STEM Education in Mathematics Classroom

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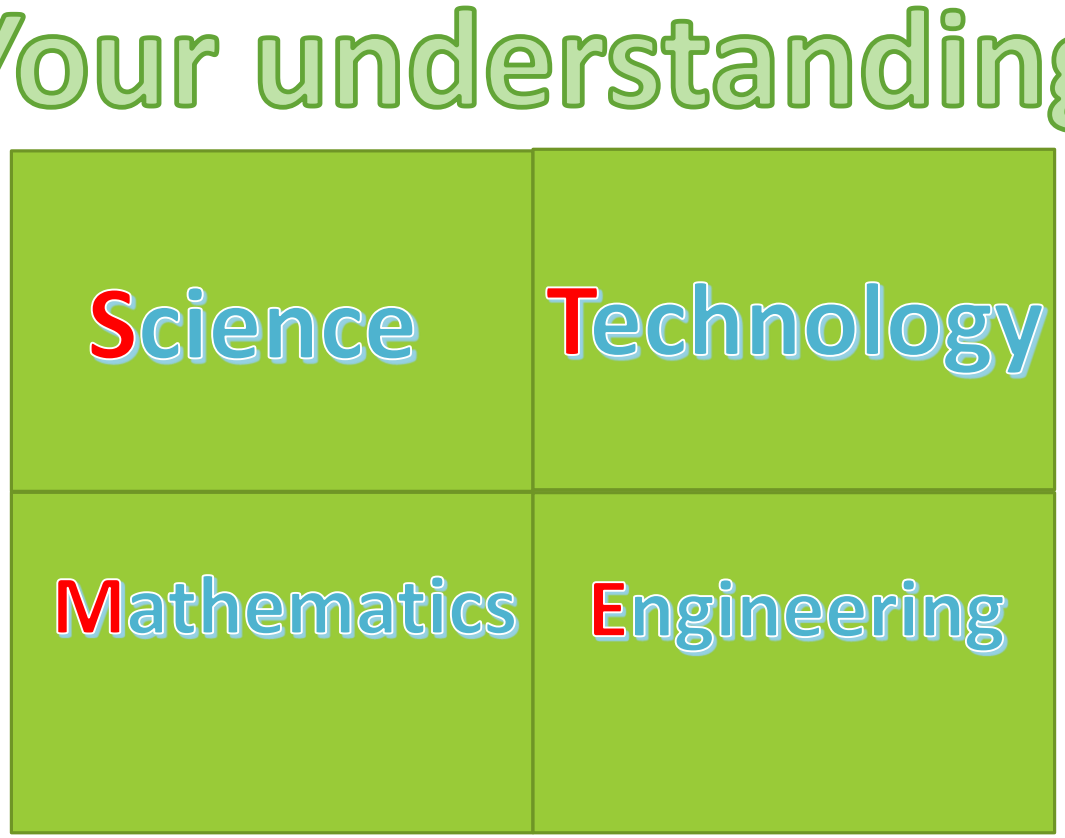
What is STEM?


Your understanding
Science
Technology
Mathematics
Engineering

What is Science?

- The study of natural world
- The Law of nature associated with physics, chemistry and biology
- The body of knowledge and a process that generates new knowledge

How do scientists answer questions in Science?

Scientific Method

- Question
- Hypothesise
- Experiment
- Observe & Record
- Analyse
- Share results

Barack Obama's Statement

Science is more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change that world…

President Barack Obama, March 23, 2015

What is Technology?

- The application of scientific knowledge and know-how for practical purposed e.g. TV, Cell phone, computer
- Modifying the natural world to meet the needs and wants of people

What is Technology?

- The continuous human innovation involves the generation of knowledge and processes to develop systems to solve problems and extend human potentials

What is Technology?

Technology can be used to describe a:

- System e.g. Fuel system, Breaking system, Wireless

Specific Device:

- Fuel injector, smartphone, computer

What is engineering?

About the design and making of:

- Structure: Models
- Products: Devices
- Process: System

Professional Occupation

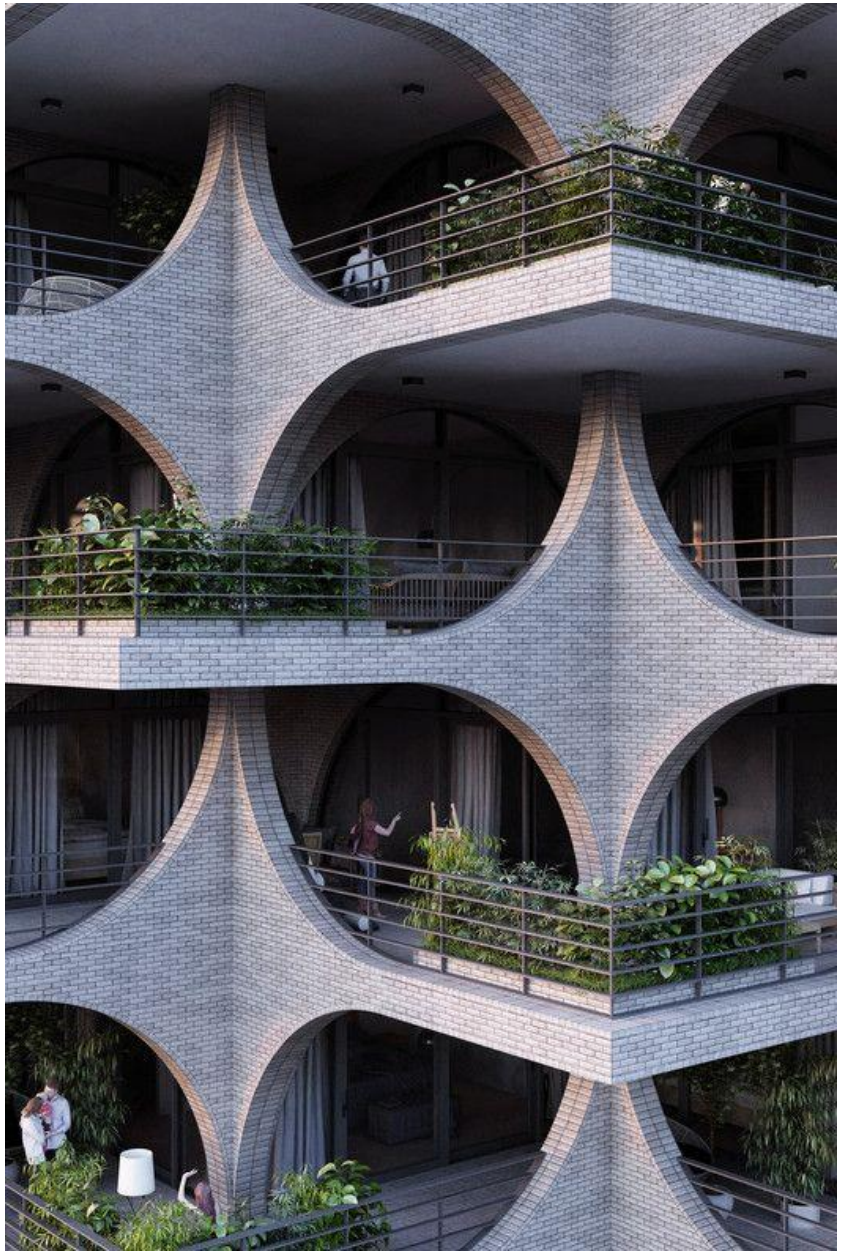
How do engineers solve problems in engineering?

