

Lecture 1: Scientific Research Methods and Types

What is Research?

Research is a careful and organized way of asking questions and looking for answers. It is not just guessing it is a **systematic process** that follows rules to make sure the results are reliable.

The American sociologist **Earl Robert Babbie** defines research as “a systematic inquiry to describe, explain, predict, and control the observed phenomenon.”

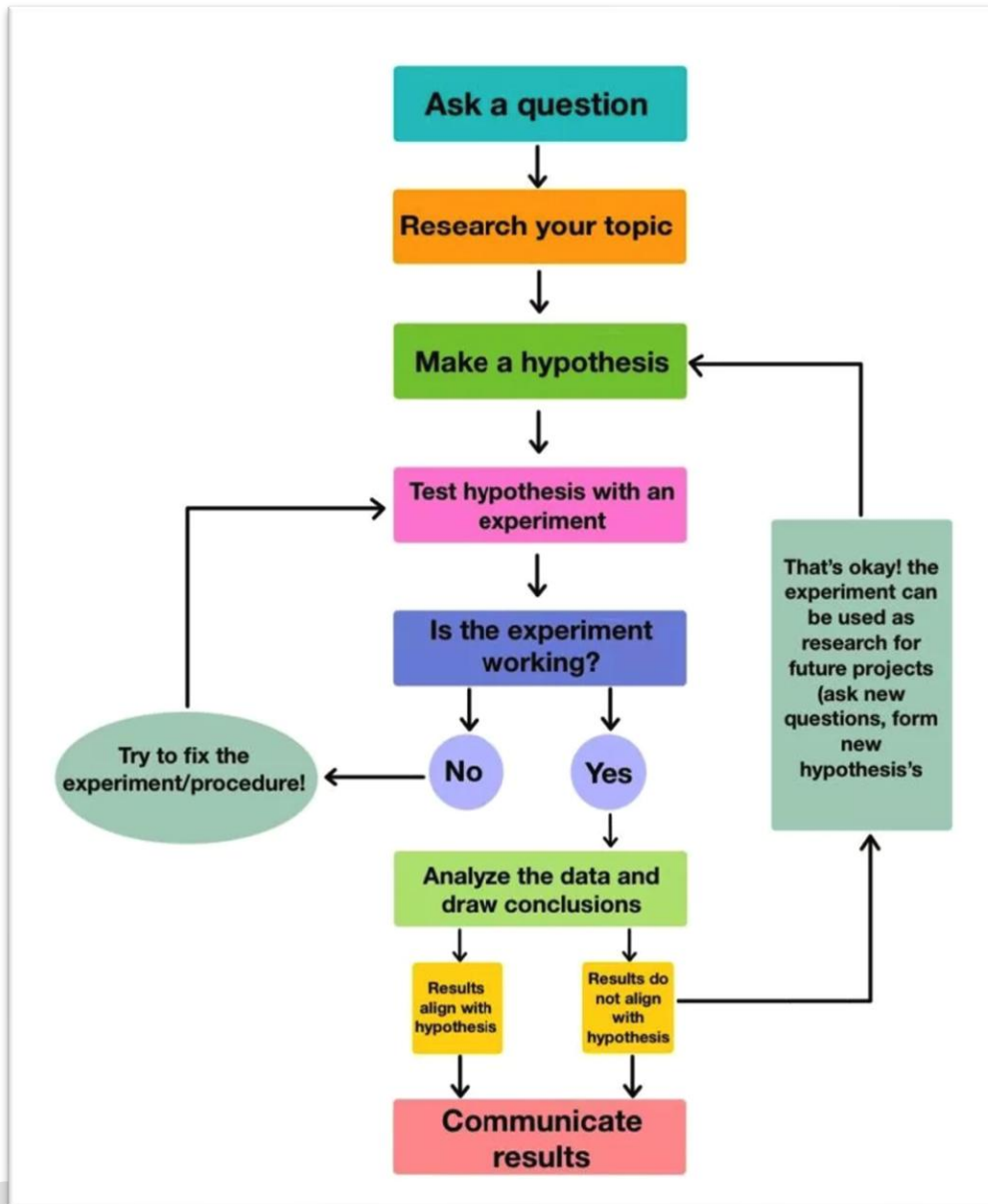
In simple words: research helps us understand **what is happening, why it is happening, and what might happen in the future.**

