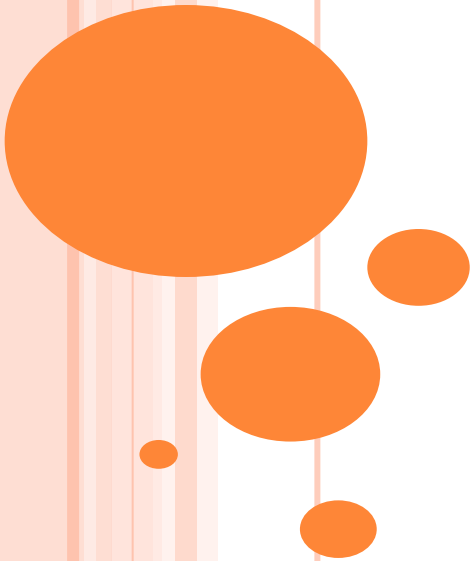
5. Additional Concepts related to Scientific Thinking (part 2)

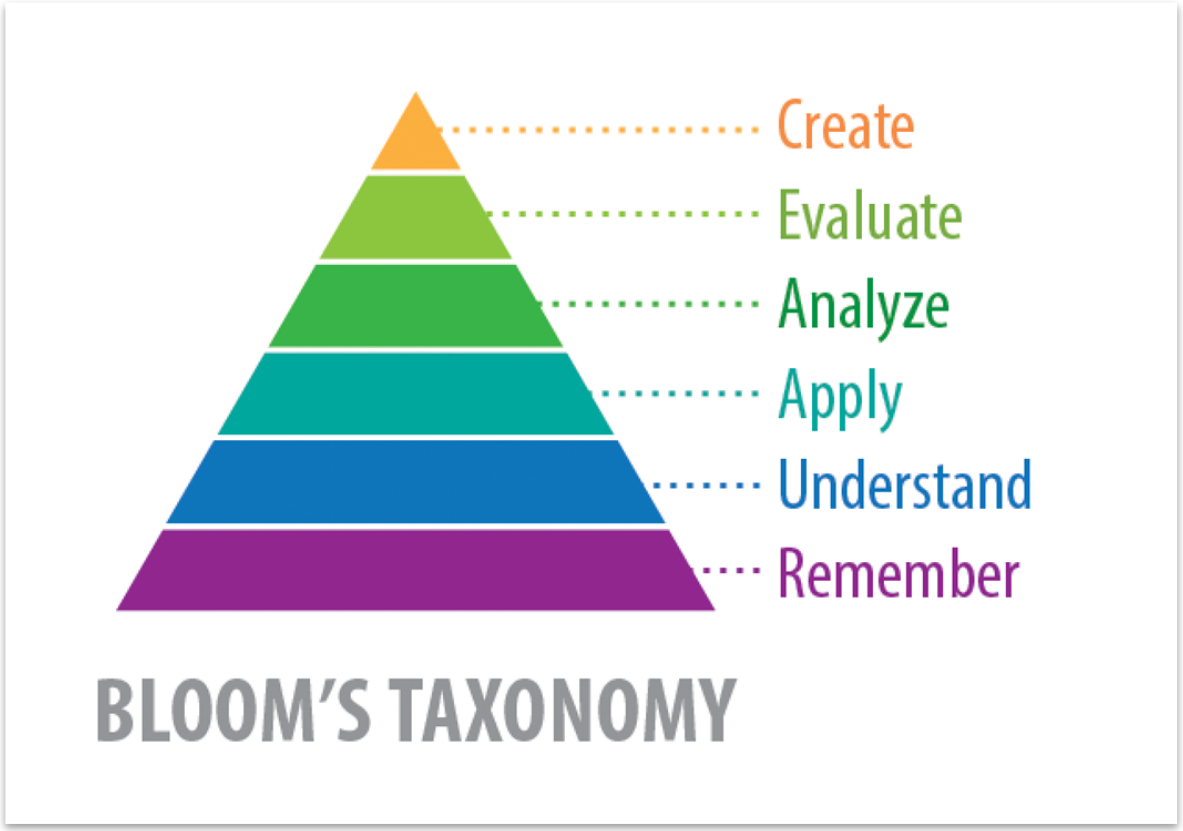


Content

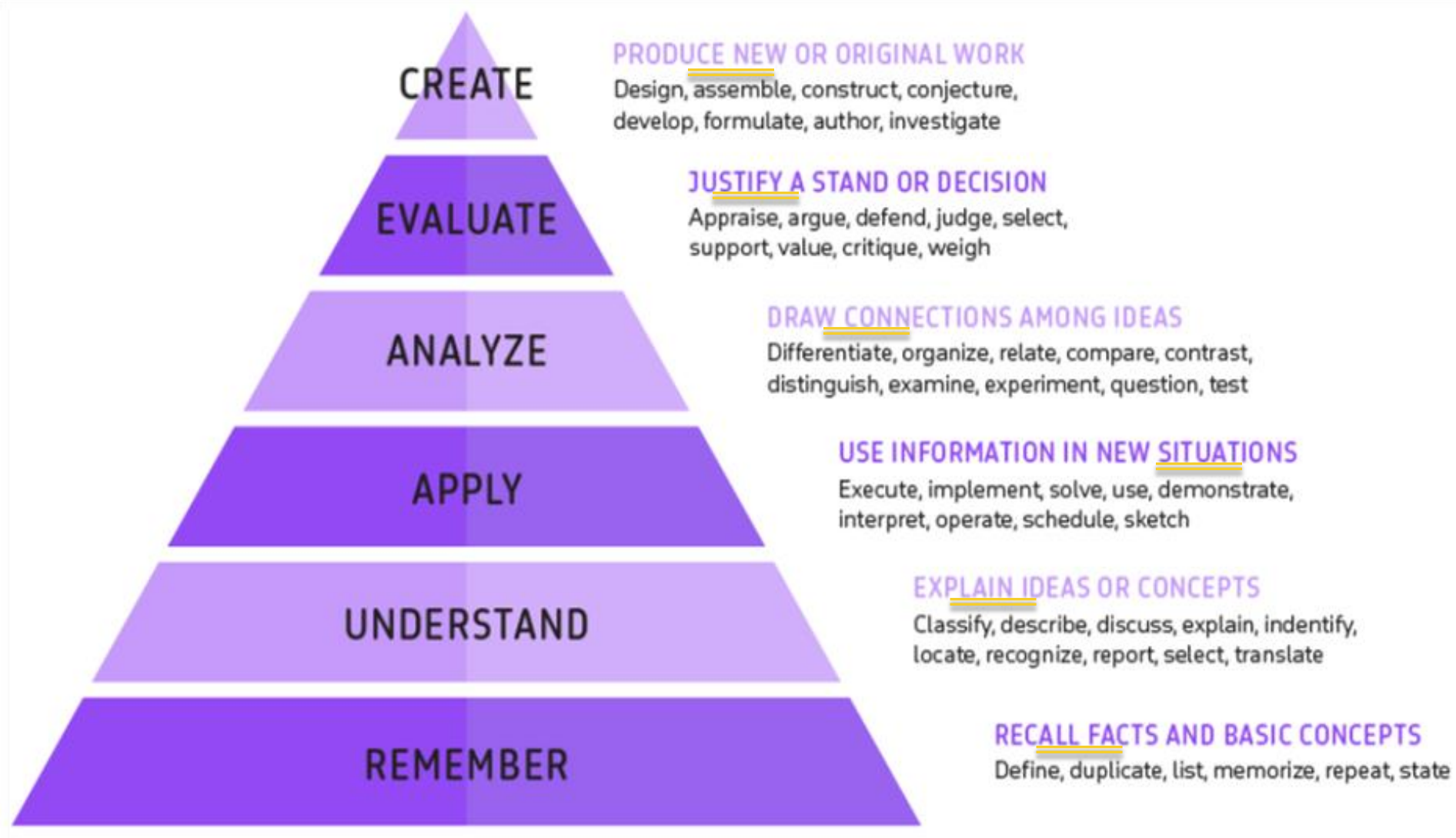
- Levels of Thinking
- Components of Scientific Thinking
- Sources of Knowledge

BLOOM'S TAXONOMY

- Bloom's taxonomy is a framework for educational achievement in which each level depends on the one below.



Levels of thinking: Bloom taxonomy



Levels of thinking: Bloom taxonomy

- It is a method to categorize the brain thinking as six level.
- They are organized into two groups.

