

How to Study Mathematics?

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A Thought Before We Begin

*"Mathematics is not merely about numbers,
it is about understanding patterns,
thinking logically,
and discovering truth."*

Let's begin a journey...

From Imagination → Understanding

From Theory → Practice

Why Do We Study Mathematics?

Before opening a textbook, ask yourself...

- Why am I studying Mathematics?
- Is Mathematics only for passing examinations?
- Is Mathematics useful only for engineers and scientists?
- Can Mathematics change the way I think?
- Can Mathematics help me solve real-life problems?

Why Do We Study Mathematics?

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The Answer

Mathematics is not merely a subject. It is a **way of thinking**.

What is Mathematics?

Different perspectives of Mathematics

Aristotle

Mathematics is the science of quantity.

Galileo Galilei

"The universe is written in the language of Mathematics."

Modern View

Mathematics is the science of

- Patterns, quantities, Structures
- Relationships
- Logical Reasoning

Mathematics: The Language of Nature

Nature follows Mathematical Laws.



Motion of planets



Rainbow



DNA structure



Sound waves



Light



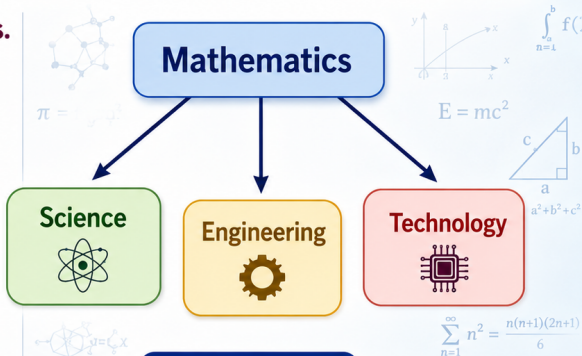
Weather



Artificial Intelligence



Space missions



Key Message



Without **Mathematics**,
there is no modern **science**,
no **engineering**,
and no advanced **technology**.



Why is Mathematics a Universal Subject?

Although people speak different languages,



English

Two + Two = Four



मराठी

दोन + दोन = चार



हिन्दी

दो + दो = चार



French

Deux + Deux = Quatre



Japanese

2 + 2 = 4



Universal Truth

No matter where you live,

$$2 + 2 = 4$$

The truth of Mathematics does not depend on



Country



Religion



Language



Culture



Hence, Mathematics is a
Universal Language.



The Soul of Mathematics

What is the most important part of Mathematics?

What is the most important part of Mathematics?

Definition

What is the most important part of Mathematics?

Definition

Everything in Mathematics begins with

Definition

What is a Definition?

Definition

A **Definition** tells us exactly

- what an object is,
- what properties it possesses,
- and what it is not.

A good definition contains

- No extra words
- No missing words
- Complete precision

Examples of Definitions

Example 1

Triangle

A polygon having exactly three sides.

Examples of Definitions

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Example 2

Circle

The set of all points in a plane that are equidistant from a fixed point.

Examples of Definitions

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Triangle

A polygon having exactly three sides.

Example 2

Circle

The set of all points in a plane that are equidistant from a fixed point.

Example 3

Prime Number

A natural number greater than one having exactly two distinct positive divisors.

How Should We Observe a Definition?

Never memorize.
Observe.

Whenever you read a definition, ask yourself

- 1 What is being defined?

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- 2 Why is every word included?
- 3 Can I remove any word?

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- ④ What happens if I remove one condition?
- ⑤ Can I give examples and non-examples?

Activity: Observe the Definition

Definition:

Even Number = An Integer Divisible by 2

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Ask students

- Why "Integer"?

Activity: Observe the Definition

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- Why "Integer"?
- Why not Rational Number?

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- Why "Integer" ?
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- Why exactly "2" ?

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- Is 2.4 an even number?

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- Why "Integer" ?
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- Why exactly "2" ?
- Is 2.4 an even number?
- Is -6 an even number?

Mathematics Teaches Precision

Mathematics teaches us

-  **Do not Ignore.**
-  **Do not Add.**
-  **Understand Exactly.**

Mathematical Thinking



Neither less.