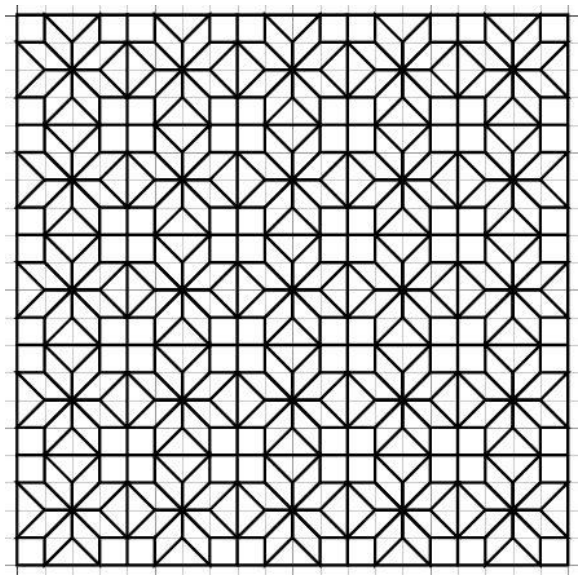
Design Process:

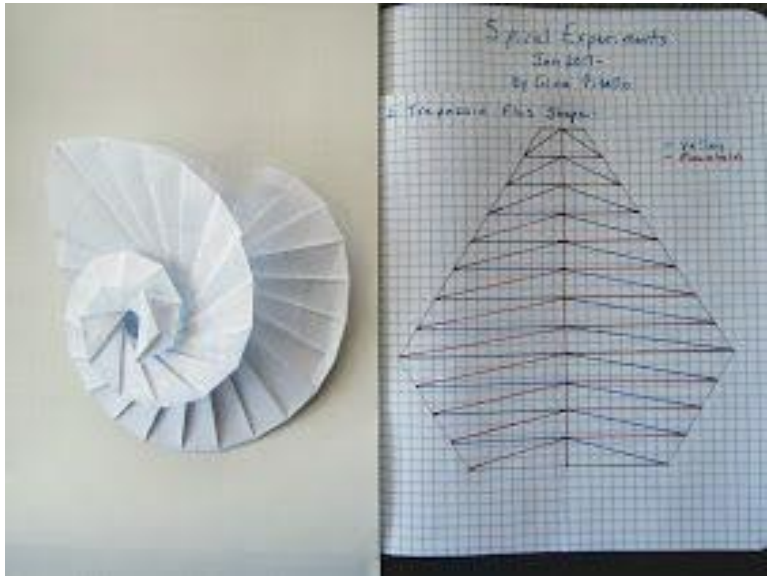
- Many models
- Many solution

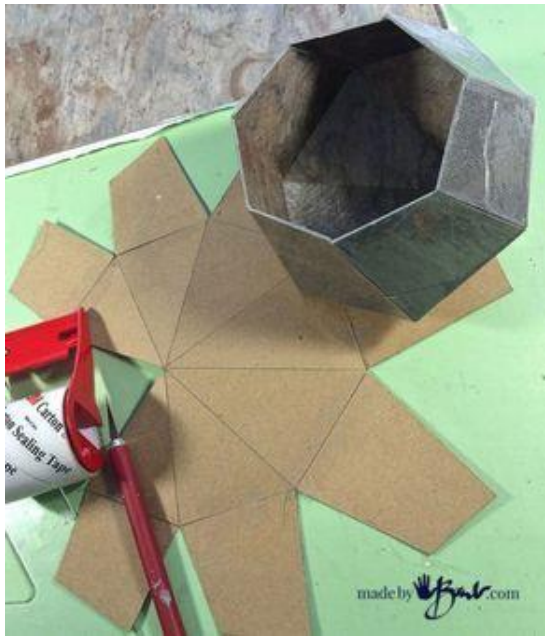
What is mathematics?

- Language of numbers, operations, patterns and relationships
- It is used in science, engineering and technology