A. Low level of thinking: includes

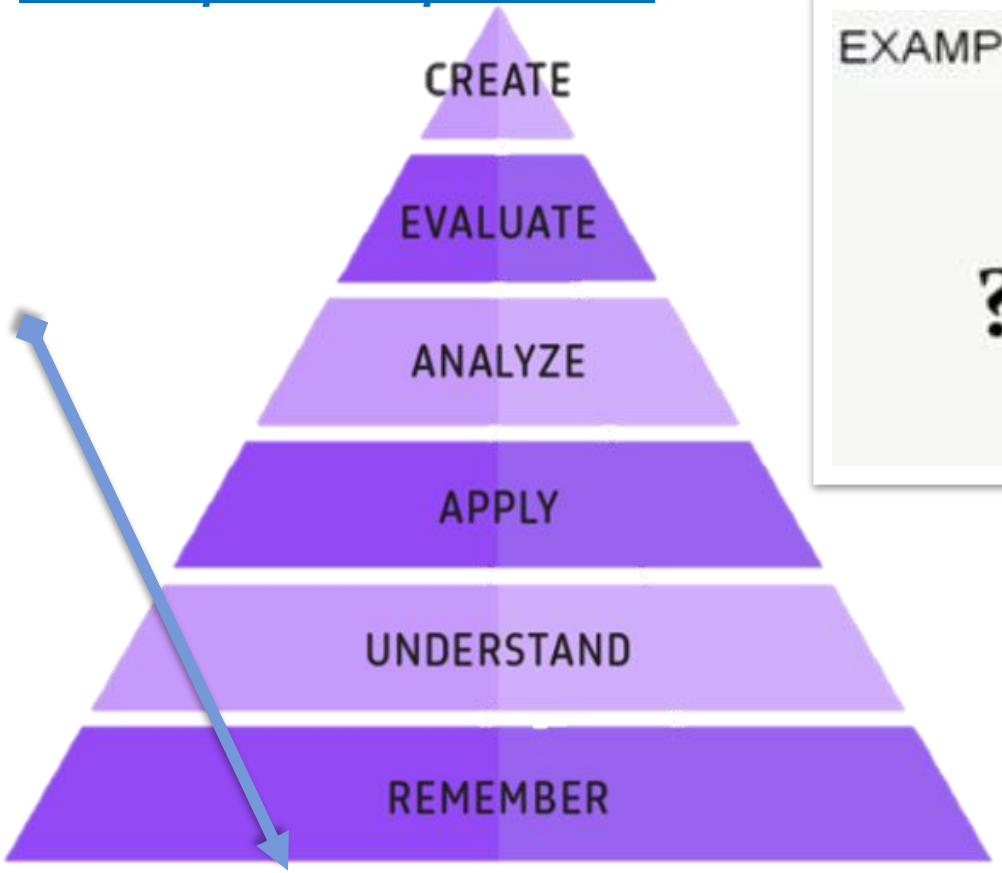
1. Remember
2. Understand
3. Apply

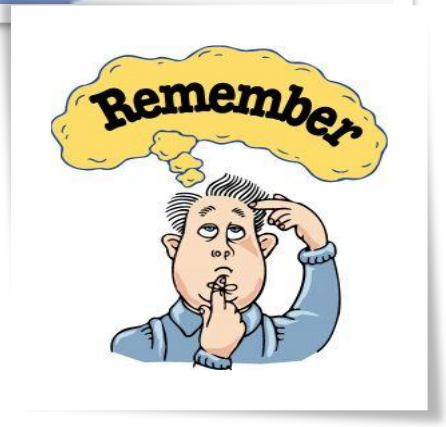
B. High level of thinking: includes

4. Analysis
5. Evaluate
6. Create

Level 1 of thinking: Bloom taxonomy

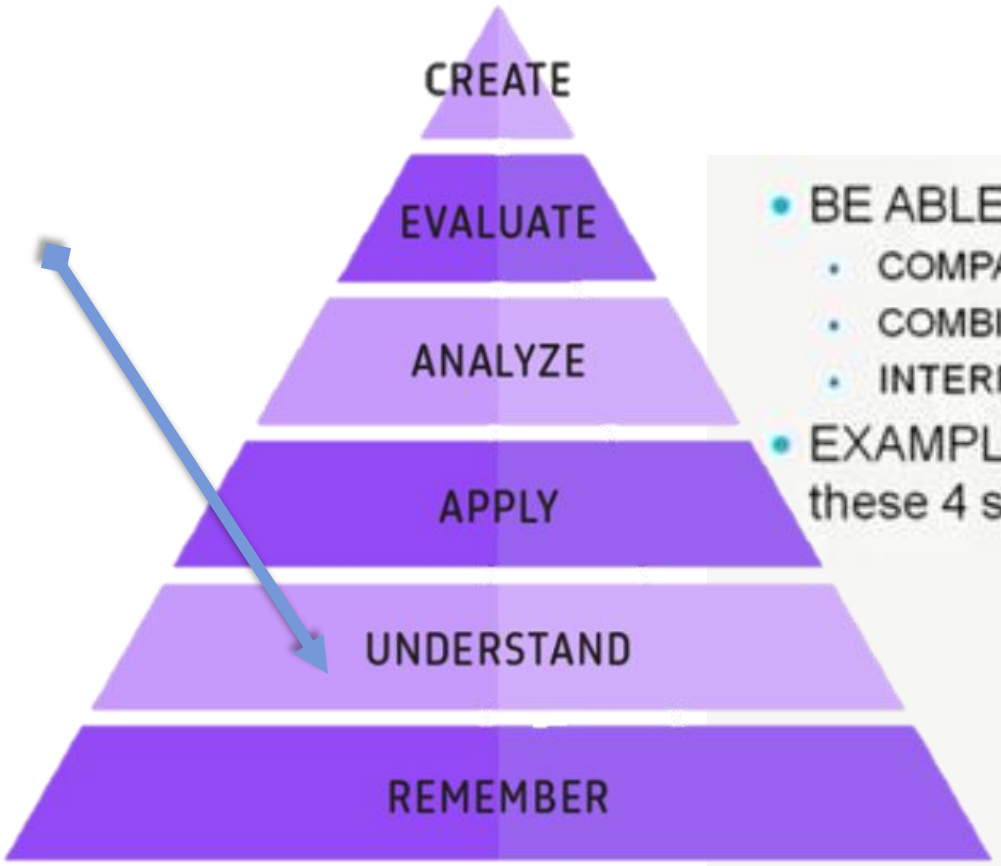
Remember: is about recalling facts and concepts. A student can define and duplicate, make a list, memorize points, repeat information, and make valid statements. But this ***does not prove Comprehension***.

