Erasmus+ Cultural connections : Enhancing EU heritage, Social Inclusion and Digital Literacy through our Pupils' hearts
Scientific and Creative Thinking Workshop
7-12 December 2025, Ukmerges, Lituania

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International Learning Mobility Week in Ukmergė: innovative teaching methods, creative thinking, and intercultural cooperation

METHODOLOGICAL GUIDE

TABLE OF CONTENTS

INTRODUCTION
LESSON PLANS
ACTIVITIES SUGGESTED
SCIENTIFIC EXPERIMENTS

INTRODUCTION

On December 8–12, 2025, **Ukmergė Užupis Lower Secondary School** organized an international learning mobility week, implemented under the **Erasmus+ program project "Cultural Connections: Enhancing EU Heritage, Social Inclusion and Digital Literacy through the Hearts of Our Students."**

Teachers from four project partner countries, Lithuania, Romania, Turkey, and Spain, participated in the mobility activities. The five-day training program focused on strengthening teachers' professional competencies, with particular attention paid to the application of **innovative teaching methods, the development of creative and critical thinking, the principles of inclusive** education, interdisciplinary teaching and the strengthening of intercultural relations. Throughout the activities, participants worked in international teams, carried out learning activities themselves, analyzed teaching methodologies, and discussed how they could be applied in different education systems and student groups.

Project Impact

The international mobility week demonstrated that modern education is based on **innovative teaching approaches, creative learning practices and active international cooperation**. During five intensive days, participants not only gained new pedagogical knowledge and practical skills, but also strengthened intercultural connections between partner schools. Such experiences encourage teachers to apply new teaching methods in their classrooms, create more inclusive learning environments and foster students' **creative, critical and scientific thinking.**

Mobility Description

From **8 through 12 December 2025**, **Ukmergės Užupio Pagrindinė Mokykla** hosted an international mobility week within the **Erasmus+** project *"Cultural Connections: Enhancing EU Heritage, Social Inclusion and Digital Literacy through the Hearts of Our Students."*

Teachers from Lithuania, Romania, Türkiye and Spain participated in the programme. The activities focused on **innovative teaching methods, creative and scientific thinking, interdisciplinary learning, inclusive education practices and intercultural cooperation.** The programme included workshops, collaborative learning activities, robotics sessions, creative tasks and an educational visit to the **Lithuanian Museum of Ethnocosmology**.

ACTIVITY RESULTS:

The results of the activity include:

- **6 learning activities** created by the teachers in the mobility based on **scientific, creative and critical thinking;**
- **2 lesson plans** based on scientific, creative and critical thinking;
- **9 practical experiments** and learning activities that provide pupils with hands-on experience on scientific experiments.

All these have been included in the current document to be used as training material for teachers to apply in their own daily activity in the 4 participant schools.

***Note**: " AI usage notice:*
Artificial intelligence tools (ChatGPT, Bing, Mindmapai) were used in the drafting or structuring of this material. All generated content was subsequently reviewed, edited, and validated by the project team to ensure accuracy and quality."

LESSON PLANS

LESSON PLAN # 1

Mathematics Lesson Plan: Proportions
Empowerment through Decision-Making and Inquiry

Subject: Mathematics
Topic: Proportions and proportional reasoning
Grade: Lower secondary (Grades 6–7)
Duration: 50 minutes
Lesson type: Inquiry-based, student-centred

Learning Objectives

By the end of the lesson, students will be able to:

- apply proportions to **real-life situations**
- make **mathematical decisions** and justify them
- work independently and collaboratively
- explain and reflect on their own reasoning

Empowerment Pillars

1. Student choice: students **choose methods**, do not follow algorithms.
2. Shared responsibility and collaboration.
3. Independent inquiry: the teacher guides learning without controlling it.
4. Reflection and self-regulation: reflection closes the learning loop.

5. Students **create mathematical content**.
6. Students **justify decisions** publicly.

Lesson stage	Duration	Activity	Student actions	Teacher role	Teacher intervention	Empowerment element
INTRODUCTION	5’	**Real-Life Trigger** The teacher presents a real context:“In a supermarket, you see two offers: 3 bottles of juice for 12 lei and 5 bottles of juice for 18 lei. Which offer is better?” No method is given.	Students think individually for 1 minute. They write **one idea** about how they might decide.	Facilitator	“I am not asking which one feels cheaper. I am asking: how could we decide mathematically? Write one idea. Any idea.” Possible student reactions “The second one is better because you get more bottles.” “The first one is cheaper because 12 is less than 18.” Some students immediately start dividing. Others hesitate, unsure how to compare.	Students are not told ***how*** to solve the problem; they decide ***how to start thinking.***

CHOOSING DIRECTION	7’	Students form **small groups (3–4)** and choose: -how to compare (price per item, ratio, table, drawing), -who will take which role (calculator, explainer, checker). Each group writes on a mini-card: “**We will compare the offers by…**	Choose strategies Answer questions Decide who takes which role. Roles are displayed: **Calculator** – carries out calculations and checks numbers. **Explainer** – prepares to explain the method and reasoning. **Checker** – asks: “Does this make sense in real life?” If something is unclear, the checker’s job is to stop the group and ask questions.	Facilitator Guide Clarifier	- Confirms mathematical validity of chosen strategies. - Asks guiding questions only: “When you compare the two, you need a constant, compare the same value or same quantity. What stays constant?” “What are you comparing: value or quantity?” - Clarifies method choice: “There is more than one correct way to compare these two offers. I am **not choosing the method for you**. Your group will decide *how* to compare them, but you must be able to explain your choice.” The teacher then **writes or displays** the following options: *Price per item (unit rate)* *Ratio or proportion* *Table of values*	Students choose the **method**, not the teacher.

INQUIRY AND ACTION Independent Inquiry	15’	Student-Designed Proportion Problem	Each group must: **Solve the supermarket problem** using their chosen method. **Create their own real-life proportion problem**, related to shopping, mobile data plans, recipes, sports statistics. Examples students may create: “Is a 10 GB plan for 25 lei better than a 15 GB plan for 40 lei?” “Which recipe is more concentrated in sugar? Compare quantity of sugar per quantity of flour.” Players’ number of goals per number of matches played	Observes Supports struggling groups with prompts, not solutions Ensures correctness through checkpoints		Students become **problem designers**, not just problem solvers.

			Groups decide: numbers, context, difficulty level. Possible group feedback: "What if Player B played fewer minutes, can we still compare goals per match?"			
COLLABORATION AND SHARING	8'	Students complete three prompts: "*One decision my group made today was…"* *"What helped me understand proportions better was…"* *"Next time, I would…"*	Expected student reflections: *"I usually wait for the formula. Today we had to decide."* *"I understood proportions better when we created our own problem."* *"I was confused at first, but our method made sense."* **Exit Ticket (Self-Assessment)** - Students rate themselves (1–5): *I contributed ideas. / I understood proportions better./ I can apply this to real life.*	Collects evidence for formative assessment.	Formative Assessment ➢ observation of decision-making, ➢ quality of student-created problems, ➢ peer explanations, ➢ reflection responses.	Students evaluate **their own learning**, not just receive grades.

LESSON PLAN # 2

Daily Routines, Habits & Growth Mindset

Empowerment through Choice, Inquiry and Reflection

Subject: English as a Second Language
Grade: 5 (A1–A2)
Duration: 50 minutes
Lesson Type: Inquiry-based, empowerment-focused
Core Message: *Daily habits + mindset shape success*

Language Objectives: By the end of the lesson, students will be able to:

A. Vocabulary (Lexical objectives)

- **identify and use** at least 8–10 verbs related to daily routines:
  wake up, eat, study, train, play, use (phone), focus, sleep
- **recognise and use** basic habit adjectives:
  good, bad, healthy, unhealthy

B. Grammar

- **use the Present Simple affirmative** to describe habits: *I study every day. He uses his phone too much.*
- **use frequency adverbs** in simple sentences: *always, usually, sometimes*

C. Functional Language (Communicative objectives)

Students will be able to:

- **describe daily routines** (self and others);
- **express cause–effect in a simple way**: *He studies, so he succeeds.*
- **express effort and improvement** using fixed growth-mindset chunks:
  I can improve. / I will try again. / This may take some time.

Life Learning Objectives

By the end of the lesson, students will be able to:

- identify **good and bad habits** in real-life situations;
- use **growth mindset phrases** instead of fixed mindset ones;
- explain how habits affect success or failure;
- reflect on their own habits and learning.

Empowerment Pillars

- **Student choice:** how to analyse the character, how to present ideas
- **Independent inquiry:** students interpret the video and poster
- **Shared responsibility:** roles and peer feedback
- **Reflection & self-regulation:** habits, mindset, learning choices
- **Student voice:** opinions, justifications, personal connections

1. START – Sparking Motivation (5 minutes)

Activity: Prediction & Personal Connection: Teacher shows the first seconds of the video (paused). Teacher prompt (scripted): “You will watch a short video. This character will make choices every day. Some choices are good. Some are not. What do you think will happen to him?” Students respond with single words or short phrases: *happy*, *successful*, *lazy*, *tired*, *rich*, *poor.*

Empowerment element: Students predict outcomes; no correct answer is given.

2. INQUIRY INPUT – Video Analysis (8 minutes)

Activity: Guided Viewing – Habits & Consequences. Students watch the full clip. On the board, teacher draws two columns:

GOOD HABITS | BAD HABITS

Teacher prompt: “Watch carefully. What does he do every day? What helps him? What hurts him?” Students call out or write:

1. eats junk food / eats healthy food
2. studies / cheats
3. trains / stays on phone
4. focuses / chats with friends during work

Teacher only clarifies vocabulary if needed (gestures, examples).

3. CHOOSING DIRECTION – Meaning Making (7 minutes)

Activity: Group Choice – How to Analyse the Story Students form groups of 3–4. Each group chooses:

1. **How to organise ideas**
    - table (good vs bad habits),
    - timeline (before → after),
    - drawing / symbols,
    - short sentences.
2. **Roles**
    - *Speaker*
    - *Writer/Drawer*
    - *Checker* (“Does this make sense?”)

Teacher prompt: “You decide how to work. I will not choose for you. But your group must explain *why*.” Teacher checks feasibility only.

4. INQUIRY & ACTION – Growth Mindset Integration (15 minutes)

Activity 1: Habit → Result Mapping Each group completes:

I. **3 bad habits** from the video → **result**
II. **3 good habits** from the video → **result**

Example student sentences: *He eats junk food. He feels tired. He studies every day. He becomes successful.*

Activity 2: Growth Mindset Poster Challenge

The teacher displays the **Growth Mindset poster**. Teacher instruction:“Now we change the story. We will help the character think better.”

Each group:

- chooses **3 fixed mindset sentences** from the poster;
- rewrites them using **growth mindset thinking**;
- connects them to the video character.

Example student output:

➔ *Instead of “I give up” → “I’ll use a different strategy”*
➔ *Instead of “This is too hard” → “This may take some time”*

Teacher intervention (scaffolded): “Which sentence fits the moment when he failed?” “Which sentence fits when he changed his habits?”

Empowerment element: Students select language, not repeat it mechanically.

5. COLLABORATION & SHARING – Responsibility Shift (10 minutes)

Activity: Peer Teaching – “Advice to the Character” Groups exchange work. Each group gives **one piece of advice** to the character: *Stop cheating and practise. Train your brain every day. Use Plan B.* Teacher rule for feedback: “Say one good idea. Say one improvement.” Teacher moderates tone, not content.

Empowerment element: Students correct thinking, not the teacher.

6. REFLECTION & SELF-REGULATION (5 minutes)

Activity: Personal Reflection (Written or Oral) - Students complete:

1. *One bad habit I want to change is…*
2. *One good habit I want to keep is…*
3. *One growth mindset sentence for me is…*

Examples:

1. *I spend too much time on my phone.*
2. *I will learn how to do this.*
3. *Mistakes help me learn*

Exit Ticket – Self-Assessment (1–5)

- I participated.
- I understood habits and results.
- I can use growth mindset sentences

WORKSHEET 1 Watch & Notice – Habits and Results

Name: _____ Class: _____

Task 1 – Watch the video

Tick (✔) what you see.

Habit	Yes	No
Eating junk food	☐	☐
Eating healthy food	☐	☐
Studying	☐	☐
Cheating	☐	☐
Training / exercising	☐	☐

Staying on the phone	☐	☐
Focusing on work	☐	☐
Hanging out instead of working	☐	☐

Task 2 – Match habit to result

Draw lines.

- Eats junk food → feels tired
- Studies every day → becomes successful
- Cheats → fails
- Trains regularly → becomes strong
- Uses phone too much → loses focus

WORKSHEET 2

Good Habits vs Bad Habits

Task 3 – Complete the table

GOOD HABITS	BAD HABITS
_____	_____
_____	_____
_____	_____

Task 4 – Write sentences

Use simple present.

1. A good habit from the video is:
   He / She _____.
2. A bad habit from the video is:
   He / She _____.

WORKSHEET 3 Growth Mindset Language (Poster-Based)

Look at the **Growth Mindset poster** in class.

Task 5 – Change the thinking. Rewrite the sentences.

1. *I'm not good at this.*
   → _____
2. *I give up.*
   → _____
3. *This is too hard.*
   → _____
4. *I made a mistake.*
   → _____

(You may copy or adapt sentences from the poster.)

WORKSHEET 4 Connect Mindset to the Video Character

Task 6 – Choose & Explain: Circle ONE sentence from the poster that could help the character.

- I can always improve
- I will learn how to do this
- Mistakes help me learn
- I'll use a different strategy

Why this sentence helps the character:

_____

_____

_____

WORKSHEET 5 My Daily Routine & My Mindset

Task 7 – My habits - Complete the sentences:

1. Every day, I _____.
2. After school, I _____.
3. A habit I want to change is _____.

Task 8 – My Growth Mindset Sentence - Choose one and complete it:

1. *I am going to train my brain by* _____.
2. *This may take some time, but I will* _____.
3. *I will learn from* _____.