Neither more.



Exactly what is stated.



The Journey of Mathematical Knowledge

Definition



Concept



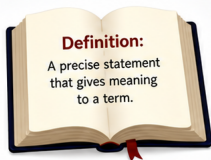
Theorem



Problem



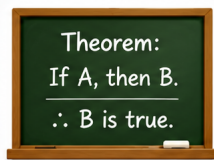
Application



Everything starts with a clear and precise definition.



From definitions, we build understanding.



Concepts lead to proved and reliable statements.



Theorems help us solve real and abstract problems.



Solutions are applied in technology, science, engineering, and daily life.

Key Message



Every **theorem**, every **formula**,
every **application**,
begins with a **precise definition**.



Think Like a Mathematician

Whenever you study a new concept, ask

- 1 What exactly does the definition say?

Think Like a Mathematician

Whenever you study a new concept, ask

- ① What exactly does the definition say?
- ② What does it NOT say?

Think Like a Mathematician

Whenever you study a new concept, ask

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- ④ Can I imagine it?

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- ④ Can I imagine it?
- ⑤ Can I give examples?

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Whenever you study a new concept, ask

- ① What exactly does the definition say?
- ② What does it NOT say?
- ③ Can I draw it?
- ④ Can I imagine it?
- ⑤ Can I give examples?
- ⑥ Can I give counterexamples?

Remember

Understanding is more powerful than memorization.

What is a Mathematical Problem?

A mathematical problem is not merely a question.

It is a **situation** in which

- We know something.

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What is a Mathematical Problem?

A mathematical problem is not merely a question.

It is a **situation** in which

- We know something.
- We need to find something.
- A logical path exists between the two.

Example

Find the area of a circle of radius 7 cm.

$$\text{Given } r = 7 \quad \text{Find } A = \pi r^2$$

George Pólya's Four-Step Method

1. Understand



2. Plan



3. Solve



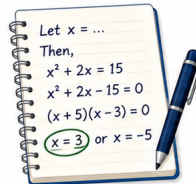
4. Verify



Read carefully.
What is given?
What is asked?



Think of a strategy.
Choose the right
approach.



Carry out the plan
step by step.
Stay focused.



Check the answer.
Does it make sense?
Is it correct?



Golden Rule



Never start solving before understanding the problem.



Step 1: Understand the Problem

Before solving, ask yourself:

- 1 What is given?

Step 1: Understand the Problem

Before solving, ask yourself:

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- ② What is required?

Step 1: Understand the Problem

Before solving, ask yourself:

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Step 1: Understand the Problem

Before solving, ask yourself:

- ① What is given?
- ② What is required?
- ③ Which definitions are involved?
- ④ Can I draw a diagram?
- ⑤ Can I rewrite the problem in my own words?

Remember

Many mistakes occur because we solve a problem we never fully understood.

Step 2: Plan the Solution

A good mathematician never guesses blindly.

Possible strategies:

- Draw a figure

Step 2: Plan the Solution

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Possible strategies:

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- Look for a pattern

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Step 2: Plan the Solution

A good mathematician never guesses blindly.

Possible strategies:

- Draw a figure
- Look for a pattern
- Use a known theorem
- Break into smaller parts
- Solve a simpler problem first
- Work backward

Step 3 and Step 4

Step 3 : Carry Out the Plan

- Solve carefully.
- Write every logical step.
- Do not skip reasoning.