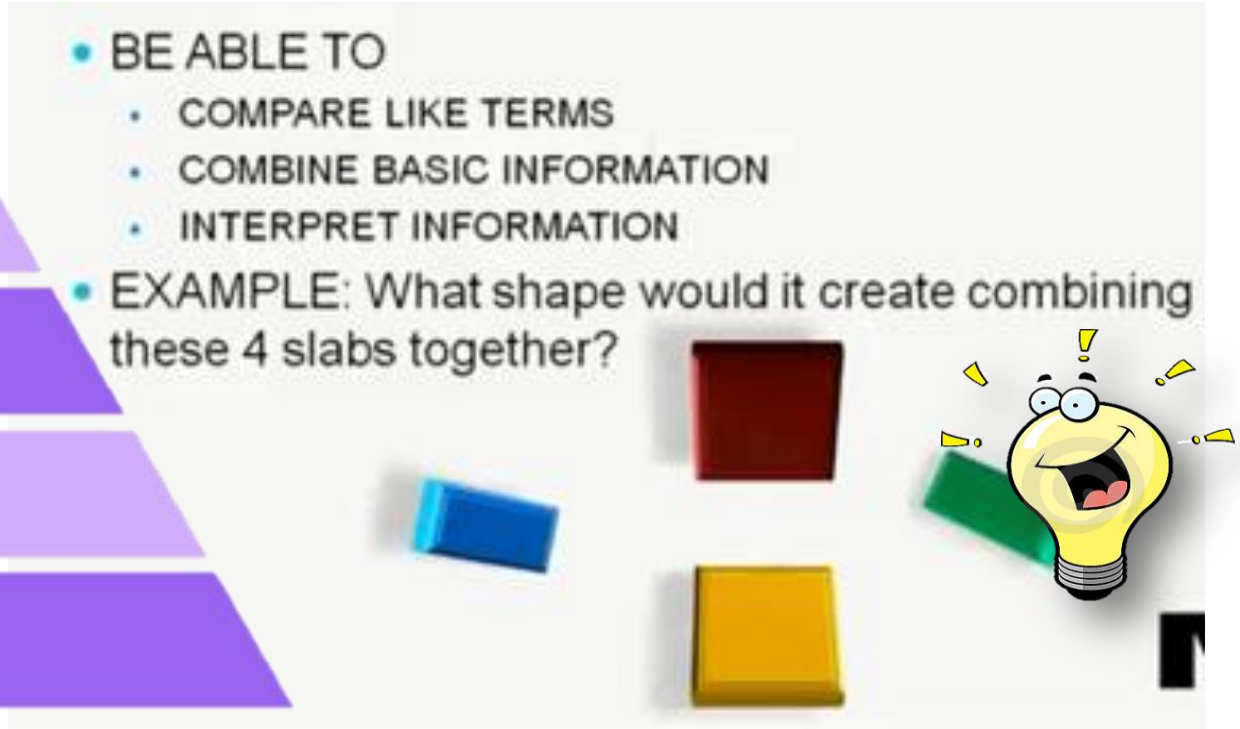




Level 2 of thinking: Bloom taxonomy

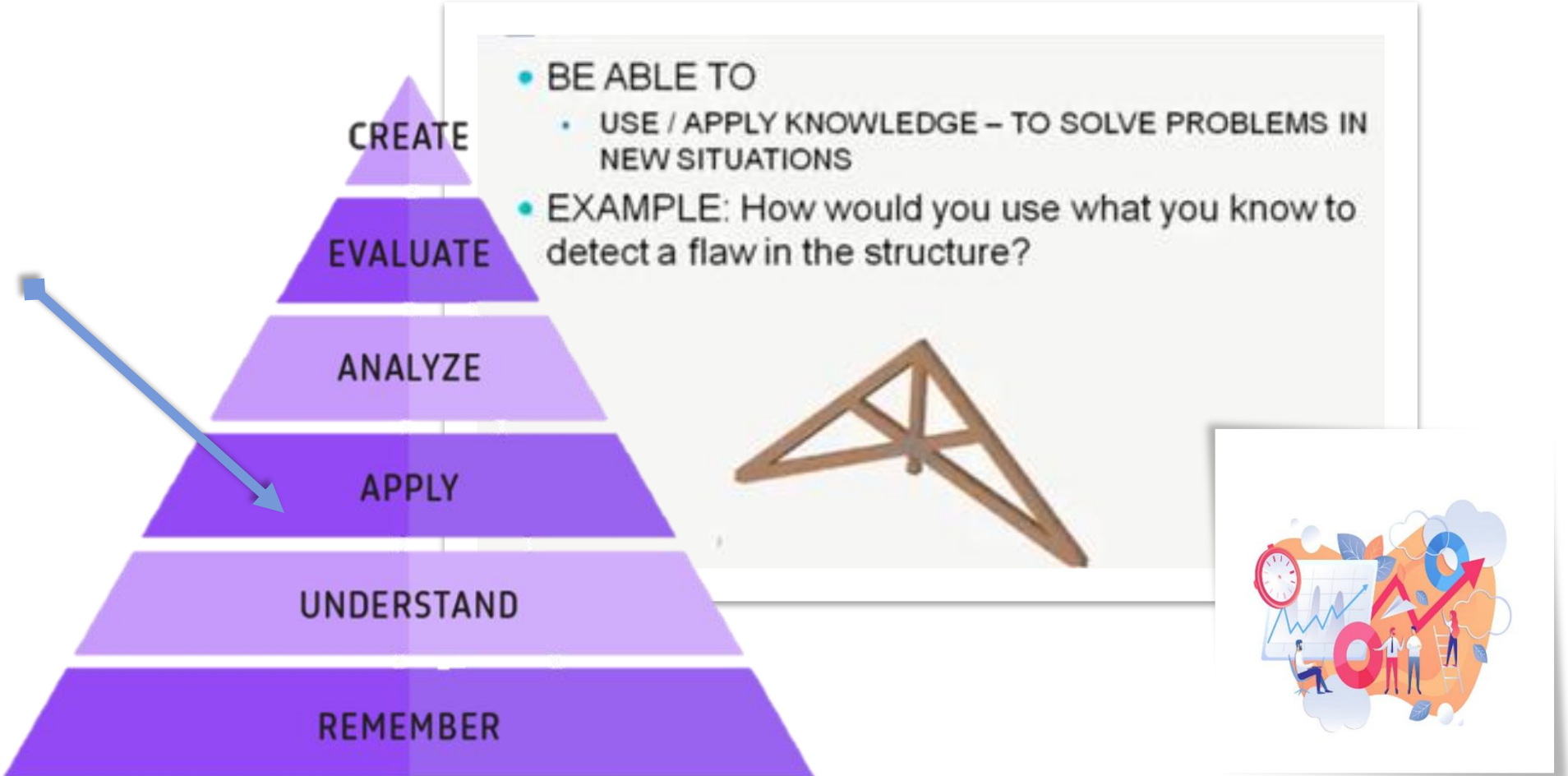
This is where the student **understand**. The student **explains ideas**, explains what they mean and translates the facts in some way. They **compare and contrast** information.
Once this level is conquered, students move up the pyramid to the ***next stage of learning: apply***