WORKSHEET 6 Reflection & Self-Assessment (Exit Ticket)

Tick (✔).

Statement	Yes	A little	Not yet
I spoke English today	☐	☐	☐
I understand good and bad habits	☐	☐	☐
I used a growth mindset sentence	☐	☐	☐

One sentence to finish:

Today I learned that habits _____.

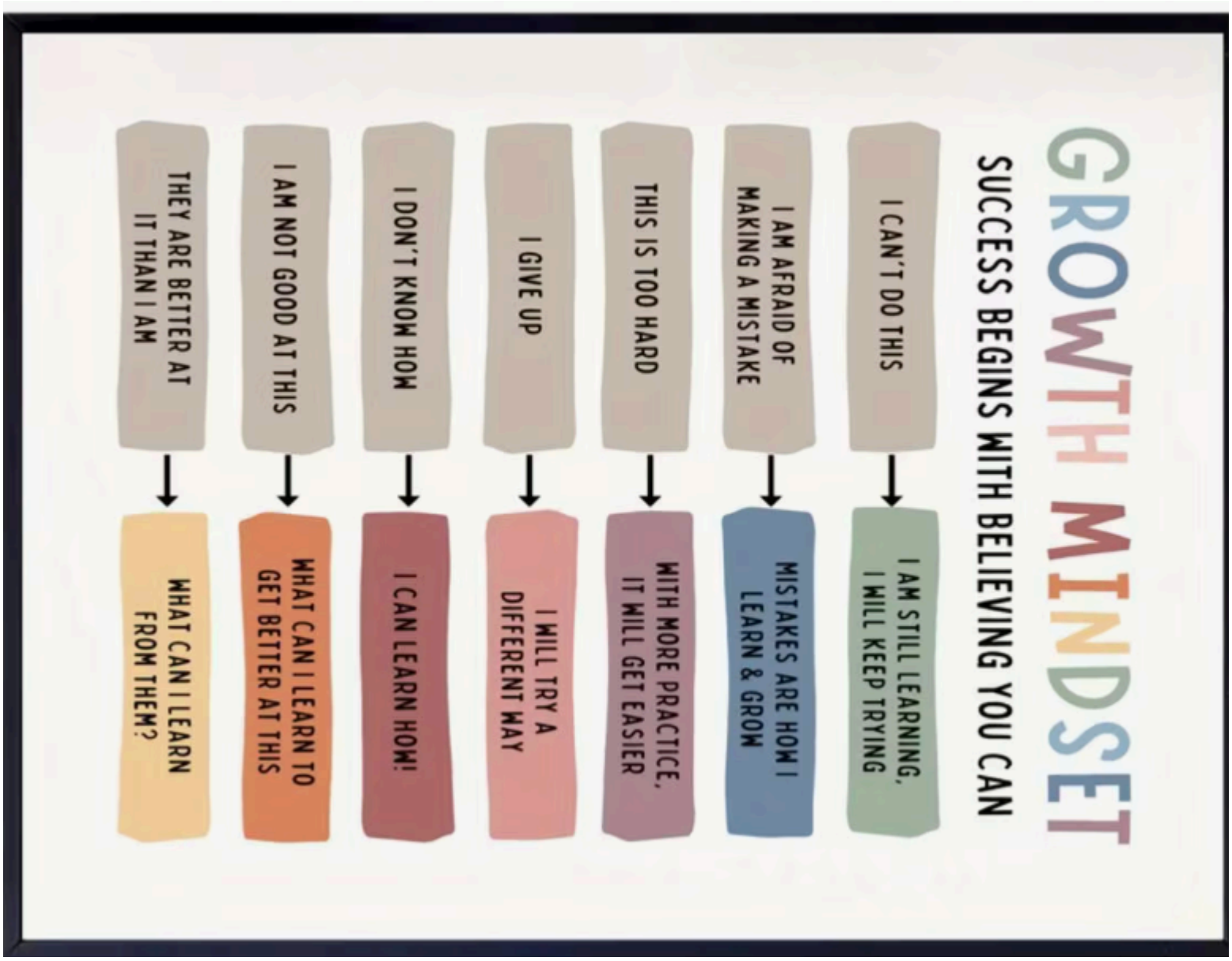
Sources:

https://hrzone.com/these-words-help-people-develop-growth-mindsets/

https://www.youtube.com/watch?v=_HEnohs6yYw

https://chatgpt.com/

Poster:


GROWTH MINDSET
SUCCESS BEGINS WITH BELIEVING YOU CAN
I CAN'T DO THIS
I AM STILL LEARNING, I WILL KEEP TRYING
I AM AFRAID OF MAKING A MISTAKE
MISTAKES ARE HOW I LEARN & GROW
THIS IS TOO HARD
WITH MORE PRACTICE, IT WILL GET EASIER
I GIVE UP
I WILL TRY A DIFFERENT WAY
I DON'T KNOW HOW
I CAN LEARN HOW!
I AM NOT GOOD AT THIS
WHAT CAN I LEARN TO GET BETTER AT THIS
THEY ARE BETTER AT IT THAN I AM
WHAT CAN I LEARN FROM THEM?

LESSON PLAN # 3

Pupils as Learning Agents – Students as Co-Creators of the Learning Process Through the Fairy Tale *"The Three Little Pigs"*

Objectives:

To develop students' ability to design their own learning process.

To analyze a fairy tale through experiential activities and visual techniques.

To solve real creative problems through group inquiry.

To promote critical thinking, reflection, and awareness of one's own learning.

To collaborate in three different groups that exchange information with one another.

Materials: Sticky notes, A3 paper, thick colored markers, pens, timers, phones or work tablets, various learning examples.

STAGE 1. INTRODUCTION (10–15 minutes)

1.1. Mini Story Reconstruction. The teacher briefly reminds students of *"The Three Little Pigs"* but does not retell the entire story—only three episodes:

1. The pigs decide to build houses.
2. The construction results are different.
3. The wolf attempts to break in.

1.2. Task for Students. Students decide for themselves what knowledge they are missing to understand why events unfolded as they did.
Questions students formulate:

1. Why did some pigs choose straw, others wood or bricks?
2. How do these materials differ?

3. What was the wolf unable to overcome?
4. How did the characters' choices affect the course of the story?
5. How could the story be changed?

STAGE 2. GROUP FORMATION AND ROLES Students work in three different groups, each with distinct tasks and methods:

Group A – "Analysts"

- Use critical thinking, discussion
- Task: analyze the characters' decisions.

Group B – "Creators / Designers"

1. Apply visual techniques:
    a. Mind maps
    b. Storyboards / comic panels
    c. Diagrams
    d. Visual design solutions
2. Task: recreate the story using visuals.

Group C – "Researchers / Experimenters"

1. Conduct mini experiments and investigations, such as:
    a. Material strength tests
    b. Wind-blowing tests (fan)
    c. Structural stability tests
    d. "What if?" investigations
2. Task: prove why some houses were stronger than others.

STAGE 3. GROUP ACTIVITY SCENARIOS (45–60 minutes)

3.1. Group A – ANALYSTS

Goal: To understand character motivation and decision-making.
Steps: Situation: Discuss what is known and what is unknown.
Task: Understand why the pigs made different choices.
Analysis methods: Character mind maps / "Why? Because!" chains / Decision trees
Conclusion: Each analyst prepares a 2–3 sentence conclusion: What influenced the choices? What were the strengths and weaknesses?
Reporting: Prepare a 3-minute mini presentation for the other groups.

3.2. Group B – CREATORS / DESIGNERS

Goal: To recreate or strengthen the story through visual techniques.

Steps:

1. Choose a technique: Storyboard / 6-panel comic sequence / Fractal mind map /House design blueprints
2. Rethink the story: What do we want to change? What would the pigs do if they were smarter, more cautious, or collaborated more?
3. Create a new version, for example: All three pigs work together / Mixed technologies (straw + wood + bricks) / Construction based on scientific research
4. Prepare a visual board on paper.

Presentation: Present to Groups A and C.

3.3. Group C – RESEARCHERS / DETECTIVES

"Find out why the characters behaved as they did"

Steps:

01. Answer the following questions:
    a. What does the character want to achieve?
    b. What does the character fear?
    c. What motivated the action?
    d. What mistake was made?
    e. How would the story change if…?
    f. What is the hidden moral?
02. Task distribution: Each group member is responsible for one of the first four questions.
03. Text analysis (8 minutes): Answer the questions; the last two are addressed collectively. SEN pictograms may be used: "angry / happy / afraid."
04. Create a **"Character Case File"** (5 minutes)

Example:

WOLF – CASE FILE No. 003
Goal: to get food
Mistake: impatience
Alternative: could have negotiated
Evidence: "he blew with all his strength"

Pig Nif – Case File No. 001

5. Presentation of reports (5 minutes):
   Groups share their "case files" with others.
6. Mini discussion (5 minutes): Is the wolf really evil? / Were the pigs fair? /How would the wolf tell the story?

Outcome: Students act as analysts and interpreters, argue their positions, and justify them using textual evidence.

STAGE 4. GROUP ROTATION SESSION (15 minutes)

Each group rotates to the others and, within 5 minutes, learns what the researchers discovered, what visual ideas the creators proposed and what analytical conclusions the analysts reached. Each group completes a **shared learning map** showing what knowledge is needed to understand, change, and improve the story.

STAGE 5. COLLECTIVE PRODUCT – LESSON CLIMAX (20–30 minutes)

All students collaboratively create an **"Improved Version of *The Three Little Pigs*"** based on research evidence, analytical reasoning and creative ideas. **Possible outcomes:**

1. Interactive poster wall
2. Unified comic
3. Mini play script
4. Animated storyboard

STAGE 6. REFLECTION Reflection takes place on three levels:

1. Individual Reflection

01. What did I learn?
02. What do I still not know but want to learn?
03. How did I contribute to the group?

2. Group Reflection

01. Did we fulfill our role?
02. What worked best?

03. What would we do differently next time?

3. Community Reflection: The whole class discusses: How did the different groups complement one another? / Did learning become more of our own creation?

SHARED LEARNING MAP EXAMPLE
"What knowledge is needed to understand, change, and improve the fairy tale The Three Little Pigs?"

[1] CHARACTERS

1. Character traits
2. Why did they make certain decisions?
3. What did they know / not know?
4. How does their behavior shape the story?
   ↓ input from Group A

[2] PROBLEMS

1. What problems do the characters face?
2. How are they solved?
3. Are the solutions effective?
   ↓ insights from all groups

[3] MATERIALS

1. What materials are used for houses?
2. What is the logic of their strength?
3. "What if…?" alternatives
   ↓ input from Group C

[4] IMPROVING STRUCTURES AND IDEAS

1. How can the story be strengthened?
2. How can character decisions be changed?
3. What design solutions are proposed?
4. How can the narrative be improved?
   ↓ input from Group B

[5] LOGIC AND STORYTELLING

1. Cause–effect chains
2. Illogical moments in the story
3. What could be added to improve accuracy
   ↓ input from Groups A, B, and C

[6] NEW VERSION OF THE STORY

1. What do we keep?
2. What do we change?
3. What do we add?
4. How do we justify our creative choices?
   ↑ compiled from all groups

[7] CONCLUSIONS

1. What did we learn?
2. What is still needed?
3. Which knowledge was most useful?

SHARED LEARNING MAP

No	Section	Purpose	Key Questions	Links
1	Characters	Analysis of decisions and behavior	What are the characters' traits? Why did they make certain decisions? What did they know / not know? How does their behavior influence the story?	→ Problems
2	Problems	Identification of conflicts	What problems arise? How are they solved? Are the solutions effective?	↓ Materials
3	Materials (I)	Resource analysis	What materials are used for the houses? What is the logic of their strength? What alternatives exist?	→ Materials (II)
4	Materials (II)	Comparative evaluation	Which materials are most suitable? Why are some stronger than others?	↓ Improvements

5	Improving Structures and Ideas	Redesign and optimization	How can we strengthen the story? How can we change the characters' decisions? What design solutions do we propose?	↓ New Story
6	New Version of the Story	Narrative reconstruction	What do we keep? What do we change? What do we add? How do we justify the changes?	↓ Conclusions
7	Conclusions	Metacognition	What did we learn? What is still needed? Which knowledge was most useful?	Final

EXPECTED ANSWERS FROM THE TEAMS
[1] CHARACTERS

The pigs have different character traits:

- One is impatient and values speed.
- One is cautious but still seeks convenience.
- One is thoughtful, patient, and plans ahead.

They made different decisions based on:

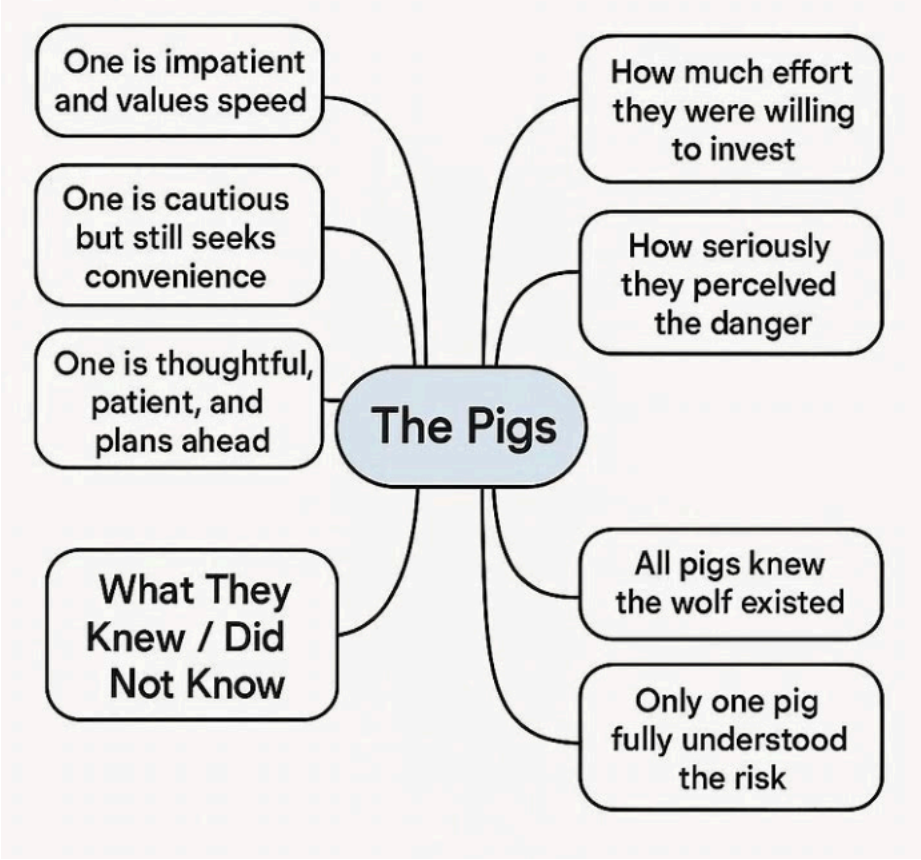
- How much effort they were willing to invest.
- How seriously they perceived the danger.

