Introductory Activity Guide

Exhibition Overview

Mazes & Brain Games, is a mind-boggling collection of mazes, 3-D puzzles and full-body brain games. On your visit, your students will engage in critical and creative thinking, individual and group challenges, and learn what makes our own brains better at problem solving.

Across this multi-layered exhibition, your students will complete cognitive and physical activities that highlight learning concepts in:

- Critical Thinking & Problem Solving
- Communication & Comprehension
- Mathematics
- Science
- Visual Art
- Music
- Social Studies
- Physical Education
- And more!

This activity guide is designed as an introduction to information and ideas that will be explored in *Mazes & Brain Games*. Each of these activities can be adapted across multiple Elementary and Middle School grade bands by using age-appropriate examples.

For information on which exhibition components connect to specific learning standards, please see the *Mazes & Brain Games* Components & Learning resource sheet.

We hope you and your students enjoy this amazing experience!

Contents

What is a Maze?

Overview:

⇒ Students will use problem solving skills to complete both mazes and labyrinths.
⇒ Students will compare and contrast mazes and labyrinths and identify similarities and differences in a variety of mazes.
⇒ Students will demonstrate an understanding of the definition of a maze by creating and sharing their own.

Standards:

- ***NGSS Engineering Design***: Defining and Delimiting Engineering Problems, Developing Possible Solutions
- ***CC English Language Arts***: Speaking and Listening, Integration of Knowledge & Ideas
- ***CC Mathematics***: Operations & Algebraic Thinking

Time: 30-45 minutes

Materials:

- ☐ Printed mazes (See Additional Resources below Activity)
- ☐ Printed labyrinths (See Additional Resources below Activity)
- ☐ Whiteboard and markers
- ☐ 8.5x11" sheets of paper
- ☐ Pencils and erasers
- ☐ *Optional*: Plastic page protectors; Dry erase markers

Activity:

Part 1:

- Provide each student with a copy of an age/skill appropriate maze (make sure the difficulty of the maze is age/skill appropriate).
- Ask the students to complete the maze. Encourage students to work with partners if they need help.
- After a few minutes, complete the maze as a class. Preferably, use an overhead projector or document camera so that students can follow along. Call on students to provide directions for completing the maze one step at a time.

Part 2:

- Provide each student with a copy of a labyrinth (make sure the complexity of the maze is age/skill appropriate). Complete the labyrinth in the same manner as the maze.
- Ask for students' reactions to completing both the maze and labyrinth.
- Draw a Venn diagram on a whiteboard, or ask students to draw one in a journal. Complete the Venn diagram individually, in small groups, or as a class to compare and contrast mazes and labyrinths.
- Content that may be included:

	Labyrinth	Maze
Meaning	A labyrinth has a single through-route with twists and turns but without branches.	A maze is a confusing pathway that has many branches, choices of path and dead-ends.
Level of difficulty	A labyrinth is not designed to be difficult to navigate. It may be long but there is only one path (unicursal).	A maze is a tour puzzle and can be designed with various levels of difficulty and complexity.
Entry and exit	A labyrinth has only one entrance and that is also the exit. There is just one path from the entrance to the center.	A maze may have different entry and exit points.
Significance	Some labyrinths have a spiritual significance. They signify the complex and long path to reach God.	Mazes are used in science experiments to study spatial awareness and (sometimes) intelligence.

Part 3:

- Review the definitions of mazes and labyrinths to see how they compare to the class Venn diagram.
- Definitions:
    - A **maze** is a path or collection of paths, often with many branches, typically from an entrance to a goal.
    - **Labyrinth** is generally used interchangeably with "maze", but it often refers specifically to a maze with a unicursal, or non-branching, pattern.

Part 4:

- Show students examples of different types of mazes. Ask students to compare the mazes to the definition of "maze" to verify that it is indeed a maze.
- Make sure samples are age/skill appropriate.
- Examples of different types of mazes include:
    - > **Arrow maze** - Mazes where movement is determined by the direction of the arrows. One version includes mazes where you move from arrow to arrow with directional choices that are limited to a few intersections. Another version is where pathways contain arrows that can only be traveled on in the direction the arrow points.
    - > **Block maze** - A maze solved by adding a determined number of blocks to create a pathway to the goal, or by moving (shifting) a determined number of blocks.
    - > **Color maze** - Mazes where the paths that can be taken are determined by a specific order of colors. i.e., moving from red to white to blue, or by alternating colors at each junction.
    - > **Math maze** - A maze where the path taken next is determined by solving a math problem and moving in the direction of the correct answer.