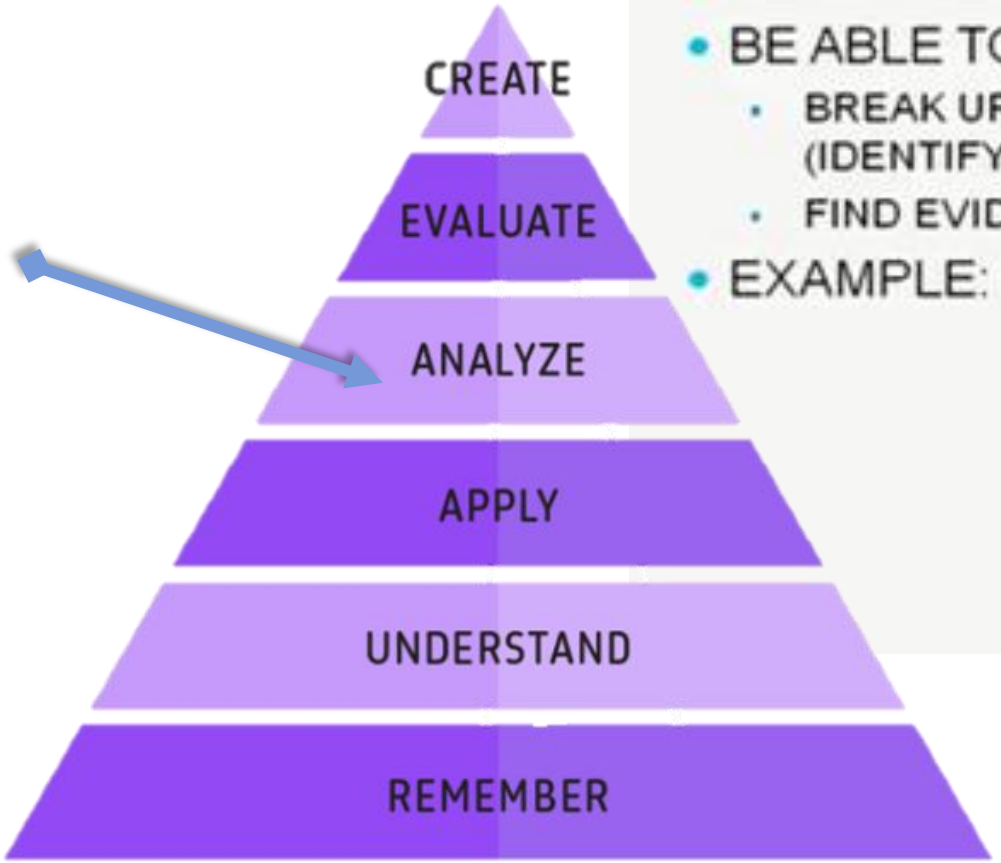
Level 3 of thinking: Bloom taxonomy

Apply. In this level, students **use the information they've learned** in new situations, whether it's to solve a problem, demonstrate an idea, Then, they must draw ***connections between ideas*** in the **analyze** level of Bloom's taxonomy,