The Research Cycle

The research process often follows a cycle of steps:

1. **Observation** – noticing something in the world.
2. **Question** – asking why or how it happens.
3. **Hypothesis** – making an educated guess.
4. **Experiment/Study** – testing the guess.
5. **Analysis** – looking at the results.
6. **Conclusion** – deciding what the results mean.
7. **Sharing Knowledge** – publishing or teaching others.





Then the cycle may start again with a new question.

Example:

- Observation: Plants near factories grow poorly.
- Question: Does factory smoke affect plant growth?
- Hypothesis: Plants exposed to smoke grow less than those in clean air.
- Experiment: Grow plants in smoke-exposed and clean environments.
- Analysis: Measure plant height and leaf color.
- Conclusion: Smoke slows plant growth.
- Sharing: Publish results in an environmental science journal.

Two Major Research Approaches

1. Quantitative Research

This type of research is about **numbers and measurement**. It is used when we want to count, compare, or calculate.

- **Aim:** To measure and explain “how much,” “how many,” or “how often.”
- **Tools:** Surveys, experiments, standardized tests, statistical analysis.
- **Data:** Numbers, percentages, charts, graphs.
- **Sample:** Large groups, often randomly chosen.
- **Nature:** Objective (not influenced by personal opinions).

Examples:

- Medicine: Testing if a new drug lowers blood pressure by measuring the blood pressure of 200 patients.
- Education: Comparing exam scores of students taught with two different methods.
- Engineering: Measuring how much weight different types of steel can hold before breaking.

2. Qualitative Research

This type of research is about **understanding experiences and meanings**. It looks at the *quality* of something, not the quantity.

- **Aim:** To describe and interpret people’s thoughts, feelings, and experiences.
- **Tools:** Interviews, focus groups, open-ended surveys, observations.
- **Data:** Words, stories, pictures, videos.
- **Sample:** Small groups, often chosen for their special experience.
- **Nature:** Subjective (interpretation is important).

Examples:

- Medicine: Interviewing patients about how they feel after surgery.
- Education: Observing how children behave in classrooms and describing their learning process.
- Sociology: Studying how families cope after natural disasters by recording their stories.

Comparing Quantitative and Qualitative

Feature	Quantitative	Qualitative
Aim	Count, measure, explain	Understand, describe, interpret
Purpose	Prediction, generalization	Contextualization, deep insight
Data Form	Numbers, statistics	Words, images, objects
Sample Size	Large, randomly chosen	Small, purposeful selection
Researcher Role	Uses tools to collect data	Researcher is main instrument
Analysis	Statistical, mathematical	Interpretive, thematic

Mixed Methods

In many cases, researchers use **both approaches together**. This is called **mixed methods research**. It combines the strengths of both.

Example:

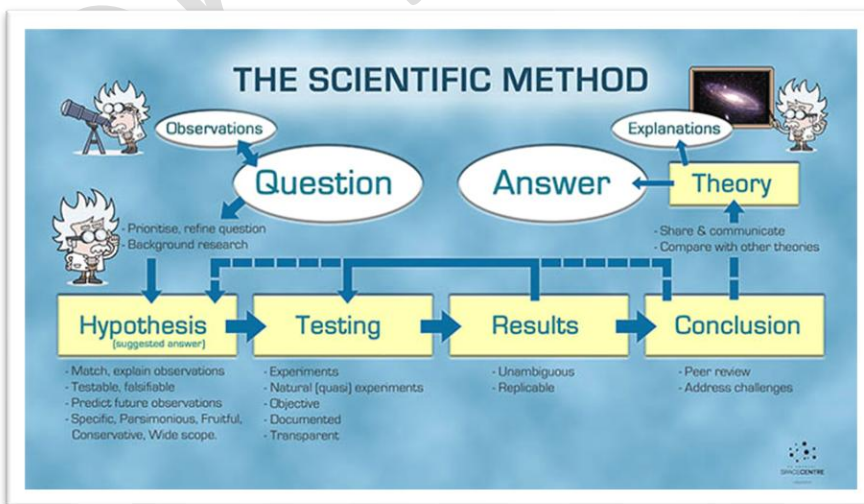
Studying **the impact of online learning** on university students:

- **Quantitative:** Survey 500 students and analyze their exam scores.
- **Qualitative:** Interview 20 students to understand their personal challenges and feelings.