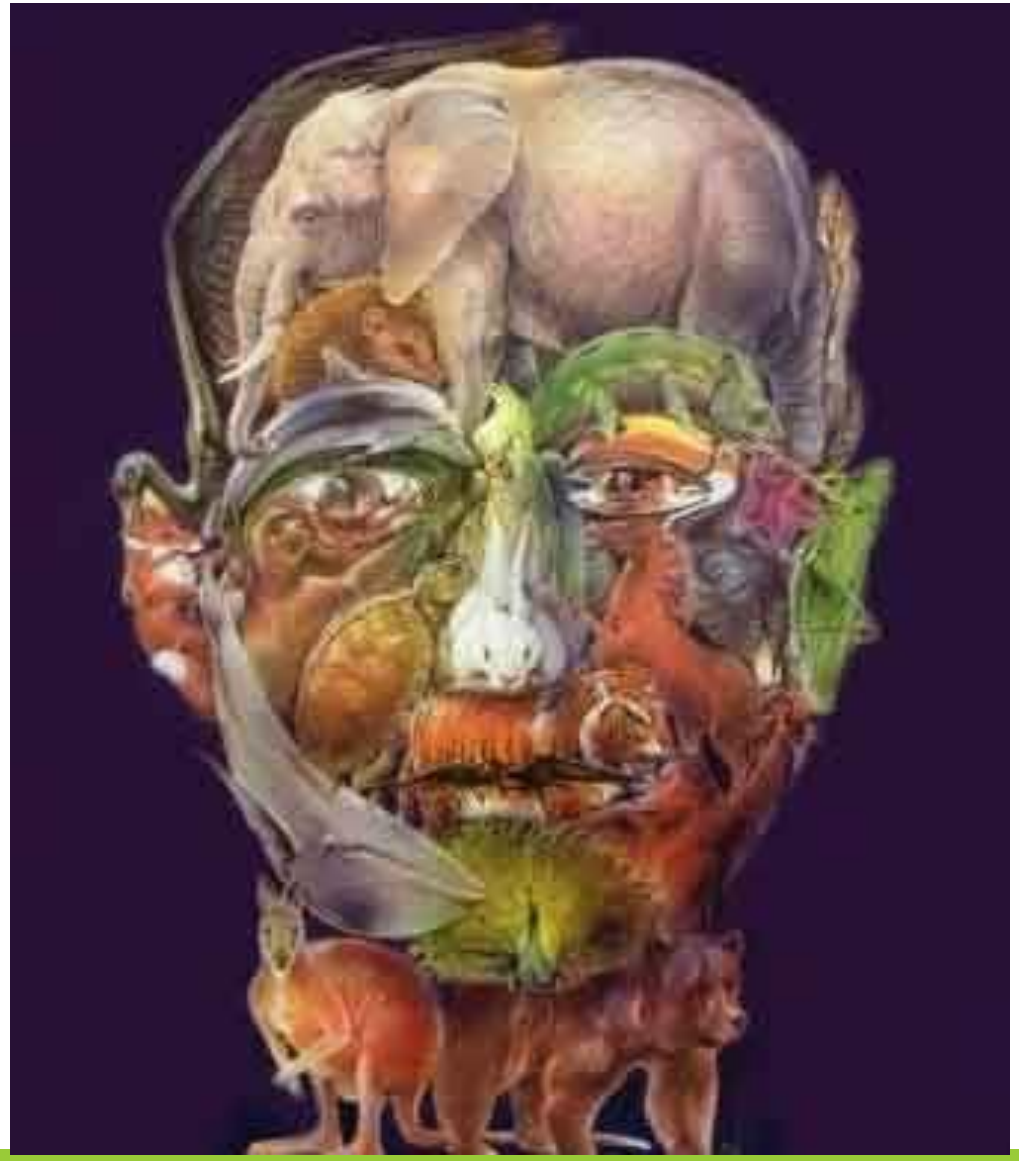




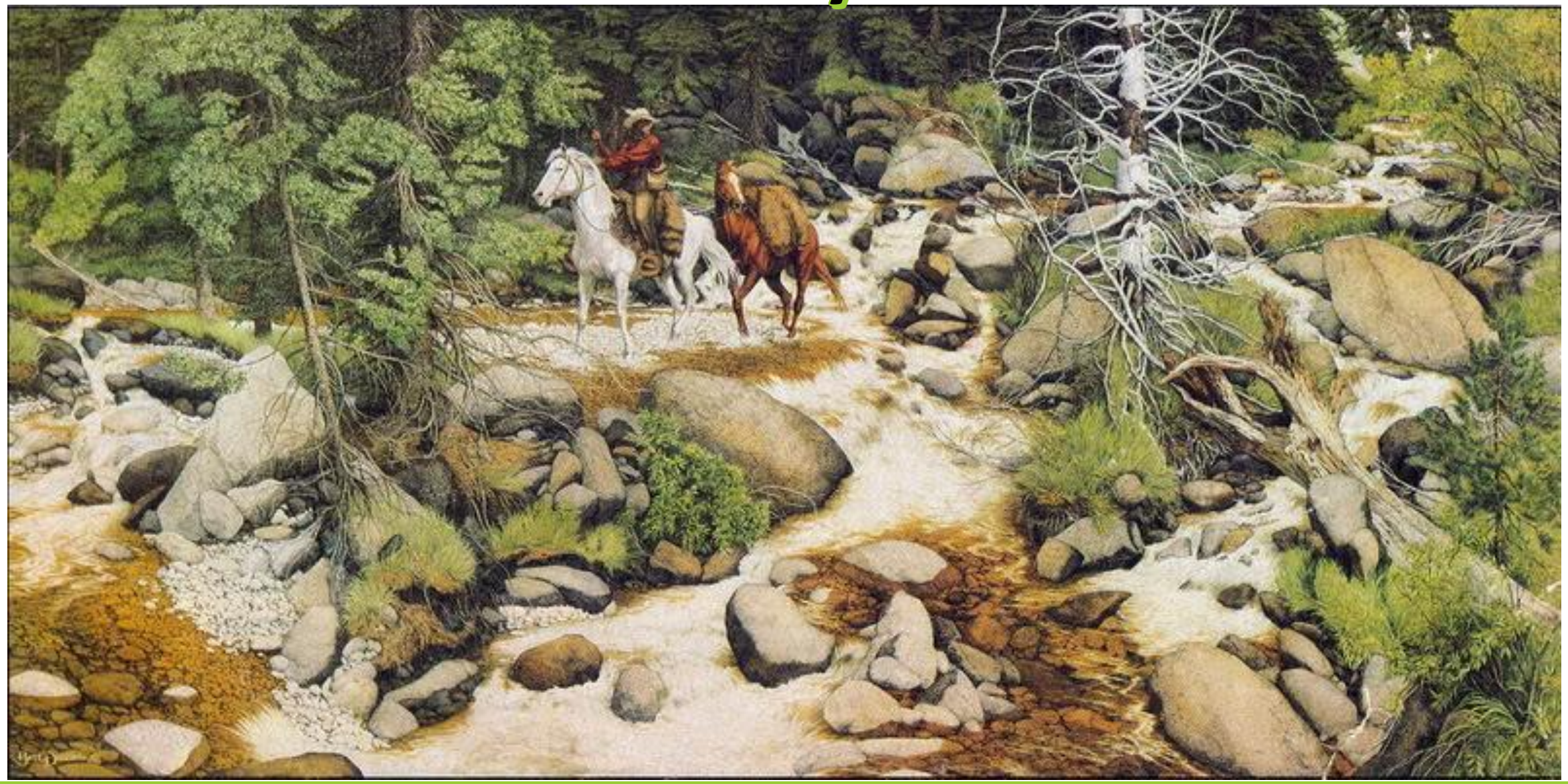

Spiral Experiments


made by

How many types of animals?