Level 4 of thinking: Bloom taxonomy

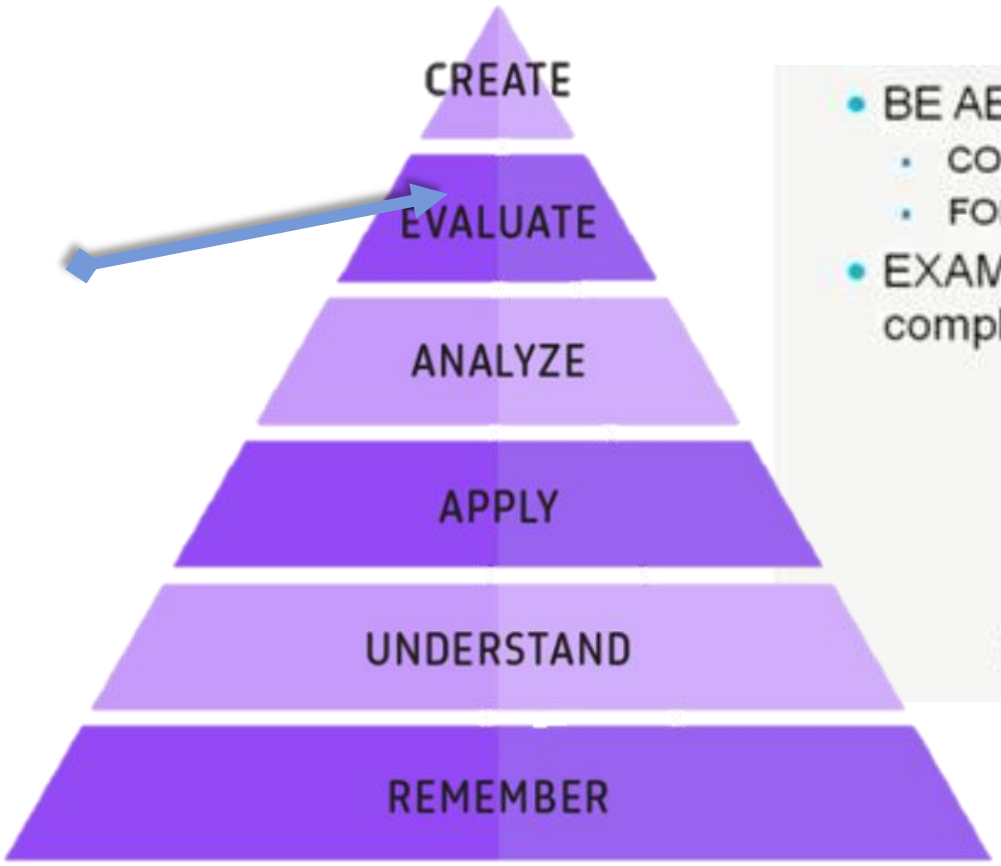
In the **analyze** level of Bloom's taxonomy, they must **draw connections between ideas** examine, question or test their knowledge. **Critical thinking** finally comes into play, as the student distinguishes between fact and opinion, and breaks information down into component parts.



- BE ABLE TO
  - BREAK UP ANY NEW INFORMATION TO PARTS (IDENTIFY REASONS, CAUSES, MOTIVES, ETC)
  - FIND EVIDENCE TO SUPPORT VIEW
- EXAMPLE: Why are Dolphins called mammals?

LEVEL 5 OF THINKING: BLOOM TAXONOMY

In the **evaluate** stage, the student can justify a decision by arguing, defending, judging, supporting, or weighing in with thoughts based on the knowledge and application they've acquired thus far.