By combining both, the researcher gets a clearer and more complete picture.

The Importance of the Scientific Method

The scientific method is what makes research trustworthy. It avoids guessing, superstition, or personal bias. By repeating tests and sharing results, scientists can confirm what is true and build knowledge step by step.



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Lecture 2: Asking Questions and Creating a Hypothesis

The **scientific method** always begins with curiosity. Scientists, doctors, and even ordinary people notice things around them and start to wonder: *Why did this happen?* or *How does this work?*

To turn curiosity into research, we need to follow three main steps:

1. Ask a clear question.
2. Collect background information.
3. Create a hypothesis (a possible answer).

Step 1: Make an Observation or Ask a Question

The first step in research is **noticing something**. This can happen anywhere: at home, in school, in a hospital, in nature, or in a laboratory.

After noticing, we turn the observation into a **question**.

A good scientific question should be:

- Clear (not confusing).
- Focused (about one idea).
- Answerable (you can test it in real life).

Examples of Questions in Different Fields:

- *Medicine*: Why do some people get side effects from a drug while others don't?
- *Biology*: Do plants grow faster in sunlight or in shade?
- *Education*: Does extra reading practice improve children's spelling?
- *Engineering*: Does using recycled plastic make road surfaces stronger?

COVID-19 Example: Scientists noticed that some reports said hydroxychloroquine increased heart rate. From this, they asked: *Does hydroxychloroquine really affect the heart, and if yes, how?*

Step 2: Gather Background Information

Before guessing an answer, we must **learn what others already know**. This is called reviewing the literature or collecting background information.

Researchers usually look at:

- Books and textbooks.
- Scientific journals and articles.

- Trusted websites (like WHO or CDC for health).
- Previous experiments and reports.

This step is important because it helps to:

- Avoid repeating the same research.
- Find what is missing (the knowledge gap).
- Build a strong base for your own research.

Example: If you want to study whether coffee improves memory, you should first check:

- Have other scientists studied this before?
 - What were their results?
 - Did they agree or disagree?
- This will help you design your own study.

Step 3: Create a Hypothesis

A **hypothesis** is a smart guess or prediction. It is not just any guess—it is based on facts and what you learned from background information.

A good hypothesis must be:

- **Specific** → Focused on one thing.
- **Testable** → You can check it with an experiment or study.
- **Connected** → Directly related to your question.

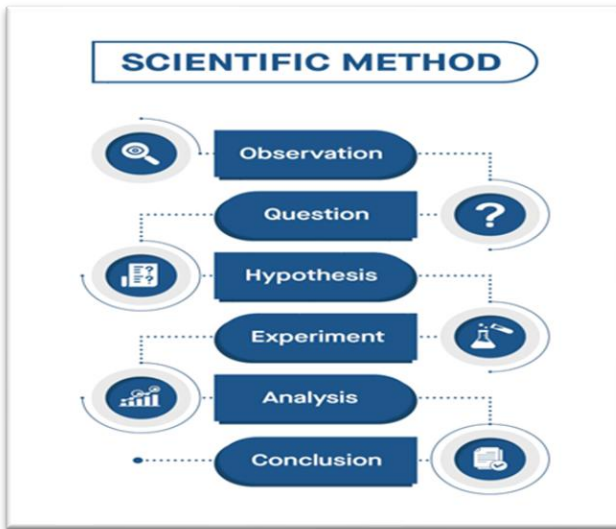
Examples of Hypotheses:

- *Medicine*: “People who walk for 30 minutes every day will have lower blood pressure than those who do not exercise.”
- *Biology*: “Tomato plants given fertilizer will grow taller than those without fertilizer.”
- *Psychology*: “Listening to calm music during study will improve memory recall.”
- *Environmental Science*: “Water collected near factories will have more heavy metals than water collected far away.”