Step 3 and Step 4

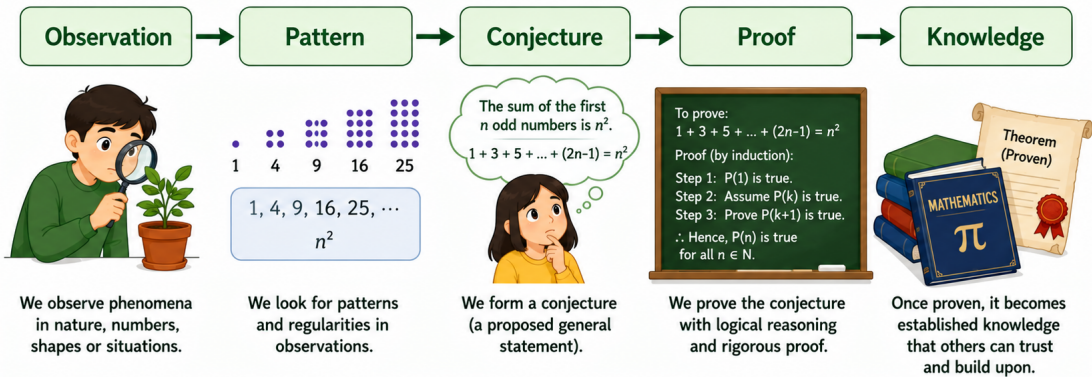
Step 3 : Carry Out the Plan

- Solve carefully.
- Write every logical step.
- Do not skip reasoning.

Step 4 : Look Back

- Is the answer reasonable?
- Can it be checked?
- Is there another method?
- What did I learn?

How Mathematical Knowledge Develops



 **Every great mathematical discovery begins with careful observation.** 

Example: Observation Leads to Discovery

Observe:

$$1 = 1^2$$

$$4 = 2^2$$

$$9 = 3^2$$

$$16 = 4^2$$

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What do you expect next?

Example: Observation Leads to Discovery

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What do you expect next?

$$25 = 5^2$$

Example: Observation Leads to Discovery

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$$9 = 3^2$$

$$16 = 4^2$$

What do you expect next?

$$25 = 5^2$$

Observation helps us discover patterns. Patterns inspire conjectures. Proof converts conjectures into Mathematics.

What is Critical Thinking?

Critical Thinking means

- Observe carefully

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- Observe carefully
- Ask questions

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Critical Thinking means

- Observe carefully
- Ask questions
- Analyze logically

What is Critical Thinking?

Critical Thinking means

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- Ask questions
- Analyze logically
- Verify evidence

What is Critical Thinking?

Critical Thinking means

- Observe carefully
- Ask questions
- Analyze logically
- Verify evidence
- Draw justified conclusions

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Critical Thinking means

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Fact

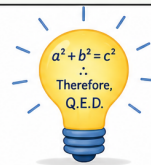
Every mathematical problem develops these abilities.

Mathematical Thinking vs Ordinary Thinking

Ordinary Thinking	Mathematical Thinking
 Guessing	 Logical reasoning
 Opinion	 Evidence
 Emotion	 Analysis
 Assumption	 Proof
 Confusion	 Precision



Mathematics teaches us
to **think** before we conclude.



Activity for Students

Imagine you are standing before a locked door.

What will you do?

Activity for Students

Imagine you are standing before a locked door.

What will you do?

- Observe the lock.

Activity for Students

Imagine you are standing before a locked door.

What will you do?

- Observe the lock.
- Identify the key.

Activity for Students

Imagine you are standing before a locked door.

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- Try different approaches.

Activity for Students

Imagine you are standing before a locked door.

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- Observe the lock.
- Identify the key.
- Try different approaches.
- Check whether it opens.

Activity for Students

Imagine you are standing before a locked door.

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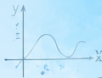
Connection

Every mathematical problem is like a locked door.
Definitions and logical reasoning are the keys.

The Mathematical Mindset

A way of **thinking**. A path to **understanding**.

$$E=mc^2$$



01



OBSERVE

Look carefully.
Notice patterns
and details.



02



UNDERSTAND

Understand the
problem.
Identify what is
known and
what is required.



03



THINK

Plan a strategy.
Use logic and
mathematical
ideas.



04



SOLVE

Apply your
strategy.
Work step
by step.

$$f(x) = x^2 + 2x + 1 \\ = (x + 1)^2$$

05



VERIFY

Check your answer.
Is it correct?
Does it make
sense?



06



LEARN

Reflect on what
you learned.
Generalize and
apply to new
problems.



“ Mathematics is not about numbers, equations, or algorithms.
It is about **UNDERSTANDING**. ”

ALGEBRA
GEOMETRY
CALCULUS