What they knew / did not know:

- All pigs knew the wolf existed.
- Only one pig fully understood the risk.

Impact on the story:

- Poor decisions led to weak houses and danger.
- Careful decisions led to safety and survival.



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[2] PROBLEMS

Main problems: Threat from the wolf. / Weak construction of houses. /Lack of cooperation between characters.

How problems were solved: Two houses failed due to poor material choices./ One house resisted the wolf because of strong materials.

Effectiveness of solutions: Quick solutions were ineffective. / Thoughtful, well-planned solutions were effective.

[3] MATERIALS (Identification)

Materials used:

- Straw, wood, bricks.

Logic of strength:

- Straw is light and weak.
- Wood is moderately strong.
- Bricks are heavy and durable.

Alternatives:

- Combining materials.
- Reinforcing structures.
- Testing materials before building

[4] MATERIAL EVALUATION

Strongest material: Bricks, because they resist force and pressure.
Comparison: Straw collapses easily. Wood resists some force but breaks. Bricks withstand strong attacks.
Conclusion: Material choice directly affects safety and success.

[5] IMPROVING STRUCTURES AND IDEAS

- Strengthening the story: Add planning and testing phases. Show cooperation between pigs.
- Changing character decisions: Pigs share knowledge. They build together instead of separately.
- Design solutions: Mixed-material houses. Strong foundations.
- Story improvement: Clear cause–effect logic. Stronger message about collaboration.

[6] NEW VERSION OF THE STORY

- What we keep: Main characters. The wolf as a challenge.
- What we change: Pigs collaborate. Decisions are evidence-based.
- What we add: Experiments with materials. Dialogue and planning scenes.
- Justification: The new version is more logical and realistic. It promotes problem-solving and teamwork.

[7] CONCLUSIONS

- What we learned: Decisions have consequences. Planning and effort lead to better results.
- What is still needed: More testing. More information before acting.
- Most useful knowledge: Understanding materials. Cause-and-effect reasoning. Collaboration skills.

Overall Rubric Achievement (Summary)

1. **Critical Thinking:** Analyzes decisions and consequences
2. **Creativity:** Redesigns the story logically
3. **Collaboration:** Integrates ideas from all groups
4. **Metacognition:** Reflects on learning and process.

GROUP A – ANALYSTS

Focus: motivation, decision-making, cause–effect logic: Expected Findings

1. Why did the pigs choose different materials?

01. Straw pig: wanted speed and comfort; underestimated risk; prioritized short-term ease.
02. Wood pig: sought balance between effort and safety; had partial awareness of danger.
03. Brick pig: anticipated risk; invested time and effort for long-term security.

2. What influenced their decisions?

1. Different levels of experience and foresight.
2. Different values (speed vs. safety).
3. Incomplete information about the wolf's strength.

3. Strengths and weaknesses of decisions

- Straw house: Strength: quick to build / Weakness: extremely vulnerable
- Wood house: Strength: moderate durability / Weakness: still insufficient against strong force
- Brick house: Strength: high resistance, safety / Weakness: time- and effort-intensive

4. Cause–effect chains

- Poor material choice → weak structure → wolf succeeds.
- Careful planning → strong structure → wolf fails.

Sample 2–3 Sentence Conclusion: "The pigs' choices were determined by their priorities and perception of risk. Short-term convenience led to failure, while long-term planning led to safety. The story shows that effort and foresight directly influence outcomes."

GROUP B – CREATORS / DESIGNERS

Focus: visual redesign, alternative narratives, collaborative solutions: Expected Creative Outcomes

1. Key changes to the story

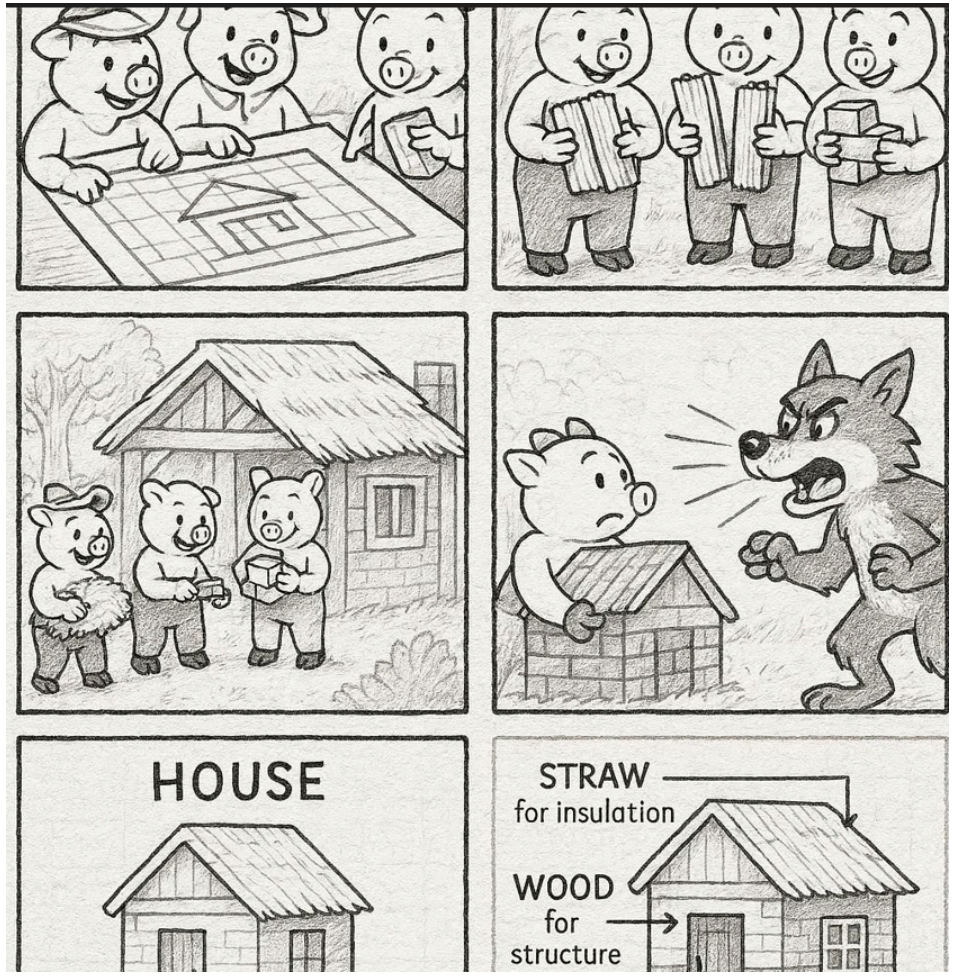
- The pigs communicate before building.
- They share knowledge about materials.
- Construction decisions are based on testing and evidence.

2. Redesigned story elements

- One shared house with zones: Straw for insulation, Wood for structure, Bricks for reinforcement
- A collaborative building process instead of individual work.

3. Visual products

- Storyboard showing: Planning phase, Testing materials, Collaborative construction, Wolf failing due to improved design
- House blueprints with labeled materials and functions.



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4. Narrative message

01. Collaboration increases success.
02. Knowledge-sharing prevents mistakes.
03. Creativity improves outcomes when combined with logic.

Expected Presentation Summary: “We changed the story so the pigs learn from each other and use mixed materials. Our version shows that cooperation and design thinking make the house stronger and the story more logical.”

GROUP C – RESEARCHERS / DETECTIVES

Focus: evidence, experimentation, character investigation: Expected Research Findings

1. Material tests

01. Straw:Easily collapses under wind / Low structural integrity
02. Wood: Resists light force / Breaks under strong pressure
03. Bricks: High resistance / Stable structure

2. Experimental conclusions

01. Material density and structure determine durability.
02. Combined materials can increase stability.
03. Testing before building leads to better decisions.

Character Case Files (Examples)

WOLF – Case File No. 003

- Goal: obtain food
- Fear: starvation
- Motivation: hunger
- Mistake: impatience and use of force
- Alternative: cooperation or negotiation
- Evidence: repeated blowing attempts

PIG (Straw House) – Case File No. 001

- Goal: finish quickly
- Fear: hard work
- Mistake: ignoring danger
- Alternative: testing materials first
- Evidence: house collapses immediately

Moral Identified: Strength comes from preparation, not speed. Conflict escalates when characters do not communicate.

ROTATION SESSION – SHARED INSIGHTS

What groups learn from each other

- **From Analysts:** decisions create predictable consequences.
- **From Creators:** stories can be redesigned using logic and imagination.
- **From Researchers:** evidence explains why some ideas fail or succeed.

FINAL COLLECTIVE PRODUCT – EXPECTED FEATURES

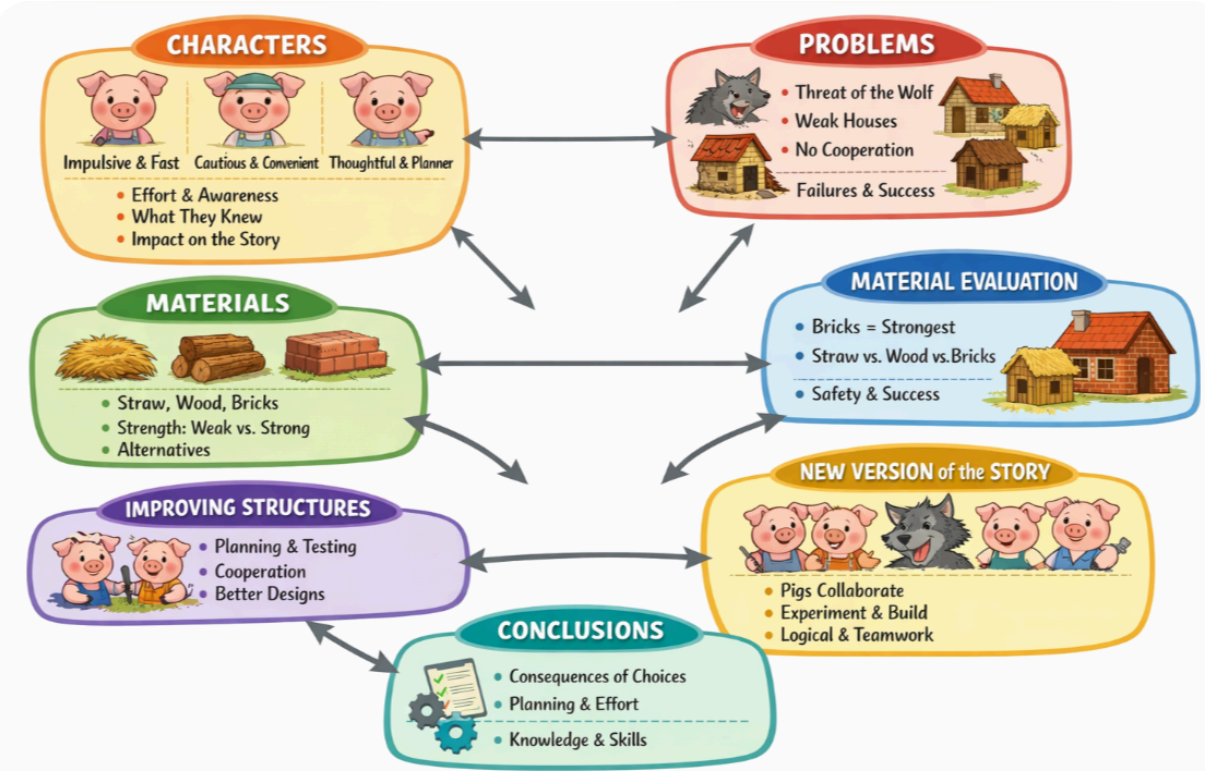
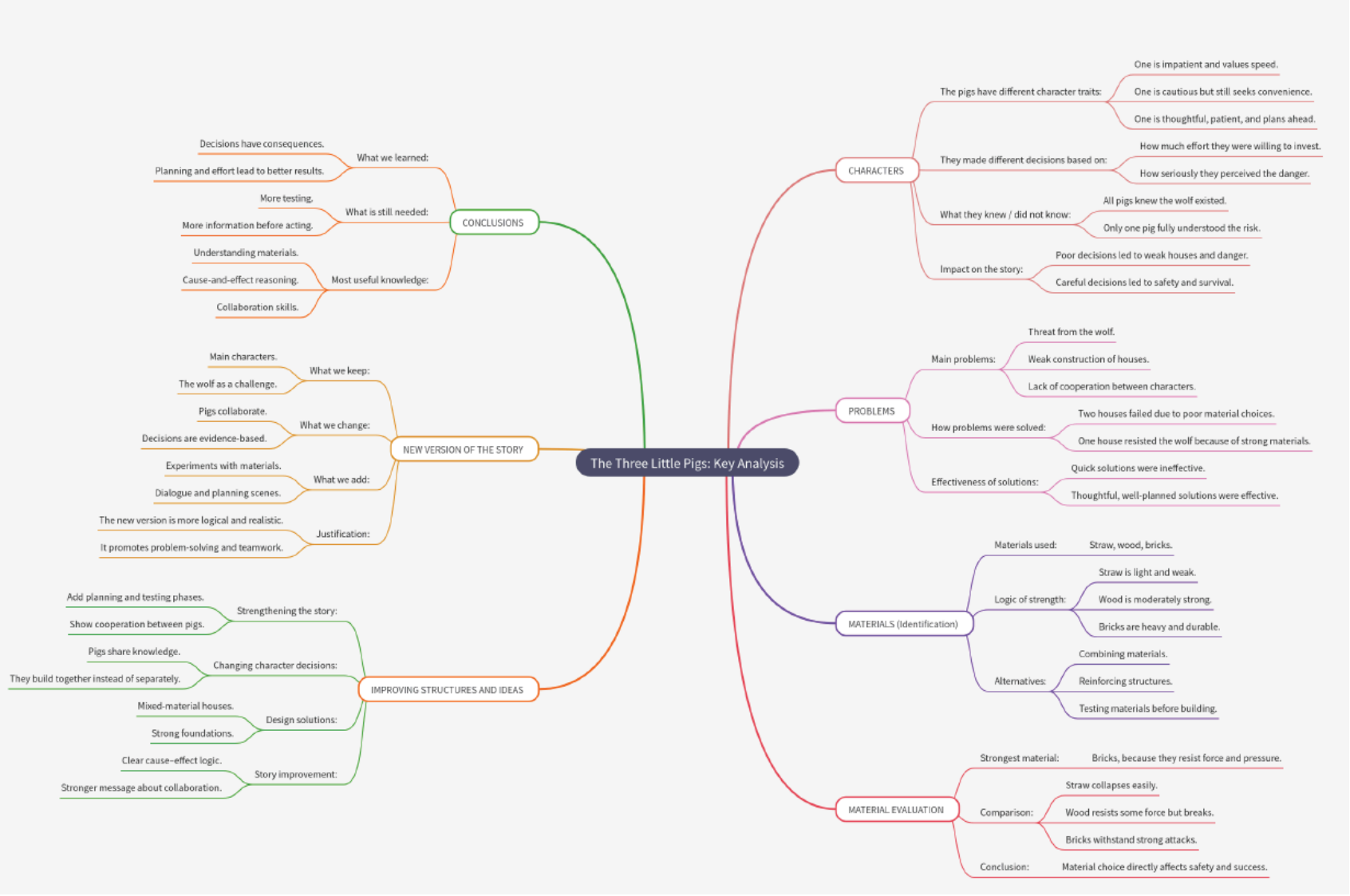