COVID-19 Example Again: After reading background information, scientists could say: “Hydroxychloroquine increases certain chemical levels in the blood and heart tissue of mice.”

Why is a Hypothesis Important?

- It guides the research. Without a hypothesis, experiments are random.
- It makes the research focused and clear.
- It allows scientists to compare their results with expectations.
- If the hypothesis is wrong, that is still useful because it gives new knowledge.



References:

- Babbie, E. (2010) *The Practice of Social Research*. 12th ed. Belmont, CA: Wadsworth Cengage Learning.
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- McLeod, S.A. (2019) 'Hypothesis definition and examples', *Simply Psychology*. Available at: <https://www.simplypsychology.org> (Accessed: 10 September 2025)

Lecture 3: Designing and Applying an Experiment

Once we have a hypothesis, the next step in the scientific method is to **test it through experiments**. This is where ideas are checked against evidence. Good experimental design makes the difference between strong, reliable results and weak, uncertain ones.

Step 4: Create a Prediction and Design the Experiment

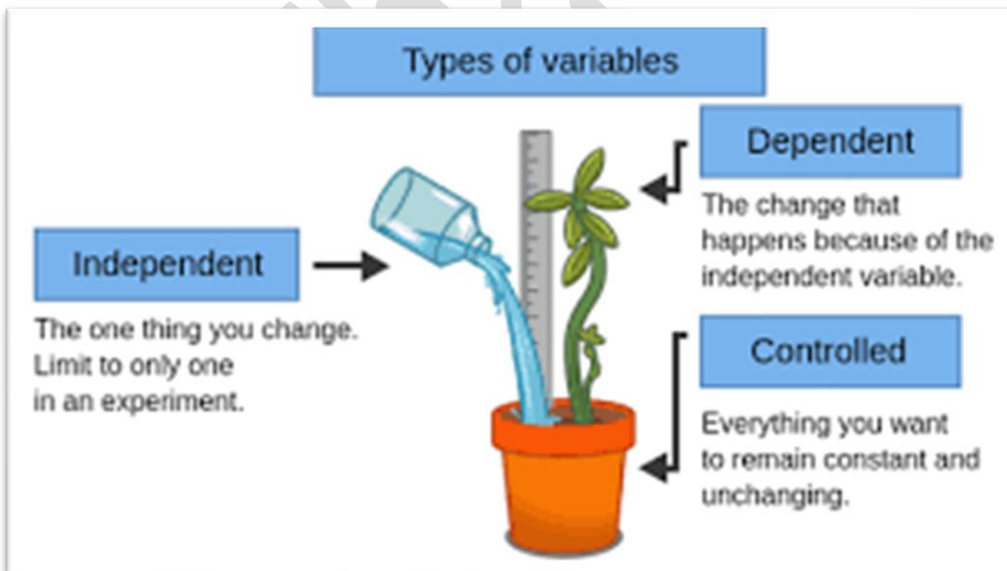
A **prediction** is what we think will happen if the hypothesis is correct.

- Example: If the hypothesis is “*Fertilizer makes tomato plants grow taller,*” the prediction could be “*Tomato plants with fertilizer will grow at least 20% taller than those without fertilizer after 6 weeks.*”

An **experiment** is a structured test of the hypothesis. In experiments, we work with **variables**:

- **Independent variable** → the factor we change (e.g., amount of fertilizer).
- **Dependent variable** → the factor we measure (e.g., plant height).
- **Controlled variables** → factors we keep the same so they don't affect results (e.g., soil type, sunlight, water).

A good experiment must be designed so that **only one variable changes at a time**.



Scientific Example: In medical trials, researchers test whether a new drug lowers blood pressure.

- Independent variable: the drug (given or not).
- Dependent variable: blood pressure level.
- Controlled variables: patient age, diet, activity.
- Control group: patients who receive a placebo (no drug).