> **Number maze** - Mazes where movement through them is set by a predetermined numerical pattern. i.e., counting by 2's, using only odd numbers, counting by 7's.
> **Picture maze** - A drawn maze that looks like a scene/picture but actually contains a maze to complete within the picture.
> **Hamilton maze** - To solve this maze, you must draw a single loop that goes through every node exactly once.

Part 5:

- Review the key characteristics of mazes.
- Provide students with 8.5" x 11" paper and pencils on which to create their own mazes.
- Students can trade mazes with each other to complete them.
- Optional: when students have finished drawing their mazes, place the mazes in plastic page protector sleeves and provide students with dry erase markers. This way, the original mazes can be reused for multiple partners.

Additional Resources:

- Background Information:
  - Labyrinth vs. Maze - Difference and Comparison
  - Do You Maze? Types of Mazes
- Printable mazes worksheets
- Printable labyrinth images

What is a Puzzle?

Overview:

⇒ Students will use critical thinking skills to complete a variety of puzzles.
⇒ Students will observe, assess, compare/contrast, and categorize each puzzle.
⇒ Students will demonstrate an understanding of puzzles by creating their own description of what qualifies as a puzzle.

Standards:

- ***NGSS Engineering Design***: Defining and Delimiting Engineering Problems, Developing Possible Solutions
- ***CC English Language Arts***: Speaking and Listening, Integration of Knowledge & Ideas
- ***CC Mathematics***: Operations & Algebraic Thinking

Time: 30-45 minutes

Materials:

- ☐ A variety of printed puzzle worksheets (See Additional Resources below Activity)
- ☐ Pencils and erasers
- ☐ Physical puzzles (See Additional Resources below Activity)
- ☐ White board and markers

Activity:

Part 1:

- As small groups or as a class, allow students time to complete a handful of different types of puzzles (can be printed or physical puzzles). Make sure to choose age/skill appropriate puzzles for your students.
- Review the solutions as a class to make sure everyone is able to solve the puzzles. Ask for student volunteers to provide instructions for completing each.

Part 2:

- Have students work in partners or as a class to come up with a list of similarities and differences between each type of puzzle.
- Example discussion questions could include: Did they use numbers, words, or pictures? What instructions were provided? Was there a grid or other structure or was it free form? What kind of logic was required or was it trial and error? Was there one solution or many?
- Record this list on a white board for future reference.

Part 3:

- Review with students the different types of puzzles listed below and an example of each:
    - **Logic puzzles**
        - As the name implies, logic puzzles require a great deal of logical deductive inferences. While there is not a standard approach to solving these puzzles, they

usually have only one unique solution. Students might see logic puzzles presented as a grid, sometimes with a few answers already filled in.
        - Examples: Sudoku, logic grid puzzles
    - **Math puzzles**
        - In a math puzzle, the solver must find a solution that satisfies a given equation that is usually laid out in the puzzle.
        - Example: Equation Crossword Puzzle
    - **Mechanical puzzles**
        - Mechanical puzzles are considered to be the oldest types of puzzles, originating from ancient Greece. They are presented as a set of interlinked pieces where the solution requires manipulating all or some of the pieces. Many of them involve trial and error, while some can have an element of logic to solving them.
        - Examples: jigsaw puzzles, nail puzzles, Rubik's Cubes, assembly and disassembly puzzles
    - **Word puzzles**
        - Word puzzles require knowledge of a language. Not only do they put your vocabulary to the test, but they also allow you to think logically, and they also include a mathematical element in them.
        - Examples: crosswords, anagrams, word searches, Scrabble, Bananagrams
    - **Cryptic puzzles**
        - A cryptic puzzle is a type of puzzle where a clue is given and the solver has to figure out the word or phrase that the clue is referring to.
        - Examples: riddles, brain teasers
    - **Photographic puzzles**
        - Photographic puzzles, also known as "Spot the Difference" puzzles, feature two similar, but not exactly the same, images arranged parallel to each other.
        - Examples: spot the difference image search
- Given what they know about the different types of puzzles now, ask students to categorize the puzzles they completed earlier and justify their decisions.