Image created with ChatGPT

Improved "Three Little Pigs" version includes:

- Evidence-based building choices.
- Clear cause–effect logic.
- Cooperative problem-solving.
- A more complex moral:
  Intelligence, collaboration, and preparation matter more than speed or force.

Mind map created with MindMap AI



REFLECTION – EXPECTED STUDENT RESPONSES

- **Individual:** “I learned that my choices affect results.” / “I helped by sharing ideas / testing materials / drawing.”
- **Group:** “We worked well when we listened to each other.”/ “Next time we would plan before acting.”
- **Whole Class:** “Learning felt like something we built ourselves.”/ “Each group was important; without one, the story would be weaker.”

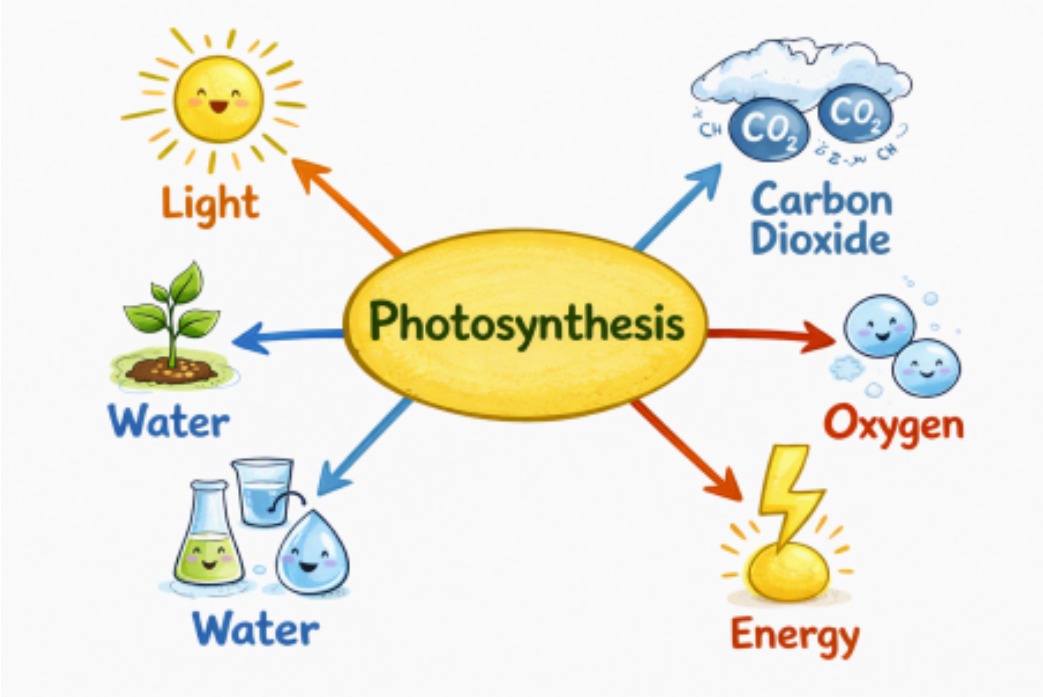
ACTIVITIES SUGGESTED

ACTIVITY #1

Mind Maps

Show a real example from a lesson: Example: "Photosynthesis Mind Map," where the word *Photosynthesis* is in the center of the page, and the branches are light, water, carbon dioxide, oxygen, energy.

Mind map example



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Discussion

The teacher explains: "A mind map is a way to organize ideas so your brain can see connections. We start with one main idea and then add related ideas using branches, words, colors, and pictures."

Teacher-guided questions (whole class):

1. What do you notice first when you look at this mind map?

2. Why do you think the main idea is in the center?

3. How do the colors and pictures help you understand or remember the topic?

Teacher explicitly models that mind maps help with understanding, memory, and organizing thinking

Procedure: Students are divided into mixed groups of 4–5 (mixed ability groups). Each group draws or selects a topic from the suggested cards:

- **Mathematics topic:** Fractions and Everyday Life
- **Science:** Ecosystems and Sustainability
- **Languages:** Describing a Person or Character
- **Social Studies:** Diversity in Our Community

Teacher Guiding Questions

To clarify the main idea:

1. What is the most important word or idea for your topic?
2. If you had to explain this topic to a younger student, what would you start with?

To build branches and connections:

1. What ideas belong with this topic?
2. Can you group these ideas together?
3. Which ideas are examples? Which explain “why” or “how”?

To encourage thinking processes (without naming them):

- What causes this to happen?
- What happens because of this?
- How are these two ideas similar or different?
- Can you think of a real-life example?

SEN-Focused Teacher Support During Planning

1. Offer **choice**: drawing, writing keywords, using images, or arranging word cards.

2. Reduce cognitive load by asking: “Let’s choose just 3 important ideas first.”

3. Provide **sentence starters or word banks** for students who need them.

4. Allow verbal contribution instead of written for students with writing difficulties.

5. Assign roles based on strengths: Organizer, drawer, idea-giver, explainer.

Outcome: Each group clearly defines the goal of their mind map and its planned structure.

Creative work: Creating a Mind Map

Materials: A3/A2 paper, colored markers, stickers, pens, pictures from magazines, glue.
Procedure: Groups create a mind map based on the chosen topic, considering:
Structure: Main idea in the center, with connections, concepts, examples branching out.
Type of thinking: Causal, hierarchical, comparative, or creative.

Visualization: Colors, shapes, and symbols help engage visual learners. ○ **Inclusivity:** Clear pictograms, simplified words, sensory elements (if applicable).

Each group specifies: How the mind map helps expand students' thinking

SEN Adaptations:

○ Use pictograms or icons instead of long text.
○ Allow keywords instead of full sentences.
○ Provide pre-written word cards or images for learners with reading or writing difficulties.
○ Assign flexible roles (e.g., drawing, organizing, explaining) so all students can participate according to their strengths.
○ Reduce the number of concepts if needed and focus on clear connections. ○ Fewer branches expected for some students; depth over quantity.
○ Option to work on **half a page** instead of full A3.
○ Frequent check-ins: "Tell me what this branch means." /"What made you connect these two ideas?"

Group Presentations

Duration: 15 min

Procedure: Each group presents their mind map (3 min), explaining:

○ Which topic they chose
○ Which thinking process it reflects

Participants from other groups ask questions and suggest improvements.

Teacher-Guided Presentation Prompts

1. What is your topic?
2. Show us one part of your mind map you think is important.
3. How did this mind map help you understand the topic better?

Teacher Follow-Up Questions

1. What connections do you see between ideas?
2. Did any group organize their ideas differently? Why might that work too? Teacher emphasizes: “Different mind maps can all correct if they show clear thinking.”

Reflection and Closing
Duration: 10 min
Activity: “3-step reflection”

Students respond **orally or with a short written/drawn response** (SEN option: verbal response, drawing, or choosing from sentence starters).

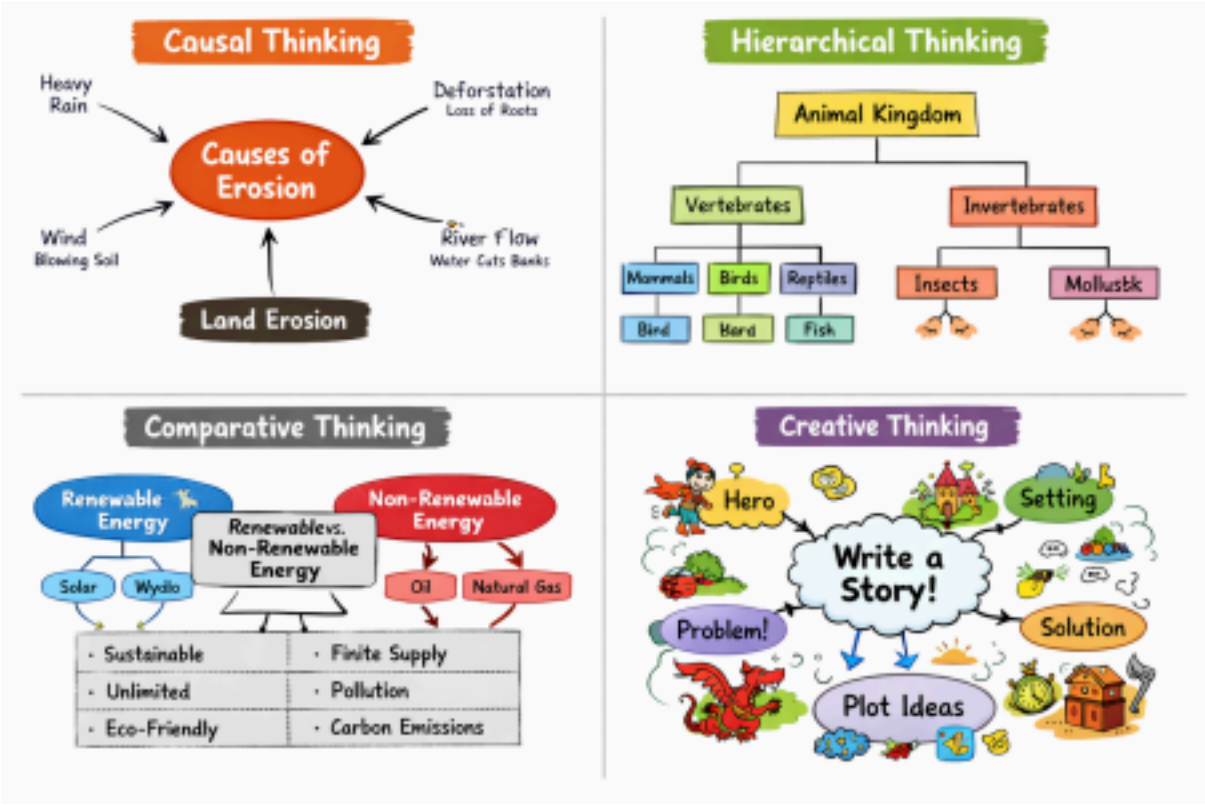
Each participant writes on a sticker:

- One new idea they are taking away/ One thing I understood better because of the mind map
- One useful idea they heard from a colleague from another group
- One way they will apply mind maps in their learning

Stickers are placed on the “Reflection Wall.”
The teacher summarizes: “Mind maps are not just pretty drawings—they are a path for students to structured yet creative thinking.”

5

Types of thinking Mind Map examples:



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6

Suggested solutions for various Subjects:

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ACTIVITY # 2

Methods of Critical Thinking That Encourage Students' Questions and Discussions

Classroom Activity: Asking Better Questions and Thinking Deeper

Learning Goal : Today you will learn how to

1. Ask stronger, more meaningful questions
2. Distinguish between surface-level and deep-thinking questions
3. Use discussion and argumentation to develop critical thinking

Activity 1: Question Mining (Warm-Up) 10 min

Purpose: To activate students and demonstrate how different types of questions open different directions of thinking.
Work mode: Group work (4 students per group)

Instructions for students:

1. Your group will receive the same object (an image or visual).
2. Look at it carefully.
3. For **3 minutes**, write down **as many questions as possible** about what you see. There are no bad questions at this stage.
4. When time is up, follow these steps:

    - Cross out questions that are **easy to answer**.
    - Keep only questions that **require thinking, explanation, or discussion**.

Outcome for students: Your group selects **4–5 strong questions** that make people think.

“Question Sorting” Carousel 15min
Purpose: Encourages understanding of which types of questions lead to deeper thinking.