Steps in Designing an Experiment

Steps in Designing an Experiment (Simplified)

1. Define the Variables

- Decide what you will change → **independent variable**.
- Decide what you will measure → **dependent variable**.
- Example: *Does sunlight affect seed growth?*
 - Independent: hours of sunlight
 - Dependent: seed germination (how many seeds sprout)

2. Think About Extra Factors (Confounding Variables)

- These are outside things that can affect your results.
- Example: In a heart drug study → diet, exercise, or stress can change results.
- Try to reduce or control these factors.

3. Design Treatments and Groups

- Make different groups to test different conditions.
- Always include a **control group** (no treatment) to compare.
- Example: Testing hydroxychloroquine on mice:
 - Group 1 → high dose
 - Group 2 → low dose
 - Group 3 → no drug (control)

4. Assign Subjects to Groups

- Put subjects (people, animals, or plants) into groups **randomly**.
- Random choice avoids unfair results or bias.
- Example: In a drug trial, patients are randomly divided into treatment and control groups.

5. Plan How to Measure Outcomes

- Decide before the experiment how you will measure the results.
- Use tools that are reliable and accurate.

- Example: Use a digital meter to measure blood sugar, not just “observe how energetic the person feels.”

Step 5: Analyze the Results and Draw a Conclusion

After performing the experiment and collecting data, researchers must analyze it.

- **Quantitative data** (numbers) → use statistics, graphs, averages, and significance tests.
- **Qualitative data** (observations, descriptions) → look for patterns and themes.

Example:

If fertilizer-treated plants grew an average of 25 cm while untreated plants grew only 15 cm, statistical analysis can confirm if the difference is meaningful or just due to chance.

The results are then compared with the hypothesis:

- If results support the hypothesis → it may become accepted as scientific knowledge.
- If results do not support it → the hypothesis must be revised or replaced.

Step 6: Share the Conclusion and Ask New Questions

The final step is **communicating results** to the scientific community. This can be through:

- Research papers.
- Presentations.
- Posters and conferences.

Sharing results increases knowledge and allows other scientists to test the findings.

Also, experiments often lead to **new questions**. For example:

- A study on hydroxychloroquine in mice might lead to testing it in humans.
- A study on plants might lead to questions about soil quality or temperature.