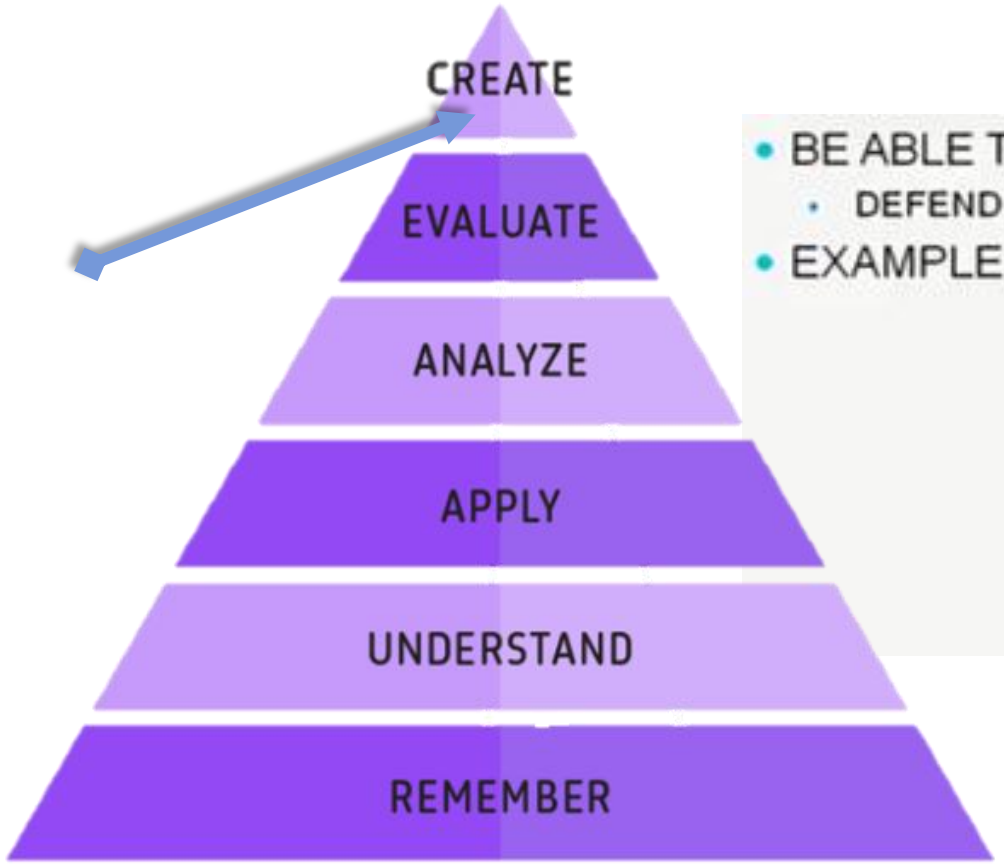


- BE ABLE TO
  - COMBINE DIFFERENT TYPES OF INFORMATION
  - FORM ALTERNATE SOLUTIONS
- EXAMPLE: Put these words together to form a complete sentence

Stitch A In Time Saves Nine

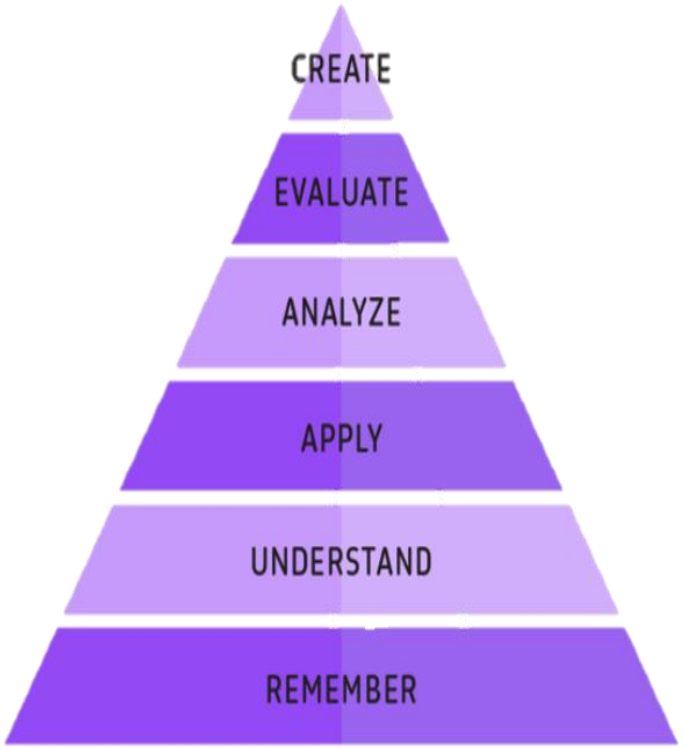
Level 6 of thinking: Bloom taxonomy

In the final level of Bloom's taxonomy, the student Create full knowledge by **applying** what they've learned, analyzed and evaluated, and built. They can design a piece of machinery, or revising a process to improve the results.



Bloom's Level	Key Verbs (keywords)	Example Learning Objective
Create	design, formulate, build, invent, create, compose, generate, derive, modify, develop.	*By the end of this lesson, the student will be able to design an original homework problem dealing with the principle of conservation of energy.*
Evaluate	choose, support, relate, determine, defend, judge, grade, compare, contrast, argue, justify, support, convince, select, evaluate.	By the end of this lesson, the student will be able to determine whether using conservation of energy or conservation of momentum would be more appropriate for solving a dynamics problem.
Analyze	classify, break down, categorize, analyze, diagram, illustrate, criticize, simplify, associate.	*By the end of this lesson, the student will be able to* differentiate between potential and kinetic energy.
Apply	calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, perform, present.	*By the end of this lesson, the student will be able to* calculate the kinetic energy of a projectile.
Understand	describe, explain, paraphrase, restate, give original examples of, summarize, contrast, interpret, discuss.	*By the end of this lesson, the student will be able to* describe Newton's three laws of motion to in her/his own words
Remember	list, recite, outline, define, name, match, quote, recall, identify, label, recognize.	*By the end of this lesson, the student will be able to* recite Newton's three laws of motion.

Example 1



Bloom's Taxonomy

1 **Remember**
What is an apple

KNOW

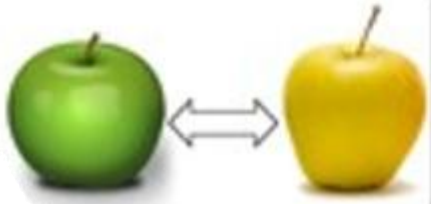
2 **Understand**: Do you understand how an apple grows?

SHOW

3 **Apply**: Can you use apple?

DO

4 **Analyze**: Can you compare apples?



COMPARE

5 **Evaluate**: what is the best type of apples?

JUDGE

6 **Create**: Can you invent a new type of apple Sause?

CREATE

EXAMPLE 2: USING BLOOM'S TAXONOMY IN DESIGNING A COURSE(NEWTON'S THREE LAWS OF MOTION)

- We are going to use the 6 levels to structure the learning objectives, lessons, and assessments of courses.

Newton's First Law:

Objects in motion tend to stay in motion and objects at rest tend to stay at rest unless acted upon by an unbalanced force.

