional vs. Non-directional Hypotheses:

- 1. Directional Hypothesis:** Predicts the direction of the effect. Example: "Increased sleep leads to higher test scores."
- 2. Non-directional Hypothesis:** Predicts an effect but not the direction. Example: "There is a difference in test scores based on sleep duration."



TESTING AND REFINING THE HYPOTHESIS

Designing Experiments:

1. Explain how to design experiments or studies to test the hypothesis, focusing on method and data collection.

Data Analysis:

1. Discuss how to analyze data to evaluate the hypothesis using statistical methods.

Refinement:

1. Mention the importance of refining the hypothesis based on preliminary results or additional findings.

Example Case Study:

1. Provide a brief example of a research study where a working hypothesis was developed, tested, and refined.



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