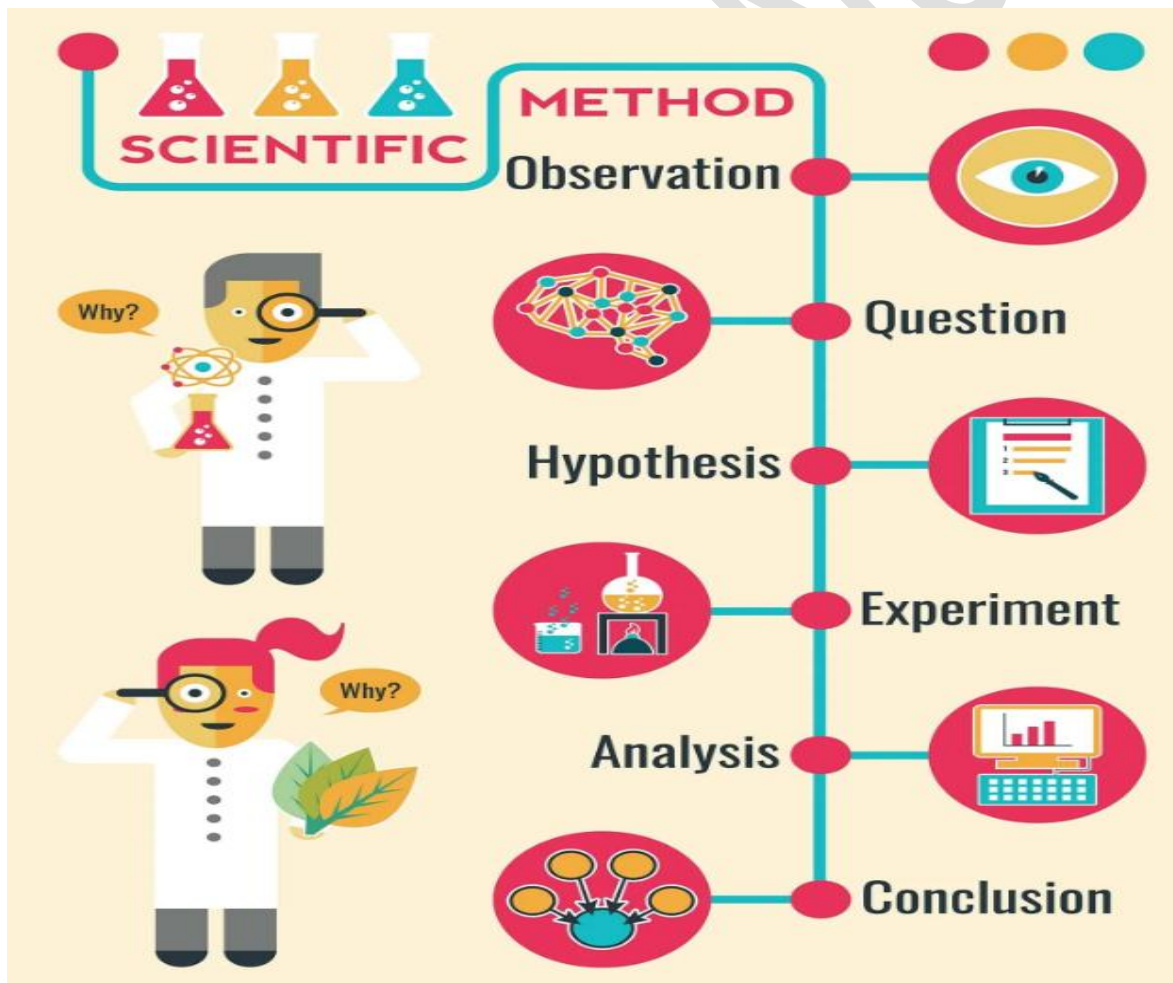
Summary:

1. Create a clear prediction.
2. Design the experiment carefully (variables, groups, measurements).
3. Perform the experiment and collect data.
4. Analyze results with proper methods.
5. Draw conclusions and compare with hypothesis.
6. Share findings and suggest new research questions.

This step is where **science becomes evidence-based**. Good experiments turn ideas into facts.

References:

- Babbie, E. (2010) *The Practice of Social Research*. 12th ed. Belmont, CA: Wadsworth Cengage Learning.
- Creswell, J.W. and Creswell, J.D. (2018) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 5th ed. Thousand Oaks, CA: SAGE Publications.
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Lecture 4: How to Write a Bachelor Work

Your bachelor work is more than just a long essay — it is a scientific project. It shows that you can do research, analyze information, and write clearly.

What Makes a Good Bachelor Work?

1. The content should be original and add something useful to science.
2. The results should be clear and easy to understand.
3. The writing must be simple, logical, and interesting to read.

Tips to Improve Readability

- Have a clear and logical structure.
- Put important information at the beginning of chapters, sections, and paragraphs.
- Avoid writing too much. Be precise and focus on what the reader really needs to know.
- Use short sentences.
- Always check your English.

Abstract

The abstract is a **mini-version** of your whole bachelor work. It should include:

- Background (why you did the study).
- Objective (what you wanted to find out).
- Method (how you did it).
- Results (what you found).
- Conclusion (what it means).

The abstract helps:

- Publishers or examiners decide if the work is relevant.
- Readers see quickly what the paper is about.
- You check if your work is complete.

Example Abstract (Simpler Topic: Sunlight and Plant Growth)

Background: Sunlight is necessary for plants, but too much or too little may affect growth.

Objective: This study aimed to test how different hours of sunlight affect seed germination.