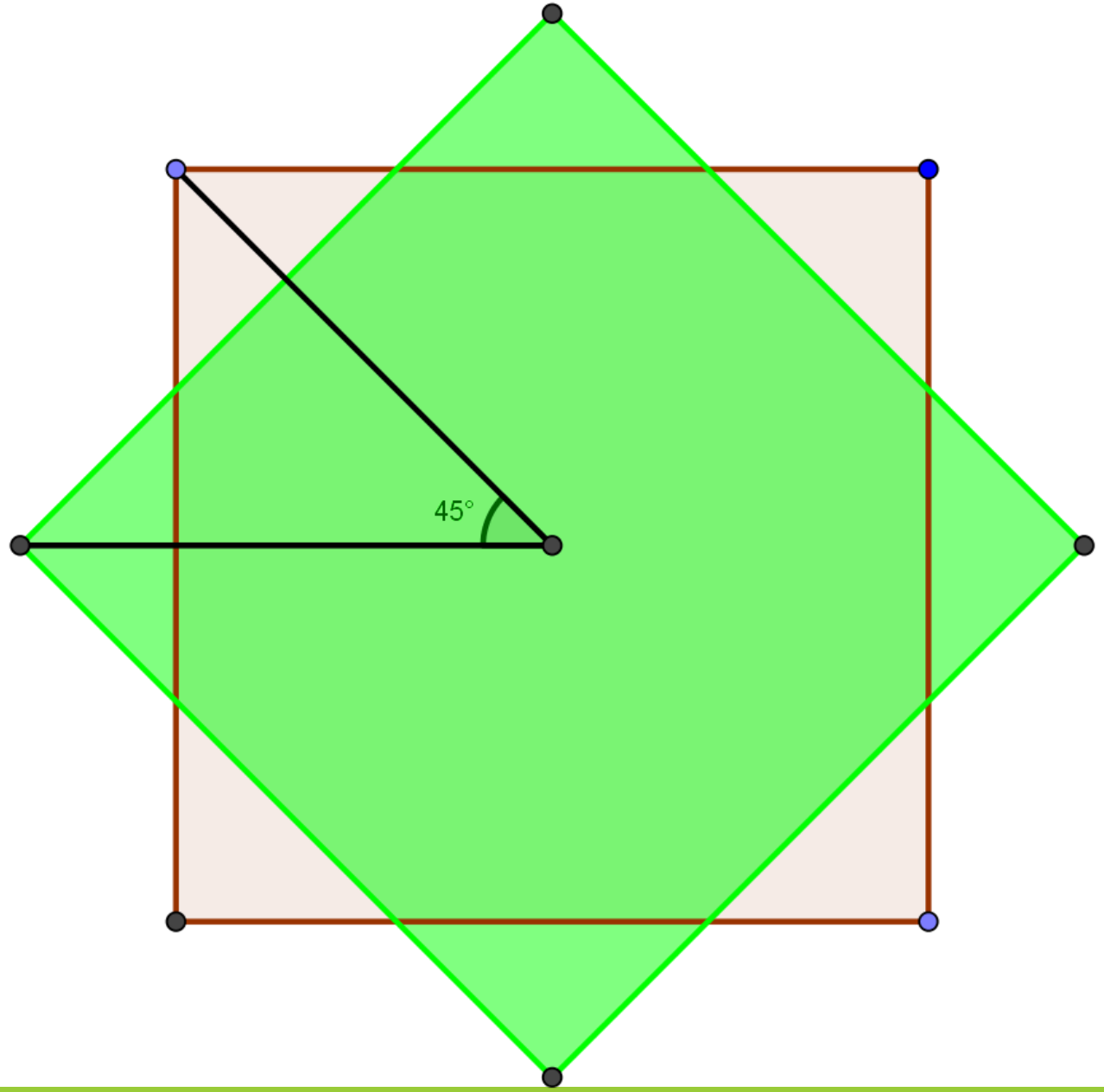
How many faces?