Part 4:

- First with a partner and then as a class, ask students to use their experience with the puzzles today to define "What is a puzzle?"
- After giving them time to think, share a simple definition of a "puzzle" as **a game, problem, or toy that tests a person's ingenuity or knowledge.**

Part 5:

- Ask students to reflect on their own as well as the standard definition of "puzzle."
    - Would they change any part of it or include or exclude something else?
    - Do they think any type of puzzle from those listed above should fall outside of the definition?

Optional Extension:

- A "puzzler" is someone who composes and/or solves puzzles. Write a report or give a presentation on one of these notable puzzlers:
    - Ernő Rubik
    - Sam Loyd
    - Henry Dudeney
    - Boris Kordemsky

  - David J. Bodycombe
  - Will Shortz
  - Oskar van Deventer
  - Lloyd King
  - Martin Gardner
  - Raymond Smullyan
- Compare what some of these famous puzzlers have in common and what are some of their differences.

Additional Resources:

- Background information
  - Types of puzzles
  - How Many Types of Puzzles are There?
- Printable puzzles
  - Assorted printable puzzles
  - Logic puzzles of varying difficulty (these can also be played online)
  - Elementary Math Puzzles worksheets
  - Cryptograms
  - Brain teasers
- Physical puzzles that can be made from common or easy to find items
  - Printable Tangrams and pattern cards
  - Balancing nail puzzle
  - Soma cube

What is an Illusion?

Overview:

- Students will identify the 5 senses and how they aid our perception of the world.
- Students will use optical illusions to help explain how our brains interpret images.
- Students will create optical illusions to explore the sense of sight.

Standards:

- ***NGSS Life Science***: Structure and Function, Information Processing
- ***NGSS Engineering Design***: Developing Possible Solutions
- ***CC English Language Arts***: Speaking and Listening

Time: 30-45 minutes

Materials:

- Example optical illusions (printed or digital)
- Drawing paper
- Pencils
- Colored pencils, markers, or crayons
- Scissors
- Tape or glue sticks
- Rulers
- *Optional*: Straws, string, or rubber bands for thaumatrope

Activity:

Part 1:

- Review the 5 human senses (sight, hearing, smell, touch, taste) with students and ask students to share examples of how we use each sense.
- Explain that we use our senses to "perceive" or develop an awareness and understanding of the world around us. For example, any time the eye perceives light, the brain processes the light to form an image that we can interpret.

Part 2:

- Introduce illusions by explaining that sometimes our senses can trick our brains and we have a hard time figuring out what we are really perceiving.
- Show students an optical illusion and gather their reactions.

Part 3:

- Explain that an illusion is a perception that doesn't agree with objective measurement or observation. This is an example of an optical illusion because our brains can't make sense of what we're seeing.
- During an optical illusion, the brain interprets the image, but there is a disconnect between what the eye sees and how the brain interprets it. The brain makes its best guess and fills in information based on prior knowledge; however sometimes the best guess is wrong. For instance, your brain may interpret that an object is moving when that is not the information the eyes meant to convey.

- Scientists have no hard explanation for optical illusions but suggest evolution and physiology play a key part. Illusions are useful because they help us learn how our brains work.

Part 4:

- Review other examples of different types of optical illusions and discuss how the tricks of the eye and the brain's interpretations are similar or different between examples.
    - **Literal** - A literal illusion is when two images seamlessly look like one image. The brain will try to interpret it as one while the eyes send communication to the brain to analyze it as two.
        - Examples: Duck-Rabbit, Rubin's Vase
    - **Physiological** - These are images formed due to the overuse of the brain's senses as the brain is susceptible to movement. Physiological illusions occur when the eye perceives too much light, movement, and color, confusing the brain.
        - Examples: Afterimage illusions such as the American Flag
    - **Cognitive** - Of the three types of visual illusions, these are the most complex. Cognitive illusions use the subconscious part of the brain and how well the brain relates to the image. The brain is responsible for giving depth to your thoughts and whatever the eyes see.
        - **Ambiguous** – Necker Cube
        - **Distorting** – Cafe Wall, or the rising full moon
        - **Paradox** – Penrose Stairs, Impossible Trident
        - **Fictional** – also known as hallucinations

Part 5

- Provide materials to students to create one or more of the following optical illusions, depending on the time available and students' skills.
    - Bird in a Cage or other thaumatrope designs
    - 3D Trick Hand Illusion

Additional Resources:

- Background information
    - Optical Illusions
    - Types of Illusions