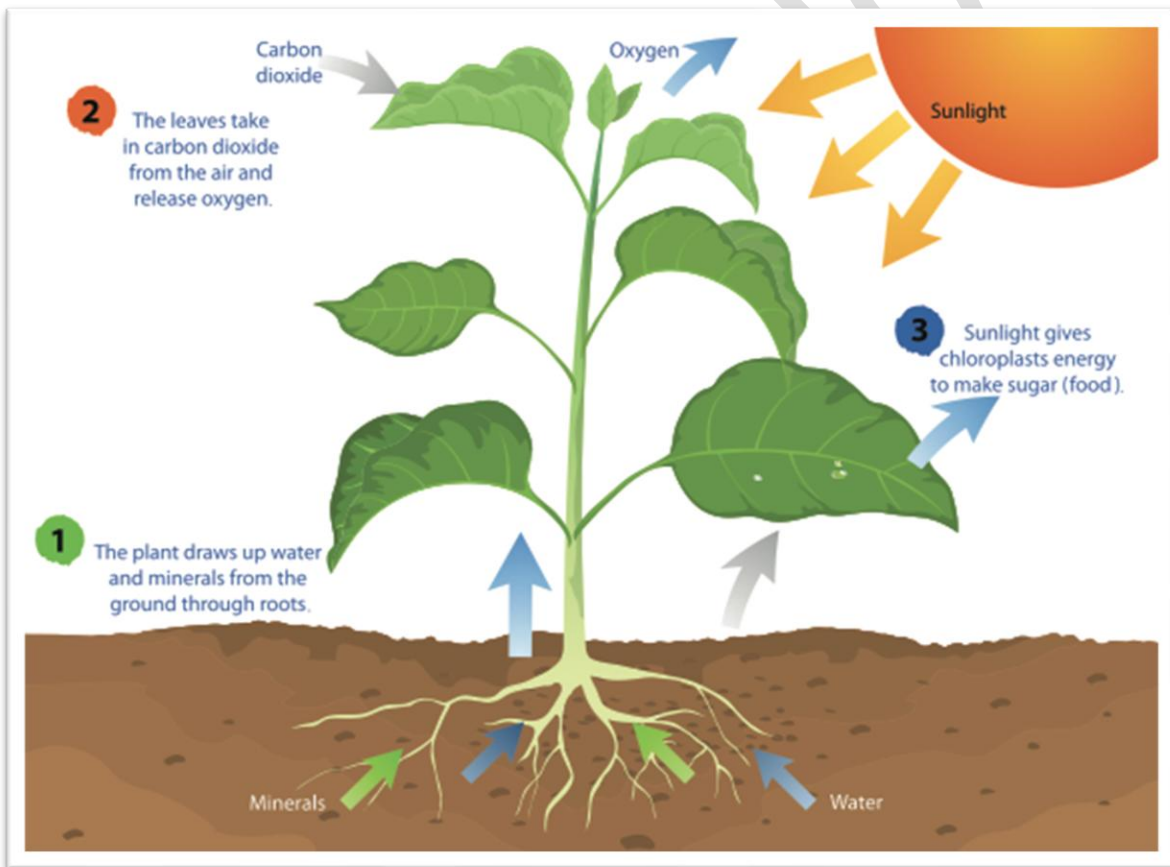
Methods: 30 bean seeds were divided into three groups: Group 1 (8 hours of sunlight), Group 2 (4 hours), Group 3 (0 hours, control). The number of germinated seeds was recorded after 10 days.

Results: Group 1 had the highest germination rate (90%), Group 2 had 60%, and Group 3 had 0%.

Conclusion: Sunlight strongly affects seed germination, and at least 4 hours of sunlight is necessary for healthy growth.

References:

- Booth, W.C., Colomb, G.G. and Williams, J.M. (2016) *The Craft of Research*. 4th ed. Chicago: University of Chicago Press.
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Lecture 5: The Structure of Bachelor Work

A bachelor work usually follows this order:

1. **Title Page** – title, your name, department, year.
2. **Abstract** – short summary (150–300 words).
3. **Acknowledgments** – thank people who helped you.
4. **Table of Contents** – list of sections with page numbers.
5. **List of Figures/Tables/Abbreviations** – if needed.
6. **Introduction** – introduce the topic, explain why it is important, state your research question and aim.
7. **Literature Review** – summarize what other researchers have said about your topic.
8. **Materials and Methods** – explain exactly how you did the research so others can repeat it.
9. **Results** – show what you found (tables, graphs, numbers).
10. **Discussion** – explain what the results mean, compare with other research, mention limitations.
11. **Conclusion** – short summary of findings, importance, and possible future research.
12. **References** – list all the books, articles, and sources you used (use Harvard style).
13. **Appendices** – extra materials like questionnaires, raw data, or pictures.