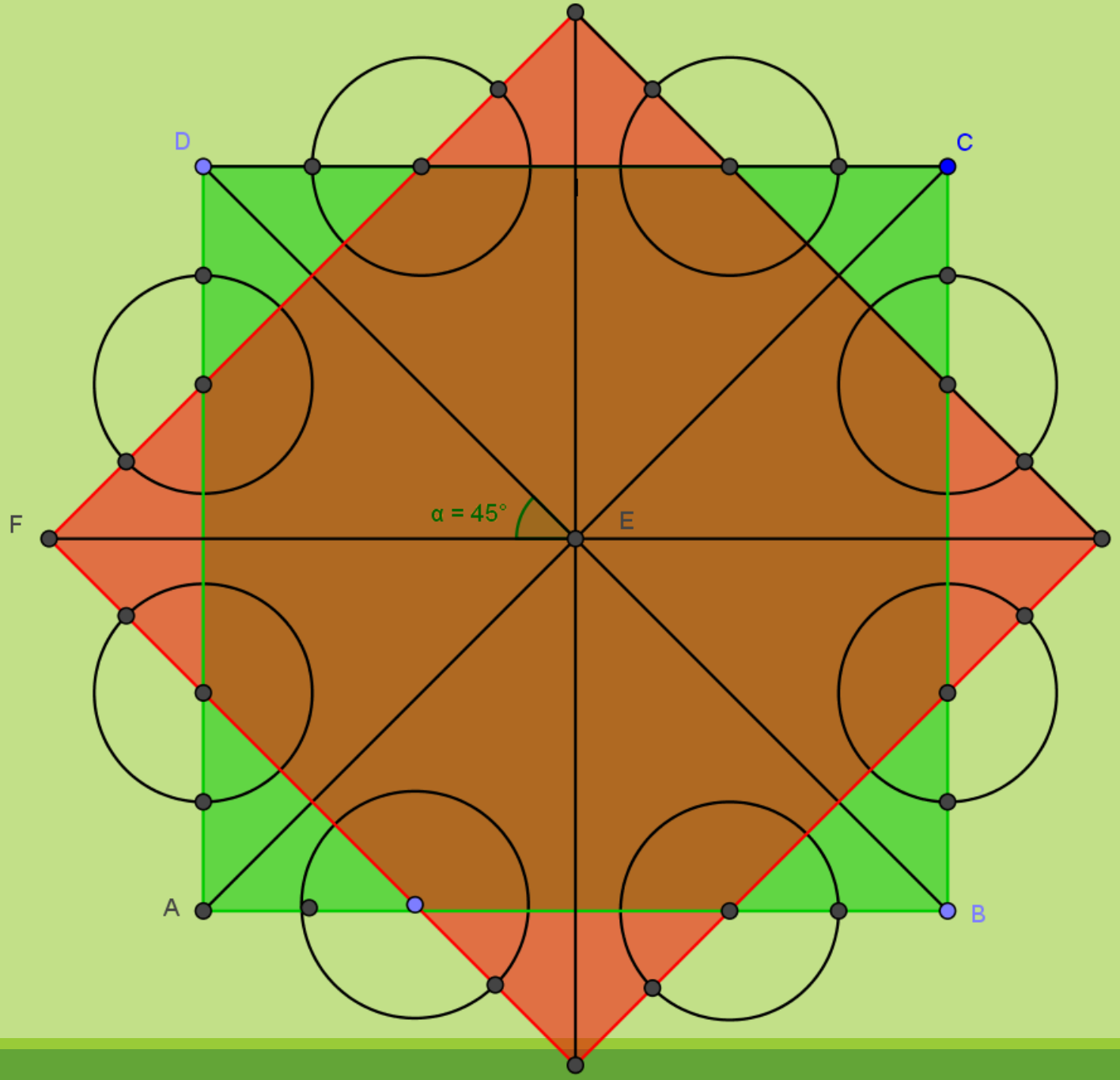


Mathematical Processes

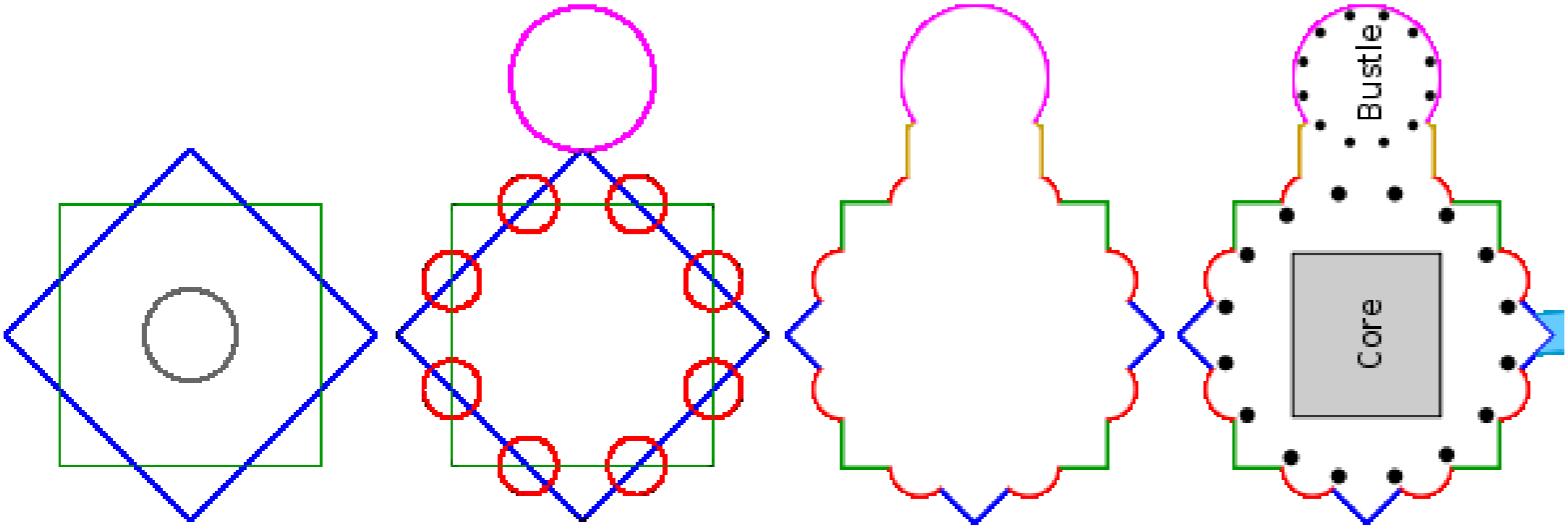
- Problem Solving
- Reasoning and Proof
- Communication
- Connection
- Representation

Islamic Art


45°

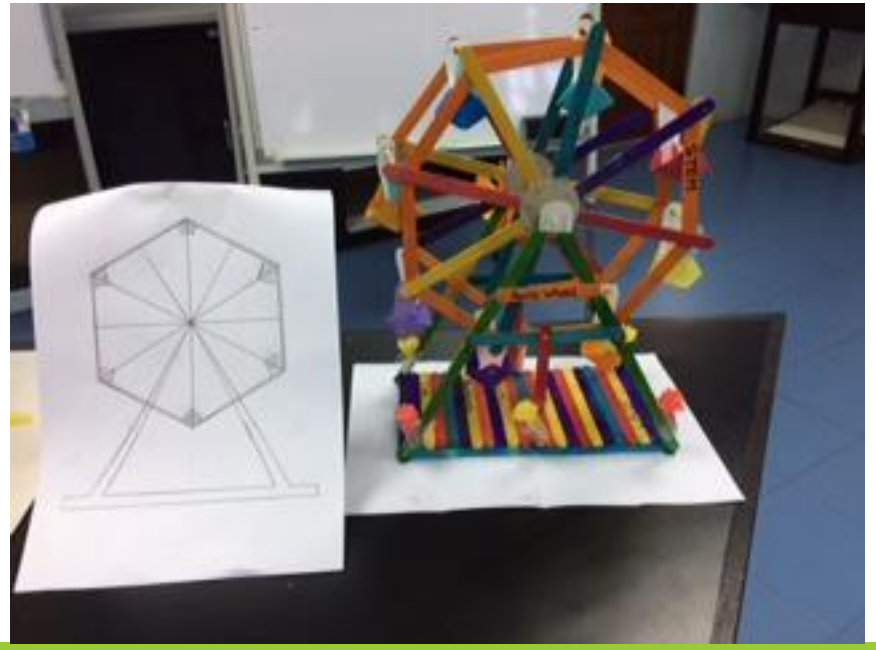

D
C
F
α = 45°
E
A
B

Where is mathematics?



What is STEM Education?

STEM Education is a teaching and learning approach in which science, technology, engineering, and mathematics (STEM) are purposely integrated.