Instructions:

1. Groups rotate their question sheets in a carousel style.
2. Each new group must sort the questions into 3 categories:
    - **Open-ended questions** (stimulate discussion)
    - **Closed questions** (answers are “yes/no” or factual)
    - **Inquiry questions** (require data, experiment, or additional information)
3. Groups add a colored marker to each category:
    - 🔵 Blue – “Question stimulates discussion”
    - 🔴 Red – “Weak question, low-level thinking”
    - 🟢 Green – “Question for research/project”
4. Every 5 minutes, the carousel continues – groups receive another sheet of questions.

Examples (from previous groups):

- “Why is the boy standing alone in the picture?” – Open-ended
- “Is the object broken?” – Closed
- “What would change if this event happened today?” – Inquiry

Outcome:
Students learn to evaluate and create higher-order questions.

“Provocative Statements Challenge” 20 min
Purpose: An active method that forces students to argue, disagree, and think critically.

Instructions: Each group is given a provocative statement (related to education, culture, or technology).

Examples: “Technology makes students lazy.”/ “Homework should be optional.”/ “Facts are more important than creativity.”

2. Each group completes a 3-stage task:
    - **Stage 1 (3 min):** Each student writes one argument “for” and one argument “against.”
    - **Stage 2 (5 min):** Group selects the strongest pair of arguments.
    - **Stage 3 (5 min):** Group prepares a 60-second micro-discussion:
        i. Two members argue “for”
        ii. Two members argue “against”

Rules for students:

1. Respect different opinions.
2. Use reasons, not just emotions.
3. You may use notes, gestures, or keywords.

Outcome for students:
You practice arguing, listening, and thinking critically under time pressure.

“Thinking Triangle Method” 15 min

Instructions: Each group receives a large sheet with a triangle drawn, corners labeled:

- ❓ What do we know?
- ❗ What do we not understand / what is unclear?
- 💡 What is worth investigating first?

Students select one question from previous activities and:

- 5 min: Fill in the “What do we know?” corner
- 5 min: Fill in the “What do we not understand?” corner
- 5 min: Decide a research path and fill in “What should we investigate?”

Each group gives a brief 1-minute presentation.

Example: **Question:** “How would students learn without textbooks?” **What do we know?** – They would need digital tools, group work, teacher support… **What do we not understand?** – How to ensure structure? What about students with poor internet? **What to investigate?** – Compare results of classes with and without textbooks.

Outcome for students: You learn how a question can become a structured investigation.

Below is a **clear, student-friendly example** you can present **before students start Activity 4**. It models the thinking process without giving them answers to copy.

Example for Activity 4: Thinking Triangle

Example Question:
“Should students be allowed to use AI tools for homework?”

❓ What do we know?

1. AI tools can help explain difficult topics.
2. Many students already use AI at home.
3. Teachers worry about cheating.
4. Homework is meant to help students learn independently.

❗ What do we not understand / what is unclear?

1. Does using AI improve learning or reduce effort?

2. How can teachers tell if work was done by the student or AI?
3. Do all students have equal access to AI tools?
4. What rules would be fair?

💡 What should we investigate first?

1. Compare homework results **with and without AI use**.
2. Ask students how they use AI and why.
3. Research school policies on AI use in education.

1-minute explanation (model for students):

"Our question is whether students should use AI for homework. We know AI can support learning, but we are not sure if it helps everyone equally or causes more cheating. To understand this better, we would investigate how learning outcomes change when AI is allowed versus when it is not."

"This is not the *right* answer. It is an example of how to move from a question to structured thinking."

Mini Reflection: "One Sentence"

Instructions: Each student writes one sentence on a sticky note, beginning with: "Today I realized that questions…", "I realized that good thinking requires…", "Next week in class I will try to ask…" Stickers are placed on a shared "Question Wall."

Outcome for students: You reflect on your learning and contribute to shared ideas.

Wrap- up: "Good thinkers are not the ones with the fastest answers, but the ones who ask the best questions."

ACTIVITY # 3

Creative Drawing: "Geometric Stories" **Creative visual techniques, active participant engagement, three-group model**

Subject: Mathematics / Integrated Arts / Inclusive Education

Topic: Using geometric shapes to create visual stories

Grade Level Primary / Lower Secondary (adaptable for mixed-ability and SEN learners)

Duration 20 minutes (can be extended to 30 minutes if needed)

Activity Objective: By the end of the activity, students will:

1. Use geometric shapes to create a short visual story
2. Develop creative thinking and imagination
3. Collaborate in groups and communicate ideas visually
4. Connect **abstract geometric forms** with emotions, actions, and social situations

Learning Outcomes Students will be able to:

1. Identify and use basic geometric shapes (triangle, square, circle, rectangle, rhombus)
2. Represent emotions, movement, and problem-solving through visuals
3. Work cooperatively in small groups
4. Explain their ideas using simple language, visuals, or symbols

Inclusive / Sen Adaptations

- Larger geometric shapes
- High-contrast colors
- Choice of materials and shapes
- Pair or small-group support
- Use of pictograms instead of written text
- Drawing with broad movements or templates

Materials Needed A4 or A3 paper; Pre-cut geometric shapes (various sizes and colors): triangles, squares, circles, rectangles, rhombi; Colored pencils, markers, stickers; Optional: stencils, templates

1. Introduction & Preparation (2 minutes)

Teacher actions: Distribute paper and materials on tables. Ensure Sen learners have access to adapted materials.

Teacher instruction (spoken): “Today we will create a short story using geometric shapes as characters. Shapes will help us show ideas, feelings, and actions without using many words.”

2. Imagination Activation – 2 minutes

The teacher leads a short imagery activation exercise:“Close your eyes for 10 seconds and imagine a triangle that has a special ability: it can move. How does it move? What does it see along the way? Now imagine a circle that is searching for something very important…”

Objective: To stimulate imagination before starting the physical creative work.

3. Group Formation – 30 seconds

Participants are divided into **3 groups**. Groups should be mixed by ability and language level.

Group 1 – Emotional Story
(Shapes express emotions)

Group 2 – Adventure Story
(Shapes travel and face challenges)

Group 3 – Social Story
(Shapes solve a problem, e.g. friendship or communication

4. Main Activity: “Geometric Story” – 10 min

Each group follows the **same creative story-building algorithm**.

Step 1: Choosing Shapes (1 minute) Each group member selects 2–3 geometric shapes (different colors and sizes).

SEN integration: The teacher may assist with selection, offer larger shapes, or allow students to work in pairs.

Step 2: Creating Characters (2 minutes) Each shape becomes a character. The group answers three questions on paper:

1. Who is our character? (e.g. “A small yellow triangle – shy but fast.”)
2. What emotion does it feel most often?
3. What can it do? (e.g. change size, fly, hide among other shapes)

Step 3: Creating the Story Space (2 minutes)

The group draws a minimal “world” in which the shapes will act: lines, a road, a mountain, a river, a city, a labyrinth, a classroom, space, etc.

SEN note: Stencils or templates may be used; drawing with large, broad movements is allowed.

Step 4: Creating the Action (3 minutes) The group creates a short four-step story:

1. **Beginning:** the characters meet or a problem arises.
2. **Event:** something unexpected happens (e.g. the circle loses its color).
3. **Obstacle:** the characters face a challenge (e.g. the triangle cannot climb a steep mountain).
4. **Solution:** the characters find a solution together.

Each step is shown by:

A. positioning the shapes on the paper,
B. adding minimal lines to indicate action.

Step 5: Mini-Plot Visualization (2 minutes) The group finalizes the story sketch:

- Moves the shapes into the final composition.

- Adds 3–4 short sentences (or pictograms for SUP learners).
- Uses color to highlight meaning:
    - **Red** – obstacle
    - **Blue** – movement
    - **Green** – solution

5. Group Discussion and Story Presentation – 4 minutes

Each of the three groups has **up to 1 minute** to present their geometric story.

Focus Points for Each Group

Group 1 – Emotional Story

- How did the shapes show emotions?
- How did colors or sizes help?

Group 2 – Adventure Story

- What was the main adventure?
- How did the shapes move through their world?

Group 3 – Social Story

- What social problem was addressed?
- How did the shapes cooperate?

6. Reflection & Closing (2 minutes)

Teacher asks:

1. How did shapes help you tell a story?
2. How could this activity help different learners?
3. Where could we use this idea in other lessons?

Assessment (Formative) Assessment focuses on:

- Participation and engagement
  - Ability to express ideas visually
- Collaboration within the group
  - No grades are required; feedback is descriptive.

Possible Extensions

1. Write a short text based on the geometric story
2. Act out the story using movement
3. Connect shapes to mathematical properties (sides, angles)

Possible Extensions – Example Answers
1. Write a Short Text Based on the Geometric Story

Example Geometric Story (Context)

- Characters: a blue triangle, a red square, a green circle
- Problem: the triangle cannot cross a mountain
- Solution: the shapes work together

Example Student Text (Simple Level)

“The blue triangle was very fast but felt scared.It wanted to cross the mountain but the mountain was too steep. The red square stood next to the triangle and helped it feel safe. The green circle rolled around the mountain and showed a new way. Together, the shapes solved the problem and were happy.”

Example Student Text (Slightly More Advanced)

“The small blue triangle wanted to explore the world, but a tall mountain blocked the way. The square tried to push the triangle forward, but it did not work. Then the circle rolled quickly and found a path around the mountain. By working together, the shapes reached the other side.”

2. Connect Shapes to Mathematical Properties (Sides, Angles) Students explain mathematical features of the shapes used in their story.

Example 1: Triangle: “The triangle has **three sides** and **three corners**. It has **three angles**. The triangle looks sharp, so we made it fast in the story.”

Example 2: Square: “The square has **four equal sides**. All angles are **right angles**. The square is strong and stable, so it helped the other shapes.”

Example 3: CircleThe circle has **no corners** and **one curved side**. It can roll easily. That is why the circle could move around the mountain.”

Combined Group Answer (Expected Outcome)

> “We used a triangle, a square, and a circle. The triangle has 3 sides and 3 angles. The square has 4 equal sides and 4 right angles. The circle has no angles and can roll. The properties of the shapes helped us decide what they could do in the story.”

1. How did visual techniques help create a story based on shapes rather than words?

Suggested answers:

1. Visual techniques allowed shapes to **act like characters**, even though they are abstract.

2. Colors helped show **emotions and meaning** (e.g., red for problems, green for solutions).
3. Movement and placement of shapes showed **actions and events** without needing long explanations.
4. Drawing simple environments (paths, mountains, spaces) helped create a **clear story setting**.
5. Visuals made it easier to understand the story **at a glance**, even without reading text.
6. Using images encouraged imagination and made the story **personal and creative**.

2. How could this activity support learners with different abilities, including SEN students?

Suggested answers:

1. Students could express ideas **without relying on written language**, which helps learners with language or literacy difficulties.
2. Large shapes and strong color contrast made the activity more **accessible visually**.
3. Working with physical shapes supported **hands-on and kinesthetic learners**.
4. Group work allowed students to **support each other** and share strengths.
5. Pictograms and symbols made it easier for SEN students to participate fully.
6. The activity allowed **choice and flexibility**, reducing pressure and anxiety.
7. Students could work at their own pace and contribute in different ways.

ACTIVITY # 4

Divergent tasks: Maths

Objective: To foster students' creative thinking through unexpected and open-ended tasks in lessons.

Activity Structure: Quick Introductory Task: "Number Puzzle"

Each group is given a simple task, for example: "Place the numbers 1–9 into a 3×3 square so that the sum of each row, column, and diagonal is the same."

Autonomy: Teachers may experiment with different solution methods (pencil and paper, cards, digital board).

Task: Place the numbers 1–9 into a 3×3 grid so that each row, column, and diagonal has the same sum.

Solution This is the classic **3×3 magic square**. **Magic sum:**

$$\frac{1+2+3+4+5+6+7+8+9}{3} = 15$$

One valid solution:

8 1 6
3 5 7
4 9 2

All rows, columns, and diagonals sum to **15**.

Alternative Solution Strategies

1. **Trial and error with physical number cards**
2. **Logical reasoning: placing 5 in the center (it balances all directions)**
3. **Symmetry and rotation (this square has 8 equivalent solutions via rotations/reflections)**

1. Trial and Error with Physical Number Cards

What This Looks Like in Practice: Students are given **nine cards** labeled 1 through 9 and a **blank 3×3 grid**. They physically place, move, and rearrange the cards while checking sums.

Step-by-Step Trial-and-Error Process

1. Students begin by placing numbers randomly.
2. They calculate the sum of each row, column, and diagonal.
3. When sums do not match, students **physically move cards** to test new arrangements.
4. Over time, patterns emerge:
    - Large numbers placed together cause sums to exceed the target.
    - Small numbers grouped together cause sums to fall short.

Why This Strategy Is Valuable

1. Encourages **hands-on exploration**
2. Reduces fear of making mistakes
3. Supports **SEN learners** and younger students
4. Makes abstract constraints visible and tangible

Teacher Prompt Examples: “What happens if you swap these two numbers?” / “Which row is too large? Which number might be causing that?”/ “How could you balance a big number with a small one?”

Expected Learning Outcome: Students discover that **balanced placement**, not randomness, is required.

2. Logical Reasoning: Why 5 Must Be in the Center

Mathematical Insight: The sum of numbers 1–9 is:

$$1 + 2 + \cdots + 9 = 45$$

Since there are **3 rows**, each row must sum to:

$$45 \div 3 = 15$$

Why the Center Is Special: The center number belongs to: 1 row, 1 column, 2 diagonals

Total: **4 lines**

To balance all four lines equally, the center must be the **average** of all numbers.

Why 5 Is the Only Possible Choice

The average of numbers 1–9 is:

$$\frac{1+9}{2} = 5$$

If any number other than 5 is placed in the center:

- Some lines become too large
- Others become too small

No rearrangement can fix this imbalance.

Classroom Explanation (Student-Friendly)"The center touches the most lines. If we want all lines to be fair, the center must be the most 'neutral' number."

Expected Learning Outcome: Students understand **constraint-based placement** rather than guessing.