Newton's Second Law:

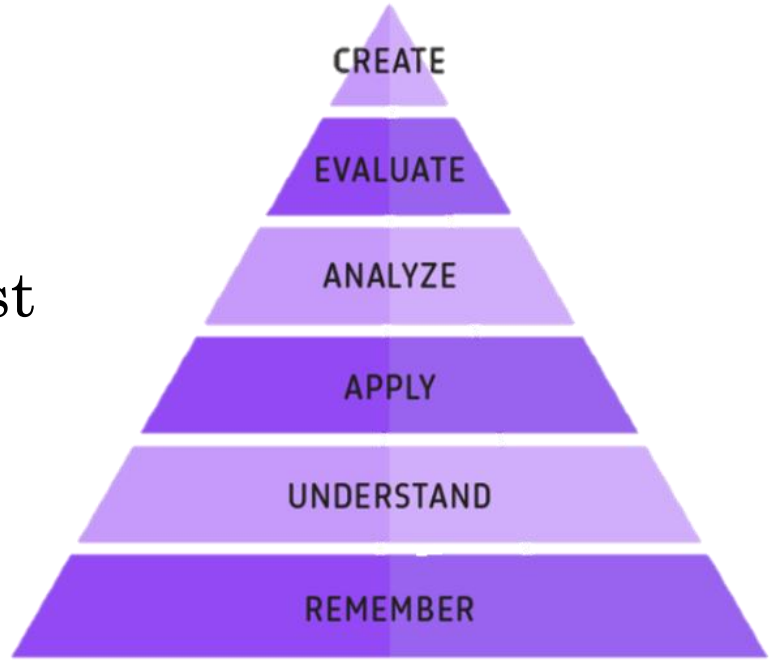
Force equals mass times acceleration (F = ma).

Newton's Third Law:

For every action there is an equal and opposite reaction.

Example 3 (Cont.): Using Bloom's Taxonomy in designing a course(Newton's three laws of motion)

- Before you can **Understand** – a concept, you must ***be able to remember it.***
- To ***apply*** a concept you must first **(understand)** it.
- In order to ***evaluate*** a process, you must have ***analyzed*** it.
- To ***create*** an accurate ***evaluation***, you must have completed a thorough aware of it.



Questions

- What is Bloom taxonomy
- What are the Levels of thinking according to Bloom.

Components of Scientific Thinking

- Whatever the type of thinking, scientific thinkers use three components of thinking
- There are three components of scientific thinking are:
  - Empiricism (the theory that the origin of all **knowledge** is sense **experience**)
  - Rationalism (is the philosophy that **knowledge** comes from **logic**)
  - Skepticism (any **questioning** attitude or doubt towards one or more items of **knowledge** or belief)

Questions

- What are the Components of Scientific Thinking

Scientific thinkers and intellectual standards

- There are seven Intellectual Standards we use to assess thinking:

1. **Clarity**
2. **Accuracy**
3. **Precision**
4. **Relevance**
5. **Depth,**
6. **Logic**
7. **Fairness.**

Intellectual Standards in Scientific Thinking

1. Clarity	A thinker must be clear in how to communicate thoughts, beliefs, and reasons for beliefs.
2. Accuracy	Make sure that all information is correct and free from error. If the thinking is reliable, then it has Accuracy.
3. Precision	Goes one step further than Accuracy. It demands that the words and data used are exact. If no more details could be added, then it has Precision.

Intellectual Standards in Scientific Thinking

4. Relevance	Means that everything included is important, that each part makes a difference.
5. Depth	If an argument includes all the degrees necessary to make the point, it has Depth.
6. Logic	Means that an argument is reasonable
7. Fairness	Means that the argument is balanced and free from bias.

Questions

- What are the Intellectual Standards in Scientific Thinking (with explanation)

Sources of Knowledge

- Gather information: Sources of Knowledge
  - Primary Sources
  - Secondary Sources

Sources of Knowledge : Primary Source

- A primary source provides direct or firsthand evidence about an event, object, person, or work .
- Primary sources provide the original materials on which other research is based and enable students and other researchers to get as close as possible to what actually happened during a particular event or time period.
- Primary sources can be written or non-written (sound, pictures, artifacts, etc.). In scientific research, primary sources present original thinking, report on discoveries, or share new information.

Sources of Knowledge: Primary Source

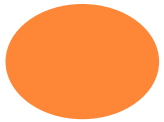
- **Examples of primary sources:**
  - Interviews, surveys, observation as well as fieldwork

Sources of Knowledge: Secondary Source

- Secondary sources describe, discuss, interpret, comment upon, analyze, evaluate, summarize, and process primary sources.
- A secondary source is generally one or more steps removed from the event or time period and are written or produced after the fact with the benefit of hindsight.
- Secondary sources often lack the freshness and immediacy of the original material.

Sources of Knowledge: Secondary Source

- **Examples of secondary sources:**
  - Reference books, including dictionaries, encyclopedias, and atlases
  - Articles from magazines, journals, and newspapers after the event
  - Literature reviews and review articles (e.g., movie reviews, book reviews)
  - Books
  - Textbooks



Questions

What are the sources of knowledge (include examples)