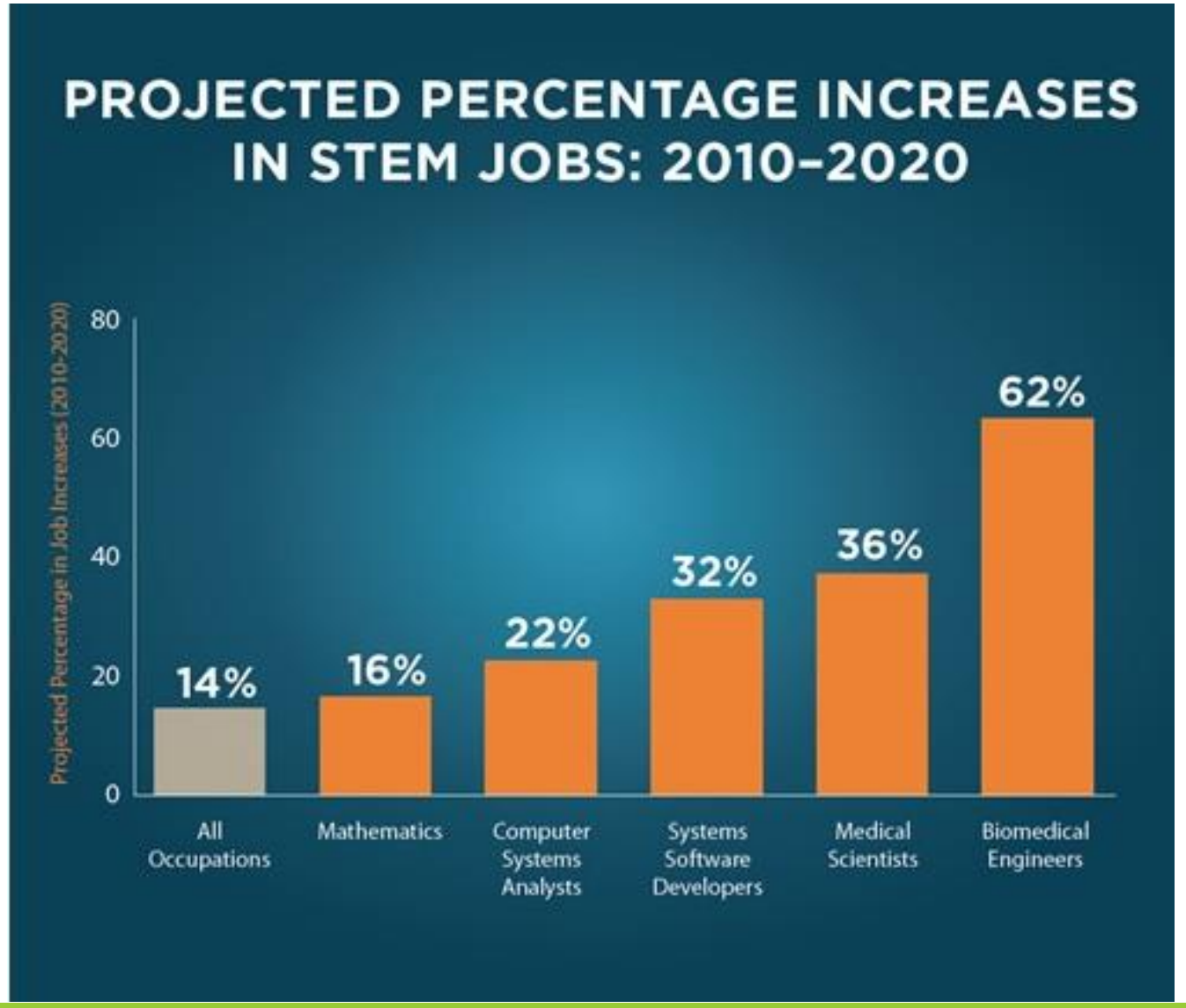
Why is STEM Education so important?

"… Leadership tomorrow depends on how we educate our students today- especially in science, technology, engineering and math."

President Barack Obama, September 16, 2010.

Transportation

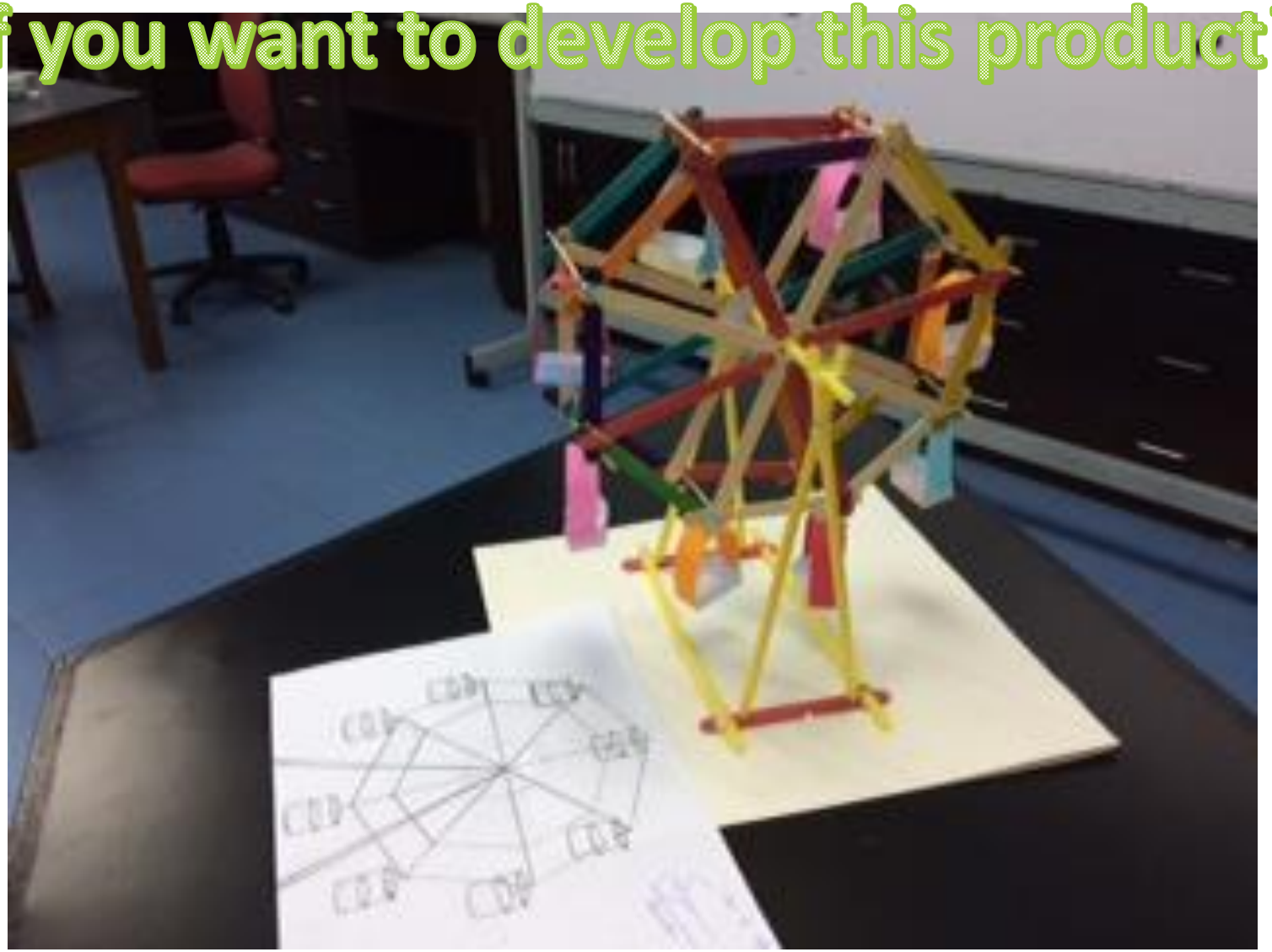
The need in the future



What do we hope from STEM education on our students?