3. Symmetry and Rotation: Why There Are 8 Equivalent Solutions

Base Magic Square: One valid magic square is:

8	1	6
3	5	7
4	9	2

Rotations (4 Solutions)

The square can be rotated:

0° (original) / 90° / 180° /270°

Each rotation preserves:

1. Row sums
2. Column sums
3. Diagonal sums

Reflections (4 More Solutions)

Each rotated square can also be: Reflected horizontally / Reflected vertically

This creates **8 total distinct arrangements**.

Why These Are Not New Solutions Although they look different: The relative positions of numbers stay consistent. The structure is unchanged

Mathematically, these are **equivalent under symmetry transformations**.

Classroom Activity Idea

1. Ask students to rotate the grid physically or on paper.
2. Count how many “different-looking” but valid solutions exist.
3. Discuss why they are essentially the same.

Expected Learning Outcome

Students learn:

1. The concept of **symmetry in mathematics**
2. That some solutions are **structurally identical**
3. How geometry and arithmetic connect

Pedagogical Summary

Strategy	Skill Developed
Trial and error	Exploration, persistence
Logical placement	Deductive reasoning

Symmetry Structural thinking

Key Teaching Insight: “A problem that seems like guessing becomes logical once we understand the structure.”

Magic Square Visual Worksheets (3×3)

Worksheet 1: Trial and Error Exploration

Cut out numbers 1–9 and place them in the grid. Try different positions until all rows, columns, and diagonals have the same sum.

Target sum for each line: _____

Worksheet 2: Logical Reasoning – The Center Number

1. Add numbers from 1 to 9: _____ 2. Divide the total by 3: _____ 3. Which number should go in the center? _____ Explain why:

Worksheet 3: Symmetry and Rotation

Below is one completed magic square. Rotate or reflect it to find other valid solutions. How many different-looking solutions can you find?

8	1	6
3	5	7
4	9	2

Number of solutions found: _____

ACTIVITY # 5

Divergent tasks: Maths - Mini Experiment: "Open Tasks in the Classroom"

The teacher starts with a standard school task (e.g.finding the area of a triangle**). The teacher** creates several divergent-thinking versions by:

1. **Modifying the conditions (**e.g. changing dimensions, adding constraints**).**
2. **Asking students to choose their own method.**
3. **Including a visual task or creative interpretation.**

Base Task: Find the area of a triangle.

Divergent Versions with Solutions

Divergent Version 1: Dimensions and Method Choice

Divergent Version 2: Modifying the Conditions (Constraints and parameters change)

Divergent Version 3: Visual or Creative Interpretation (Meaning and representation change)

Divergent version 4 Creative Challenge: "A Mathematics Story"

Other divergence versions: Transforming Traditional Questions into Creative Ones

- *Freedom of tools*
- *Freedom of sequence of work*
- *Unexpected elements (both geometric and real-life*

Divergent Version 1.1: Choice of Dimensions

“Choose any triangle with area 24 cm².”

Sample Solutions:

- Base 6, height 8
- Base 12, height 4
- Base 16, height 3

All satisfy:

$$A = \frac{1}{2}bh = 24$$

Step 1: Area Formula

For any triangle:

$$A = \frac{1}{2}bh$$

To achieve an area of 24 cm²:

$$\frac{1}{2}bh = 24 \quad \Rightarrow \quad bh = 48$$

So, **any base–height pair whose product is 48** is valid.

Step 2: Complete Set of Sample Solutions

Base (b)	Height (h)	Calculation	Area
6	8	$(6 \times 8) \div 2$	24
8	6	$(8 \times 6) \div 2$	24
12	4	$(12 \times 4) \div 2$	24
4	12	$(4 \times 12) \div 2$	24
16	3	$(16 \times 3) \div 2$	24
24	2	$(24 \times 2) \div 2$	24
48	1	$(48 \times 1) \div 2$	24

Step 3: Visual and Geometric Interpretation

1. Tall, narrow triangles (e.g. base 48, height 1)
2. Short, wide triangles (e.g. base 1, height 48)
3. Balanced triangles (e.g. base 6, height 8)

All have the **same area**, but look very different.

Step 4: Key Mathematical Conclusion There are infinitely many triangles with area 24 cm², because there are infinitely many pairs of numbers whose product is 48.

Divergent Version 1.2: Method Choice

"Find the area of a triangle using **any method**."

Valid Methods:

- Formula $\frac{1}{2}bh$
- Coordinate geometry
- Decomposition into rectangles
- Counting squares on grid paper

Finding the Area of a Triangle

Given example used consistently:
Base (b = 6) units, height (h = 8) units
(Expected area: **24 square units**)

Method 1: Using the Formula

$$\frac{1}{2}bh$$

$$A = \frac{1}{2} \times 6 \times 8 = 24 \text{ cm}^2$$

Method 2: Decomposition into Rectangles

Visual Idea Enclose the triangle inside a rectangle.

- Rectangle dimensions:
  Width = 6, Height = 8
- Rectangle area:
  $6 \times 8 = 48$

Step-by-Step Reasoning

1. The triangle occupies exactly **half** of the rectangle.
2. Therefore:
   $$A = \frac{48}{2} = 24$$

Final Answer

$$\boxed{A = 24 \text{ square units}}$$

Pedagogical Note This method:

1. Builds intuition for the factor $\frac{1}{2}$
2. Is excellent for visual and SEN learners
3. Can be introduced **before formal formulas**

Method 3: Coordinate Geometry

Step-by-Step Setup

Place the triangle on a coordinate plane.

Let the vertices be:

$$A(0,0)$$
$$B(6,0)$$
$$C(0,8)$$

Method 3A: Base × Height on Axes

- Base lies along the x-axis: length = 6
- Height lies along the y-axis: length = 8

Apply the area formula:

$$A = \frac{1}{2} \times 6 \times 8 = 24$$

Method 3B: Using the Determinant Formula (Optional Extension)

$$A = \frac{1}{2}|x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$$

Substitute:

$$A = \frac{1}{2}|0(0-8) + 6(8-0) + 0(0-0)|$$

$$A = \frac{1}{2}|48| = 24$$

Final Answer

$$\boxed{A = 24 \text{ square units}}$$

Pedagogical Note This method:

- Connects algebra and geometry
- Reinforces coordinate systems
- Is ideal for lower secondary and above

Method 4: Counting Squares on Grid Paper

1. Draw the triangle on **1 cm × 1 cm grid paper**.

2. Count the full squares inside the triangle.
3. Combine partial squares into full ones.
4. Total counted area equals **24 square units**.

Step-by-Step Process

1. Draw the triangle on grid paper.
2. Count: Full squares inside the triangle /Half-squares along the edges

Example Count

- 12 full squares
- 24 half-squares = 12 full squares

Total area:

$$12 + 12 = 24$$

Final Answer

$$\boxed{A = 24 \text{ square units}}$$

Pedagogical Note This method:

1. Is concrete and accessible
2. Develops estimation skills
3. Helps students *see* area, not just calculate it

Step 5: Comparison of Methods

Method	Mathematical Idea	Skills Used
Formula	Direct calculation	Algebraic reasoning
Rectangle	Halving area	Visual reasoning
Coordinates	Geometry + grid	Spatial reasoning
Grid counting	Estimation and counting	Concrete reasoning

Final Teaching Insight These divergent tasks show that: One problem can have **many correct answers;** One result can be reached by **many valid methods;** Mathematical understanding deepens when students **choose and justify** their answer.

Key Teaching Insight "Different methods reveal the same structure from different perspectives."

Divergent Version 2: Modifying the Conditions (Constraints and parameters change)

Task A: Variable Dimensions "Draw **three different triangles** that all have an area of **24 cm²**. Label their base and height."

Expected Student Solutions Students may produce, for example:

Base (cm)	Height (cm)	Area
6	8	24
12	4	24
16	3	24

All satisfy:

$$A = \frac{1}{2}bh = 24$$

Pedagogical Value Students discover that: Area depends on the **product** of base and height; Many different shapes can share the same area; Geometry is **flexible**, not fixed.

Extension (Higher Cognitive Demand) "Which triangle uses the **least material** (shortest perimeter)? Explain your reasoning." (Expected insight: more compact shapes tend to minimize perimeter.)

Task B: Constraint-Based Optimization"Your triangle must: Have an area of **at least 30 cm²,** Use a base **no longer than 10 cm and** Be drawn on grid paper"

Expected Reasoning Students: Adjust height to compensate for base limits, Test possibilities visually or numerically and Justify choices mathematically

Divergence Type: Conceptual and conditional divergence

Divergent Version 3: Visual or Creative Interpretation (Meaning and representation change)

Task A: Visual Design Challenge

Task B: Story-Based Interpretation (Fully Exemplified)

Task A: Visual Design Challenge "Design a triangular **park, stage, or roof** with an area of **24 m²**. Draw it to scale and explain how you know the area is correct."

Expected Student Representations Students may:

1. Draw on grid paper
2. Decompose shapes into rectangles
3. Annotate dimensions visually
4. Use colors to highlight base and height

Example Student Explanation "I made the base 6 m and the height 8 m. I checked the area by dividing the surrounding rectangle in half."

Pedagogical Value

1. Connects math to **real-world contexts**
2. Encourages visual reasoning
3. Supports SEN learners
4. Integrates math with design thinking

Another more complex Visual Design challenge: **Community Micro-Park Project**

Your town is creating a small community space on an unused triangular plot of land. The city council has asked student teams to propose a **triangular park design**.

Design Brief (Given to Students): The **area must be exactly 24 m².** One side of the park borders a **pathway** and must be **straight.** The park must: Be **easy to walk around,** Use **as little fencing as possible and** Allow space for **at least one tree and a bench.**

Student Tasks

1. Geometry & Calculation (Mathematical Core)

01. Choose base and height values that give:

$$A = \frac{1}{2}bh = 24$$

02. Draw the triangle **to scale** on grid paper
03. Label: Base, Height, Side lengths (estimated or calculated)

2. Design Thinking & Constraints

Students must justify: Why they chose these dimensions and How their design Minimizes fencing (shorter perimeter), Supports movement (not too narrow or sharp) and Uses space efficiently

3. Decision-Making & Trade-Offs

Students compare **at least two designs**, for example:

Guiding question: “Which design would you recommend to the city council, and why?”

Design	Base (m)	Height (m)	Area	Estimated Perimeter

A	**6**	**8**	**24**	**longer**
B	**8**	**6**	**24**	**shorter**

4. Visual & Creative Representation Students must:

1. Add icons for **tree, bench, path**
2. Use color to show: Walking area, Green space, Entry points
3. Include a **legend** (No artistic skill required; clarity over decoration.)

Expected Student Solutions (Examples) Mathematical Validity All designs must correctly satisfy:

$$A = 24\ \mathrm{m}^2$$

Design Reasoning Examples: “We chose a wider base because it allows a bench along the path and makes the park feel open.” “This triangle uses less fencing because the sides are shorter overall.” “We rejected a tall narrow triangle because it would feel cramped.”
Why This Is Genuine Design Thinking This task now requires students to: Work with **real constraints** / Make **trade-offs** / Compare alternatives/ Justify decisions with data /Communicate visually and verbally. They are not just *finding* an area — they are **using mathematics to make decisions**.

Built-in Differentiation (Including SEN)

1. Use **physical grid mats or cut-out triangles**
2. Allow **pair work**

3. Accept **verbal explanations** instead of written ones
4. Provide a **partially filled table** for support

Assessment Focus (What the Teacher Looks For)

Criterion	Evidence
Mathematical accuracy	Correct area calculation
Design reasoning	Clear justification
Use of constraints	Meets all conditions
Communication	Clear drawing and explanation

Key Teaching Insight "Design thinking begins when there is no single 'best' answer — only better-justified ones."

Task B: Story-Based Interpretation

Create a short story in which a character must build something **triangular**. The character needs the **area to be exactly 24 units**. Show clearly **how the character figures this out** using numbers, drawings, or explanations.."

Expected Outcomes

1. Mathematical reasoning embedded in narrative
2. Use of drawings, diagrams, or dialogue
3. Multiple correct mathematical paths

Divergence Type: Representational and semantic divergence
Model Student Example

Title: *The Triangle Stage*

Lina is helping her school prepare a small outdoor show. There is only one free space in the yard, and it has to be shaped like a triangle. The teacher tells Lina: “The stage must have an area of exactly 24 square meters.” Lina draws a triangle on grid paper. First, she chooses a base of **6 meters**. She knows the formula for the area of a triangle:

$$A = \frac{1}{2} \times \text{base} \times \text{height}$$

She thinks:“If the base is 6, I need a height that makes the area 24.” She calculates:

$$24 = \frac{1}{2} \times 6 \times h$$

$$24 = 3h$$

$$h = 8$$

Lina draws a height of **8 meters** straight up from the base. She checks her work:

$$\frac{1}{2} \times 6 \times 8 = 24$$

The stage is the right size, so Lina adds places for students to stand and a small speaker in one corner. The teacher approves the plan.

Why This Is a Valid Mathematical Solution

- The **area requirement is met exactly**
- The reasoning is **clearly explained**
- The story does not replace mathematics; it **carries it**
- The solution could be assessed for **accuracy and understanding**

Embedded Mathematics

Mathematical Idea	Where It Appears in the Story
Area formula	Used by the character
Algebraic reasoning	Solving for height
Verification	Re-checking the area
Representation	Drawing on grid paper

Alternative Student Ending (Different Choice)

A student could instead write:

> "Lina changed the design and used a base of 12 meters and a height of 4 meters.
> She checked that:
>
> $$\frac{1}{2} \times 12 \times 4 = 24$$
>
> The stage was wider and easier to decorate."

This is **equally correct**.

Teacher Notes: What to Accept as Correct

✔ Any base–height pair satisfying

$$\frac{1}{2}bh = 24$$

✔ Diagrams, tables, or verbal explanations

✔ Different narratives, as long as the math is sound

✖ Stories without mathematical justification

Differentiation (Including SEN)

- Allow:
  - Bullet-point stories
  - Comic-strip formats
  - Sentence starters:
    - "The base was ___ because…"
    - "The area was checked by…"
- Accept oral storytelling with a drawing

Assessment Focus

Criterion	Evidence
Mathematical correctness	Area = 24
Reasoning	Steps explained
Representation	Drawing or calculation
Communication	Clear narrative

Key Pedagogical Insight

> "Storytelling does not simplify mathematics — it **situates** it."