How to Write a Paragraph

- First sentence: introduce the main idea.
- Middle sentences: explain and give examples.
- Last sentence: summarize or conclude.
- Keep sentences short and clear.

Example Paragraph (Simple Topic)

Plants need sunlight to grow. Sunlight helps them make food through photosynthesis. In this study, bean seeds with more sunlight grew taller than those in shade. This shows that light is an important factor for healthy plant growth.

Results and Discussion (Tips)

- Describe results clearly without repeating methods.
- Use graphs, charts, and tables.
- Discuss what the results mean and how they compare with past research.
- Mention any problems or limitations.
- Be careful with language → don't sound 100% certain. Use soft words like “*may*,” “*seems to*,” or “*our results suggest*.”

Conclusion

- Summarize what you did (very short).
- State the significance of your findings.
- Suggest what could be studied next.

Example: “This study showed that sunlight is essential for seed germination. Future work could test whether different colors of light also affect growth.”

References:

- Gibaldi, J. (2009) *MLA Handbook for Writers of Research Papers*. 7th ed. New York: Modern Language Association of America.
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Lecture 6: How to Be Concise and Simple in Bachelor Writing

Writing a bachelor work is not about writing many pages. It is about writing **clearly** so the reader understands your ideas easily. Being concise means: **use fewer words, but say more.**

1. Why Be Concise?

- Makes your work easy to read.
- Helps examiners understand your ideas quickly.
- Avoids confusion.
- Shows you understand your topic.

2. How to Write Simply and Clearly

Rule 1: Use Short Sentences

✗ Long: “It is clearly observed from the findings of this experiment that the amount of light which was provided to the plants during the growth process had a very strong and obvious impact on their overall height and strength.”

✓ Simple: “Plants with more light grew taller and stronger.”

Rule 2: Avoid Unnecessary Words

✗ Long: “Due to the fact that water is very important for all living organisms, it is necessary for plants to be watered regularly in order for them to survive.”

✓ Simple: “Plants need regular water to survive.”

Rule 3: Use Common Words Instead of Complex Ones

✗ Complex: “Utilize”

✓ Simple: “Use”

✗ Complex: “Commence”

✓ Simple: “Start”

✗ Complex: “Terminate”

✓ Simple: “End”

Rule 4: Write Only What the Reader Needs to Know

- Don't add too much background information.
- Focus on your research, not on general facts.

Example:

✗ “The sun is a very important star in our solar system. It gives heat and light, and without it life would not exist. It rises every morning and sets every evening. This study is about the effect of sunlight on plants.”

✓ “This study tests how sunlight affects plant growth.”

Rule 5: Use Active Voice

- Active voice makes sentences shorter and clearer.

✗ Passive: “The seeds were watered by the researcher every day.”

✓ Active: “The researcher watered the seeds every day.”

Rule 6: Use Lists and Tables When Possible

- Lists and tables save words.
- They make information easier to see.

◆ Example (instead of a long paragraph):

Three groups of seeds:

1. 8 hours sunlight → 90% germinated
2. 4 hours sunlight → 60% germinated
3. No sunlight → 0% germinated

3. Practice Exercise for Students

Rewrite this long sentence in a simple and clear way:

✗ “It can be observed from the data that the students who spent more hours studying before the examination achieved significantly higher marks compared to the students who studied for fewer hours.”

Suggested Answer:

✓ “Students who studied more hours scored higher marks.”

✓ Summary of the Lecture

1. Use short sentences.
2. Cut unnecessary words.
3. Choose simple words.
4. Give only needed information.
5. Use active voice.
6. Use lists or tables.

Clear and Concise Communication