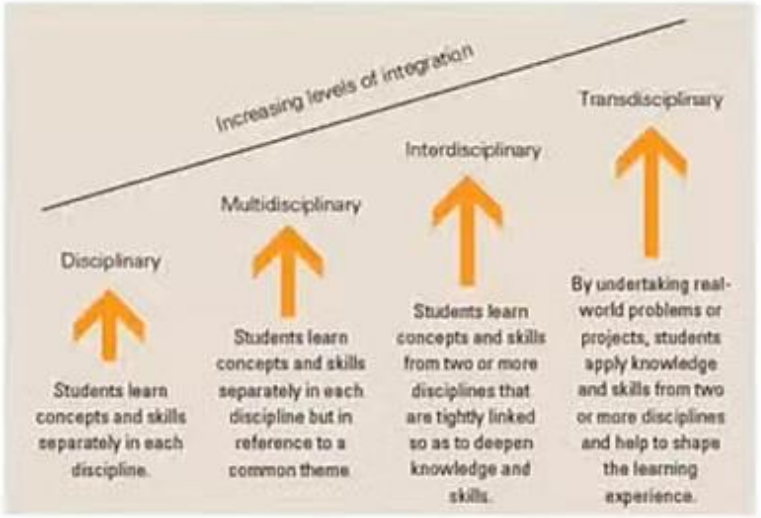
Students	How/Characteristics
Problem solves	Tackle problems
Innovators	To pursue independent and original investigation
Inventors	Creatively design and implementing solutions
Self-reliant	Se self agendas and work within timeframes
Logical thinkers	Able to calculate and make connections
Collaborators	Working in groups

What are you going to do if you want to develop this product?



STEM Integration

- Multidisciplinary Integration or Thematic Integration
- Interdisciplinary Integration
- Transdisciplinary Integration



Multidisciplinary Integration

- "Connects the individual disciplines by organizing the curriculum around a common theme such as "Oceans," "Ecosystems," "Flight," or "Pirates.""
- Coherent learning experience
- Different ways to learn about a topic
- Standards
- Students' interests
- Negative: theme the only connection between disciplines

Interdisciplinary Integration

- "Teachers organize the curriculum around common learning across disciplines."
- "Learning goals from two disciplines are "fused" to form a single key concept or skill."

Interdisciplinary Example

Better concept of scale

- Science
  - Similarities and differences between planets
- Mathematics
  - Use of ratios
- Single key concept/skill
  - Scale a model to grasp size and distances of planets

Images from Wikipedia ("Solar System" and "New Solar System")

Interdisciplinary Integration

- "Teachers organize the curriculum around common learning across disciplines."
- "Learning goals from two disciplines are "fused" to form a single key concept or skill."
- Deeper level of understanding
- Not entirely distinct from Multidisciplinary Integration
- Differ in degree
- Identifying disciplines not as significant

Transdisciplinary Integration

- "Real-world problems or projects students apply knowledge and skills from two or more disciplines"
- Relevant problems and projects
- "Organize curriculum around student questions and concerns"

Transdisciplinary Example

- Essential or Driving Question:
  - "How would a meteorologist forecast the weather on Planet X?"
- Science: give weather report from different planet
- Art: build studio sets
- English: scripts for forecast
- Math: time it takes for radio transmission to reach Earth

Images from Wikipedia ("Sky" and "Today - U.S. TV Program")

Project-Based Learning + Problem Solving = Transdisciplinary Learning

Project-Based Learning (PBL)

- Essential Question (Driving Question)
- Standards-Based STEM Learning Objectives
- Students' Previous Experiences
  - Decision-making skills
  - Apply own interests and prior experiences
  - Teachers as facilitators
- Project Central to Curriculum
  - Broken into manageable small tasks
  - Product or performance
  - Ongoing and multiple types of assessment
  - Models and rubrics

Integration of STEM in Math Classroom

Strategies for Implementation

- Identity Content Standards
- Identify Big Ideas & Key Concepts
- Identify Essential Questions (Driving Question)
- Establish what the students know and be able to do
- Create multiple and ongoing assessment opportunities throughout the learning experiences
- Design interdisciplinary learning activities

MULTI- , INTER-, OR TRANS-

Theme Park

Engineering Design Process

Marble Roller Coaster Challenge

Materials:

1. masking tape
2. newspapers
3. scissors/Cutter
4. A 4 paper (recycle paper)
5. ruler
6. cutting mat
7. marble

Marble Roller Coaster Challenge

Instruction:

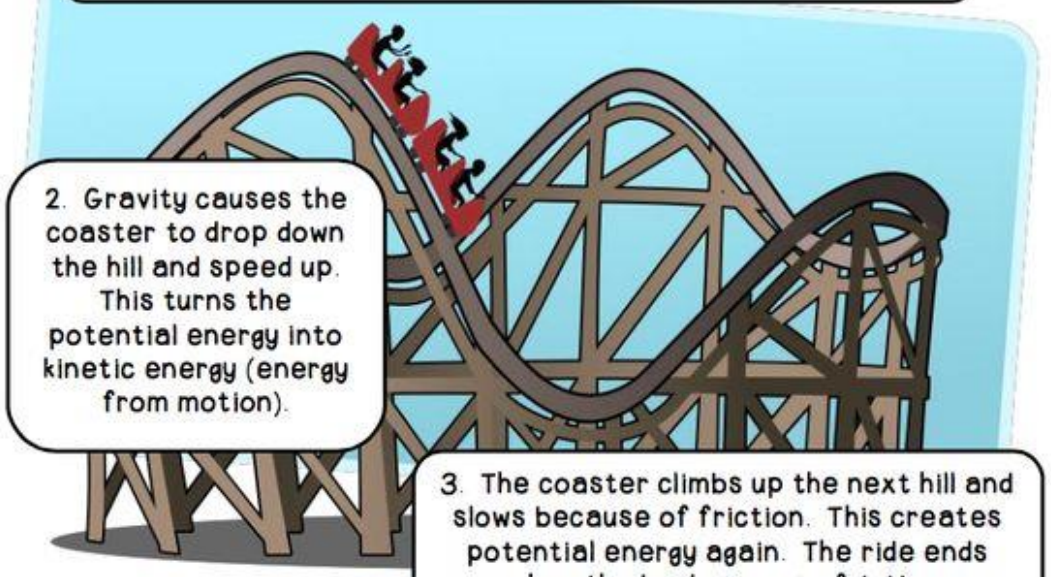
- Create a roller coaster that will carry a marble down a height of at least 35 cm. high.
- It must make one turn and come to a complete stop.
- You will not get any additional resources.
- Once you release the marble, you may not touch it.