Summary: Three Types of Divergence in One Task

Divergence Type	What Changes	Example Outcome
Method	How students solve	Formula, grid, coordinates
Conditions	What must be satisfied	Same area, different shapes
Representation	How meaning is expressed	Drawing, story, design

Key Pedagogical Insight "Divergence is not about removing rigor — it is about multiplying legitimate mathematical thinking

Divergent version 4 Creative Challenge: "A Mathematics Story"

The teacher gives students a short "story" or real-life scenario in which mathematical problems are solved creatively.

Example: "In the classroom, students must count objects, divide into teams, and perform various measurements."

Example Story Solution Students must arrange desks into triangular groups. Each group must cover exactly 20 square meters of space.

Possible Mathematical Solutions: Base 10 m, height 4 m / Base 8 m, height 5 m / Comparison of layouts to minimize unused space

Other divergence versions: Transforming Traditional Questions into Creative Ones

Examples of Creative Questions by Type

1. **Freedom of tools**
2. **Freedom of sequence of work**
3. **Unexpected elements** (both geometric and real-life)

1. Freedom of TOOLS *(Students choose what they use, not just how they calculate)*

Creative Question 1: "Show Me the Area" Find the area of a triangle with base 6 and height 8. You may choose **any tools** you think will help you. Be ready to explain **why your tool works**.

Permitted Tools (Not Assigned)

1. Grid paper
2. Ruler and scissors
3. GeoGebra / digital drawing tool
4. Physical cut-out triangle
5. Formula only (no drawing)

Expected Student Outputs

★ A student cuts a rectangle and folds it in half
★ A student draws the triangle on grid paper and counts squares
★ A student uses GeoGebra and measures
★ A student uses the formula directly

All reach: **A = 24**

Why This Is True Divergence

1. The **representation depends on the tool**
2. The mathematics remains fixed
3. Tool choice reveals **student thinking preferences**

Teacher Look-For "Does the student justify why their tool gives the correct area?"

2. Freedom of SEQUENCE OF WORK *(Students decide the order: draw → calculate → check, or calculate → draw → justify)*

Creative Question 2: "Solve It Backwards"

You need a triangle with an area of 24 cm². Decide **your own order of steps**:

- ➢ draw first
- ➢ calculate first
- ➢ check at the end

Show the steps **in the order you chose**.

Possible Student Sequences

Student A: Draws several triangles / Measures base and height /Calculates area /Adjusts drawing

Student B: Starts with formula/ Chooses numbers that work/ Draws triangle to match/ Verifies on grid

Expected Mathematical Outcomes: Any valid base–height pair such that:

$$\frac{1}{2}bh = 24$$

Why This Matters: Students learn that **mathematics is not linear/** Encourages planning and self-monitoring/ Mirrors authentic problem-solving

3. Unexpected GEOMETRIC ELEMENTS *(Breaking the "expected shape")*

Creative Question 3: "The Hidden Triangle"

Inside the shape below is a triangle. Find the area of the triangle **without removing it from the shape**. You may: subtract areas, decompose shapes, add auxiliary lines *(The "shape" can be a trapezoid, rectangle, or irregular polygon.)*

Expected Student Strategies: Subtract rectangle area minus triangle/ Split shape into known figures / Draw extra heights or diagonals

Unexpected Element: The triangle is **not isolated;** Students must *see* it mathematically

Mathematical Outcome: Correct triangle area + explanation of reasoning

4. Unexpected REAL-LIFE ELEMENTS *(Math enters a decision-making situation)*

Creative Question 4: "You Are the Planner"

A food truck wants a triangular serving area of exactly 24 m². One side must be along the sidewalk (fixed length). You decide:

1. the other dimensions
2. the shape
3. how to explain your choice to the owner

Expected Student Thinking: Fix base, Adjust height, Consider usability, shape, access, Justify mathematically and practically

Why This Is Unexpected: No single "correct" triangle, Mathematics supports **a recommendation,** Blends geometry with reasoning

5. Combined Example (All Three Types at Once)

Creative Question 5: "Design Under Constraints"

Design a triangular space with an area of **24 units²**.

1. Choose **any tools**
2. Choose **your own order of steps**
3. The triangle must fit **inside a circle or rectangle**

Explain your design decisions.

Divergence Present

Type	Present?
Tool choice	✓
Sequence choice	✓
Unexpected geometry	✓

What Makes These Truly "Creative Questions"

They:

1. Preserve **mathematical rigor**
2. Multiply **legitimate solution paths**
3. Shift focus from "answer" to **decision-making**
4. Reveal how students **think**, not just what they know

Final Reflection – Expected Outcomes

From these solutions, teachers should observe that:

1. Multiple correct answers are possible
2. Reasoning and explanation are more important than the final number
3. Creativity emerges naturally when constraints are flexible

Key Teaching Insight "Creativity in mathematics does not come from novelty alone — it comes from **choice under constraint**."

ACTIVITY #6

Divergent tasks: Maths

A. Unexpected Task: “Hidden Pattern”

Groups are given a geometric pattern or a table with “incomplete” values.

Task: Identify the rule or pattern and complete the table.

Example: Number sequence: 2, 4, 8, ?, ?, ? → find the logic and fill in the missing terms.

Autonomy: Choose a solution approach – draw a diagram, use symbols, or collaborate within the group.

Possible Valid Solutions Because the task is open, **multiple rules are acceptable**, provided they are logically justified.

Solution A: Multiplication Pattern

Each number is multiplied by 2.

$$2, 4, 8, 16, 32, 64$$

Solution B: Add Increasing Powers of 2

Add 2, then 4, then 8, then 16…

$$2, 4, 8, 16, 32, 64$$

(Same result, different reasoning.)

Solution C: Exponential Interpretation

$2^1, 2^2, 2^3, 2^4, 2^5, 2^6$

Key Teaching Point The value lies in **explaining the rule**, not merely finding numbers.
B. Creative Exercise: “Creative Numbers”

Groups are given a simple number or shape.

Task: Generate as many different interpretations or solutions as possible.

Example: Number 12 → divide it, add it, represent it in diagrams, stories, or geometric shapes.

Task: Given the number **12**, generate as many interpretations as possible.

Example Solutions

Arithmetic: $12 = 3 \times 4$; $12 = 2^2 \times 3$; $12 \div 3 = 4$

Geometry:

- Area of a rectangle: 3×4
- 12 unit squares forming multiple rectangles
- Regular clock face with 12 hours

Data / Representation: Bar chart with total value 12/ Fraction representations: 12/1, 6/½

Story Context: 12 students split into equal teams or 12 eggs in a carton

SCIENTIFIC EXPERIMENTS

SCIENTIFIC EXPERIMENT #1

Recycling Paper: From Waste to New Material

Type of Activity

Experimental science activity with transdisciplinary applications (Science, Ecology, Art, Civic Education)

Target Age Group

Primary or lower secondary students (adaptable for older students with added variables)

Learning Objectives

Scientific Objectives

Students will:

1. Understand that paper is made from plant fibers (cellulose).
2. Observe how cellulose fibers can be reused through mechanical processing.
3. Identify the stages of a material transformation process: soaking, pulping, filtering, pressing, and drying.
4. Develop basic experimental skills: observation, sequencing, and cause–effect reasoning.

Transdisciplinary Objectives

Students will:

1. Develop ecological awareness by understanding recycling as a method of resource conservation.
2. Express creativity by designing recycled paper with colors, textures, or natural inclusions.
3. Practice collaboration, responsibility, and respect for shared resources.

4. Strengthen fine motor skills and procedural discipline.

Research Question

Can used paper be recycled and transformed into new paper using water, mechanical processing, and drying?

Hypothesis

If used paper is soaked in water and mechanically processed, then its fibers can be recombined to form a new sheet of paper after filtering, pressing, and drying.

Materials

- Used paper (newspapers, notebooks, scrap paper)
- Water
- Container or basin
- Blender or manual tearing (age-appropriate)
- Sieve or mesh screen
- Absorbent cloth or sponge
- Heavy books or press
- Flat drying surface

Optional: natural dyes, flower petals, leaves, threads

Experimental Procedure

1. **Preparation**
   Tear used paper into small pieces and place them in a container with water.
2. **Soaking**
   Allow the paper to soak until it becomes soft and fibrous.
3. **Pulping**
   Mix the soaked paper mechanically to separate the fibers and form pulp.

4. **Filtering**
   Pour the pulp onto a sieve and spread it evenly to form a thin layer.
5. **Pressing**
   Remove excess water using a cloth or sponge, then apply pressure.
6. **Drying**
   Leave the paper to dry completely on a flat surface.

Observations

Students observe:

1. Changes in texture and structure of the paper
2. Water absorption and fiber separation
3. Formation of a continuous sheet from loose fibers
4. Differences between original and recycled paper

Results: A new sheet of recycled paper is obtained, demonstrating that paper fibers can be reused through a physical transformation process.

Conclusion The experiment confirms that paper recycling is possible using simple physical methods. No new raw materials are required, only water, mechanical action, and time. This demonstrates an important principle of sustainable material use.

Transdisciplinary Connections

Ecology and Environmental Education

- Highlights the importance of reducing waste and saving trees
- Encourages responsible consumption and recycling habits
- Introduces concepts of sustainability and circular economy

Art and Creativity

- Recycled paper can be decorated or customized
- Students explore texture, color, and design

- Connects science with visual expression

Civic and Social Education

- Promotes teamwork and shared responsibility
- Builds awareness of individual impact on the environment
- Encourages active citizenship through small, meaningful actions

Skills Development

1. Fine motor coordination
2. Following scientific procedures
3. Problem-solving and reflection

Extension Activities

1. Compare thickness or strength of recycled paper samples
2. Test different paper types (newspaper vs. notebook paper)
3. Write or draw on the recycled paper
4. Create an ecological poster or artwork using the recycled sheets

_____ Experiment

Write the name of your experiment in the blank space above. Then, complete the rest of this page with information about your experiment.

Question: What are you testing?

Hypothesis: What do you think will happen?

Observations: What happened during the experiment? Draw a picture or record data below.

Conclusion: What conclusions can you draw based on the results of your experiment?

Observation sheet source: WeAreTeachers, 2024

SCIENTIFIC EXPERIMENT #2

The Balloon and Skewer Experiment: Understanding Courage Through Science

Learning objectives

Scientific Objectives

Students will:

1. Observe the physical properties of latex (elasticity and tension).
2. Understand how friction and surface tension affect materials.
3. Identify how soap reduces friction and allows materials to pass through elastic surfaces without rupture.
4. Practice prediction, observation, and explanation.

Interdisciplinary Objectives

Students will:

1. Explore the moral virtue of **courage** through a concrete metaphor.
2. Reflect on fear as a natural emotion that can be managed rather than eliminated.
3. Develop emotional literacy and ethical reasoning.
4. Improve oral language skills through explanation and discussion.
5. Strengthen fine motor control and attention.

BEFORE THE EXPERIMENT

Integration with a courage based story *"I'm Not Scared, You're Scared"*, by Seth Meyers

Pre-Experiment Discussion: Preparing for Courage

Guided Class Discussion

1. Before the experiment
    - How do you feel when you have to try something new?
    - Is it normal to feel scared sometimes?
    - In the story, how did the character feel at the beginning?
2. Connecting to the story
    - Did the character say they were scared, or did they hide it?
    - Why do you think people sometimes say “I’m not scared” when they really are?
    - What helped the character keep going in the story?
3. Encouragement moment
    - What can we say to ourselves when we feel scared but want to try?
    - Who can help us feel brave in class?
    - What does courage look like right now, before we start the experiment?

“Courage does not mean we are not scared. Courage means we try even when we feel scared.”

RUNNING THE EXPERIMENT

Type of Activity

Scientific demonstration and guided experiment with interdisciplinary applications (Science, Social-Emotional Learning, Ethics, Language, and Art)

Target Age Group

Primary education (with teacher-guided execution)

Research Question

How does applying soap to a skewer allow it to pass through a balloon without popping, and how can this process represent courage?

Hypothesis

If a skewer is covered with soap and inserted carefully into specific points of a balloon, then the balloon will not pop because friction is reduced and the latex can stretch without breaking.

Materials

- Latex balloon
- Wooden skewer
- Liquid soap
- Paper towels
- Tray or protective surface

During the Experiment: Guided Reflection

As students prepare to participate or observe:

- How does your body feel right now?
- Are you more scared, less scared, or the same as before?
- What helps you feel calm enough to try?

Link explicitly to the metaphor:

- The balloon is like fear.
- The soap is like courage and calm thinking.
- The skewer is like us, moving carefully.

Experimental Procedure

1. **Preparation**
   Inflate the balloon and tie it securely. Explain that the balloon represents *fear*.
2. **Prediction**
   Ask students what they think will happen if the skewer touches the balloon.

3. **Application of Soap**
   Cover the skewer with soap. Explain that the soap represents *courage*.
4. **Insertion**
   Slowly push the skewer through the balloon at the top or bottom (where the latex is thickest).
5. **Observation**
   Observe whether the balloon pops or remains intact.
6. **Discussion**
   Relate the scientific observation to the emotional concept of courage.

Observations

Students observe:

- The balloon stretches instead of breaking
- The skewer passes through smoothly
- Soap reduces resistance between materials
- Fear does not disappear, but it can be managed

Results: The balloon remains intact when the skewer is inserted carefully with soap, demonstrating how reduced friction allows materials to adapt rather than break.

Scientific Explanation: Latex is elastic and can stretch when stress is applied evenly. Soap reduces friction and prevents sudden tearing. When force is controlled and applied thoughtfully, the material remains intact.

Conclusion: The experiment demonstrates that courage does not mean the absence of fear, but the ability to move through fear calmly and thoughtfully. Scientifically, this is shown by how controlled force and reduced friction prevent rupture.