Roller Coasters

Roller coasters don't have engines. They run by forces. Forces can make objects speed up, slow down, or change direction. Their speed comes from racing down the first hill.

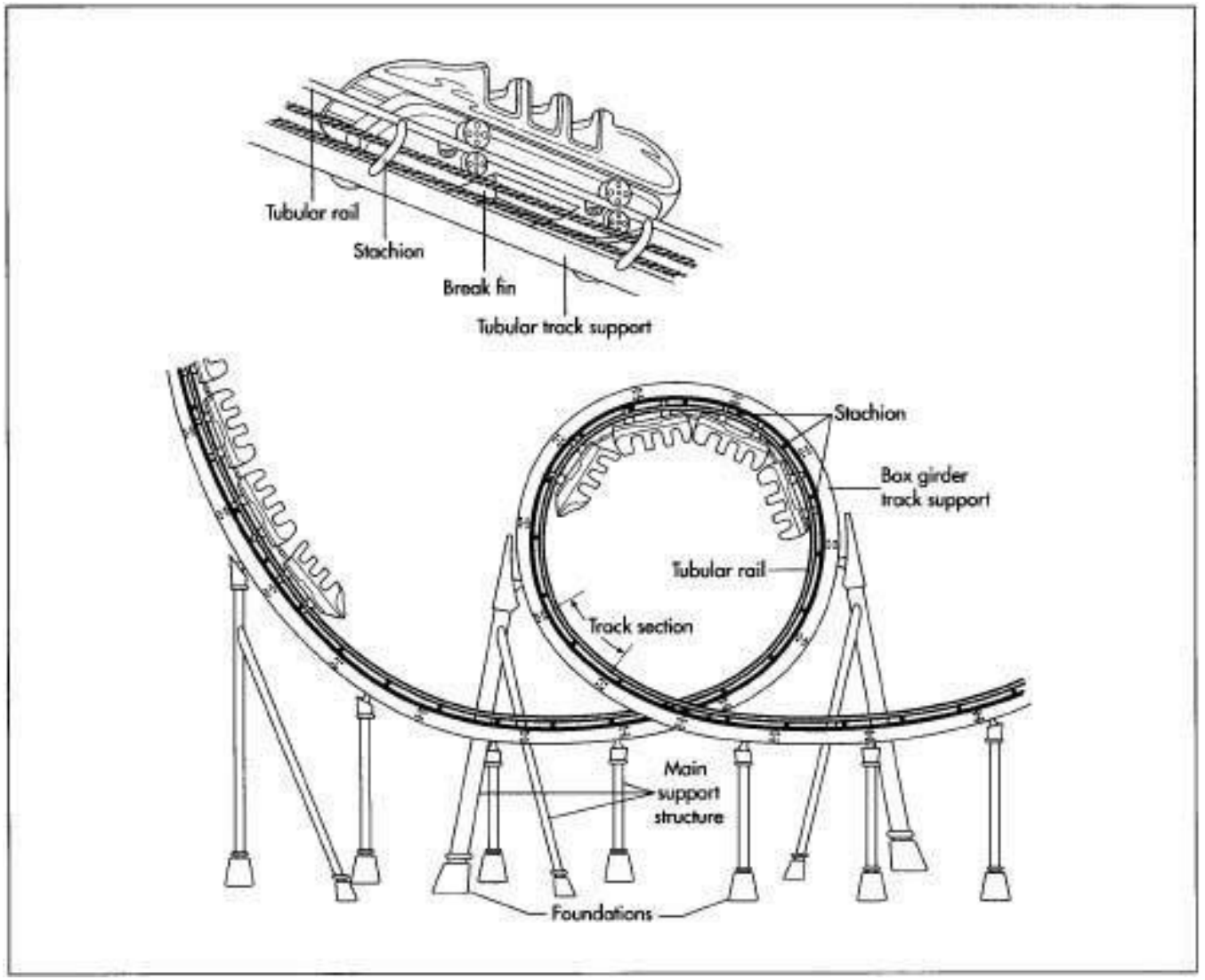
Gravity is the force that pulls the car through the coaster. Gravity pulls the coaster toward the earth.

1. The ride starts with an electric motor pulling the coaster up a tall hill. Potential energy (stored energy) occurs.



2. Gravity causes the coaster to drop down the hill and speed up. This turns the potential energy into kinetic energy (energy from motion).

3. The coaster climbs up the next hill and slows because of friction. This creates potential energy again. The ride ends when the brakes cause friction.



How is mathematics used for roller coaster?

- Math is used to calculate the height of the roller coaster and to produce the optimal results for speed after the roller coaster has left the pulley.
- The engineers must calculate the perfect angles, heights and directions that will allow the roller coaster to reach great speeds without going off of the track.
- They use many machines, test coasters and models to come up with the perfect angles.

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How is mathematics used for roller coaster?

- Roller coaster cars do not have any engines.
- They are completely controlled by the angles and the velocity they reach while going down the first big drop.

How is mathematics used for roller coaster?

- The most exciting roller coaster designs contain one or more loops.
- The loops must be built with extreme caution.
- A loop that is too circular will require very high speeds. This would result in a g-force that is too high for people to comfortably withstand.

How is mathematics used for roller coaster?

- A perfect roller coaster loop is a teardrop shape called a clothoid loop.
- In a circle loop, the radius is constant but In a clothoid loop the radius changes and is shorter at the upper part of the loop than it is across the center. This means the roller coaster car can get through the loop at lower entry speeds.
- Advanced math functions are used to model clothoid loops in computer programs.

References

https://www.ed.gov/stem

https://www.stemschool.com/articles/what-is-stem-education