AFTER THE EXPERIMENT

In this experiment, each object has a clear meaning:

The balloon represents the person. Just like a person, the balloon is sensitive and can be hurt if something sharp touches it.

The skewer represents fear. Fear can feel sharp, sudden, and painful. When fear comes too fast or too strongly, it can overwhelm a person.

The soap represents courage. Courage does not remove fear. Instead, it helps us face fear calmly and carefully.

When the skewer (fear) touches the balloon (the person) **without soap**, the balloon pops. This shows what can happen when fear is faced without support, preparation, or courage.

When the skewer is covered with soap (courage), it can pass through the balloon **without destroying it**. This shows that: Fear still exists. Fear still touches the person. But courage helps the person stay whole. **Courage is not the absence of fear. Courage is what helps us face fear without breaking.** Just like soap helps the skewer move gently through the balloon, courage helps a person move through fear safely.

Reflection Questions

Understanding Courage

1. Does fear go away in the experiment?
2. What changes when courage is added?
3. How does courage help a person stay strong?

Reflection link: Fear does not disappear. Courage helps us move through fear safely.

Personal Reflection Students answer orally, in writing, or by drawing:

1. Before the experiment, I felt:
   ☐ scared ☐ excited ☐ nervous ☐ calm
2. During the experiment, I felt:
   ☐ scared ☐ excited ☐ nervous ☐ calm
3. After the experiment, I felt:
   ☐ proud ☐ surprised ☐ brave ☐ happy

Story + Experiment Connection

Sentence starters suitable for young learners:

➔ In the story, courage helped the character to _____.
➔ In the experiment, courage helped us to _____.
➔ Courage means _____.
➔ I can be courageous when _____.

Final Reflection Question (Key Takeaway)

Is courage about not being scared, or about trying even when you are scared?

Students to justify their answer using:

- the story
- the experiment
- their own feelings

Interdisciplinary Connections

Science

- Elasticity
- Friction

- Material properties

Moral and Civic Education

- Courage as a learned virtue
- Managing fear responsibly
- Making thoughtful choices

Social-Emotional Learning

- Naming emotions
- Building resilience
- Self-confidence

Language and Communication

- Describing observations
- Explaining cause and effect
- Reflective discussion

Art and Drama (Extension)

- Draw the experiment as a metaphor
- Role-play situations requiring courage
- Create posters illustrating “Courage helps us move through fear”

Assessment Methods

- Oral explanations
- Observation sheets
- Reflection questions
- Student drawings or short written responses

SCIENTIFIC EXPERIMENT #3

Comparing Bread Storage Methods

Lesson Plan: "How to Keep Bread Fresh Longer?"
1. Lesson Information

Grade Level: Primary / Lower Secondary (adaptable)

Subject: Science (with interdisciplinary integration)

Duration: 60–75 minutes (plus 7–10 days of observation)

Materials:

- 4 identical slices of bread
- 4 types of storage (plastic bag, paper bag, container, cloth wrap)
- Marker
- Observation sheet
- Digital camera or phone (optional for documentation)

2. Lesson Title

"How to Keep Bread Fresh Longer?"
(Experiment: Bread Storage and Mold Growth)

3. Learning Objectives

Science Objectives

Students will be able to:

1. Design a simple experiment to test a hypothesis.
2. Identify variables: independent, dependent, and controlled.

3. Observe and record the growth of mold over time.
4. Explain how moisture and air exposure affect mold growth.

Interdisciplinary Objectives

Students will be able to:

1. Biology: Understand that mold is a fungus and needs moisture to grow.
2. Ecology: Explain how food waste affects the environment and why reducing waste matters.
3. Mathematics: Measure and compare the rate of mold growth using simple data.
4. Civic Education: Develop responsible consumption habits and make ethical choices.
5. Art: Create a visual representation of the experiment results (poster or infographic).

4. Competencies (Skills)

Scientific Competencies

- ➔ Inquiry and Investigation: Formulating questions and testing hypotheses.
- ➔ Observation: Using senses and tools to collect data.
- ➔ Reasoning: Drawing conclusions based on evidence.

Key Competencies (Cross-curricular)

1. Critical Thinking: Analyzing causes of food spoilage.
2. Responsibility: Making informed choices about food consumption.
3. Communication: Presenting results clearly.
4. Creativity: Designing visual outputs (poster, drawing).

5. Key Vocabulary

- ★ Mold / Fungus
- ★ Spoilage
- ★ Moisture
- ★ Air exposure
- ★ Storage

- ★ Variables
- ★ Hypothesis
- ★ Observation
- ★ Data
- ★ Waste reduction

6. Lesson Procedure

A. Warm-up and raising awareness (10 minutes)

Start by playing a short video on food waste and global hunger.
https://youtu.be/TVP3j7_W7og
Classroom Prompt Questions

Use these to tie the statistics into your lesson activity:

1. What do these numbers tell us about how much food is wasted compared to how much people need to eat?
2. How does wasting bread at home connect to these global statistics?
3. What could we do in our own homes or school to reduce waste?
4. Why might reducing food waste help both the environment **and** people who are hungry?

5. "Have you ever thrown away bread because it was moldy?"
6. "Why do you think bread becomes moldy?"
7. Introduce the lesson question:
    - "How can we store bread to keep it fresh longer?"

B. Introduce the Experiment (5 minutes)

- 4 identical slices of bread
- Each slice is stored differently
- Observe which slice molds first

C. Hypothesis and Variables (10 minutes)

- Hypothesis: Which storage method will keep bread fresh the longest?
- Variables:
    - Independent: storage method
    - Dependent: time until mold appears
    - Controlled: same bread, same temperature, same observation time

D. Experiment Setup (10 minutes)

Students work in groups to:

1. Label each storage method.
2. Place one bread slice in each storage type.
3. Write the starting date and conditions on the observation sheet.

E. Observation Phase (7–10 days)

Students observe daily and record:

1. Mold presence (Yes/No)
2. Mold color
3. Bread smell and texture

This can be done as homework or in class, depending on schedule.

F. Data Analysis and Discussion (20 minutes)

After the observation period:

1. Students compare results in a table.
2. Discuss:
    - Which storage method was best?
    - Why did mold grow faster in some conditions?
    - What does mold need to grow?

7. Assessment (Evaluation)

Formative Assessment

- Observation sheets completed correctly
- Participation in discussion
- Correct identification of variables and hypothesis

Summative Assessment

Students create one of the following:

1. A short report (5–8 sentences) explaining the results.
2. A poster showing the experiment and results.
3. A chart or graph comparing mold growth time for each storage method.

8. Interdisciplinary Connections

Biology

- Mold is a living organism (fungus).
- It grows when there is moisture, food, and warm temperature.

Ecology

- Food waste increases environmental impact.
- Reducing waste saves resources and energy.

Mathematics

- Students measure days until mold appears.
- They calculate and compare results.

Civic Education

- Responsible consumption (buy only what you need).
- Ethical behavior: not wasting food.

Art

- Create posters or infographics about the experiment.
- Use drawing or collage to represent mold growth stages.

9. Safety Notes

- Students must not open containers with mold without gloves.
- Avoid inhaling mold spores.
- Dispose of moldy bread in sealed bags.

10. Extension Activities (Optional)

1. Compare Bread Types

White bread vs whole grain vs gluten-free.

2. Make a “Bread Saving Plan”

Students create a weekly plan to reduce bread waste at home.

3. Community Project

Share results with families and create a school campaign to reduce food waste.

SCIENTIFIC EXPERIMENT #4

Experiment Title The Jar Experiment: Time, Capacity, and Priorities

Type of Activity: Scientific demonstration and inquiry-based experiment using a physical model to explain abstract concepts (time management and prioritization)

Grade Level : Upper primary / lower secondary (adaptable for older students)

Learning Objectives

Scientific Objectives

Students will be able to:

1. Observe how volume and capacity affect what can fit into a container.
2. Understand sequencing and order as critical variables in experimental outcomes.
3. Use a physical model to represent abstract concepts.
4. Draw conclusions based on evidence from a demonstration.

Interdisciplinary Objectives

Students will be able to:

1. **Civic / Personal Education:** Identify priorities in life and decision-making.
2. **Mathematics:** Reason about volume, space, and capacity.
3. **Ethics / Values Education:** Reflect on what is essential versus optional.
4. **Language:** Explain observations and conclusions using cause-and-effect language.

Research Question : *How does the order in which we add materials affect what can fit into a fixed container, and how can this model represent life priorities?*

Hypothesis: If large objects are placed into the jar first, followed by smaller ones, then all materials will fit.
If small materials are added first, there will not be enough space for the larger objects.

Materials

- 1 transparent jar or container
- Large stones or rocks
- Small pebbles
- Sand
- Tray or surface mat
- Observation sheet

Variables

A. **Independent Variable:** Order in which materials are added
B. **Dependent Variable:** Whether all materials fit inside the jar
C. **Controlled Variables:** Same jar, same materials, same quantities

Experimental Procedure

Part A: Incorrect Order (Sand First)

1. Place the empty jar on the table.
2. Fill the jar completely with sand.
3. Attempt to add the pebbles and rocks.
4. Observe what happens.

Part B: Correct Order (Rocks First)

1. Empty the jar completely.
2. Place the large rocks into the jar first.
3. Add the pebbles, allowing them to settle between the rocks.
4. Pour the sand last, filling the remaining spaces.

5. Observe the final result.

Observations: Students observe that:

- When sand is added first, there is no room for rocks or pebbles.
- When rocks are added first, all materials fit.
- Smaller materials fill the empty spaces between larger ones.
- The container's total capacity never changes—only the order does.

Results: All materials fit into the jar **only** when the largest objects are placed first.

Scientific Explanation: The jar has a fixed volume. Large objects take up more space and cannot adjust their position easily. Smaller materials can move into gaps between larger objects. Therefore, placing large objects first allows maximum use of available space.

Model Interpretation (Life Analogy): This experiment functions as a **model**:

★ **The Jar** represents a person's life or the total time available in a day.
★ **The Big Rocks** represent the most important priorities (health, family, core values).
★ **The Pebbles** represent important but secondary responsibilities (school, work, hobbies).
★ **The Sand** represents minor tasks, distractions, and material concerns.

Conclusion: The experiment demonstrates that **order matters**. If minor tasks take up time first, there may be no space left for what truly matters. By prioritizing essential values early, everything else can still find its place.

Key Lesson: *If you do not make time for your most important priorities first, you may never have time for them at all.*

Interdisciplinary Connections

Science (Modeling and experimentation, Cause and effect, Capacity and volume),

Mathematics (Spatial reasoning, Comparing quantities, Understanding fixed capacity),

Civic / Personal Education (Decision-making, Time management, Responsibility and values),

Ethics / Character Education (Clarifying priorities, Understanding long-term consequences),

Language / Communication (Explaining models, Using metaphors, Structured reflection)

Reflection Questions

1. What happened when the sand was added first?
2. Why did the order change the result?
3. What might “sand” look like in everyday life?
4. What are examples of “big rocks” for a student?
5. How can this experiment help us make better choices?

Student Observation Worksheet (older students)

The Jar Experiment: Time, Capacity, and Priorities

Name: _____
Date: _____
Class: _____

---

1. Experiment Title

The Jar Experiment: Time, Capacity, and Priorities

---

2. Research Question

How does the order in which materials are added to a jar affect what can fit inside?

---

3. Prediction (Before the Experiment)

What do you think will happen?

☐ All materials will fit no matter the order
☐ The order will change the result
☐ I am not sure

Explain your prediction:

4. Materials Used

Circle the materials used in the experiment:

1. Jar
2. Large rocks
3. Pebbles
4. Sand

5. Observation – Part A (Sand First)

What happened when the jar was filled with sand first?

☐ Rocks fit easily
☐ Pebbles fit easily
☐ Rocks did not fit
☐ Pebbles did not fit

Describe what you observed:

6. Observation – Part B (Rocks First)

What happened when the rocks were placed in the jar first?

☐ All materials fit
☐ Some materials did not fit
☐ Pebbles filled the spaces
☐ Sand filled the small gaps

Describe what you observed:

_____
_____
_____

7. Results

Which order allowed all materials to fit into the jar?

☐ Sand → Pebbles → Rocks
☐ Rocks → Pebbles → Sand

8. Scientific Explanation

Why did the order of materials change the result?

_____
_____
_____

9. Life Model Connection

Match each object to what it represents:

➔ The jar represents: _____
➔ The big rocks represent: _____
➔ The pebbles represent: _____

➔ The sand represents: _____

10. Reflection: Understanding Priorities

Answer in complete sentences.

1. What happens if we fill our time with “sand” first?

_____

2. Why are the “big rocks” important?

_____

3. What could be one “big rock” in a student’s life?

_____

_____

11. Personal Reflection (Optional)

Write or draw one thing that is a **big rock** in your life.

_____

_____

_____

12. Conclusion

Complete the sentence:

This experiment teaches us that _____

_____.

Teacher Observation (Optional)

1. Student participated actively: ☐ Yes ☐ Somewhat ☐ No
2. Student understood the model: ☐ Yes ☐ Partially ☐ Needs support

SCIENTIFIC EXPERIMENT #5

Experiment Title **How Microbes Spread: A Model of Sneezing and Droplet Transmission**

Type of Activity: Scientific experiment using a **physical model** to simulate the spread of microorganisms through respiratory droplets

Grade Level: Primary / Lower Secondary (teacher-guided)

Learning Objectives

Scientific Objectives

Students will be able to:

1. Understand that microbes spread through droplets released by sneezing or coughing.
2. Observe how far droplets can travel.
3. Compare how barriers (hand, tissue, mask) reduce spread.
4. Use a model to represent an invisible biological process.

Interdisciplinary Objectives :Students will be able to:

- **Biology:** Recognize microbes as microscopic organisms.
- **Health Education:** Understand hygiene and disease prevention.
- **Civic Education:** Develop responsibility for protecting others.
- **Mathematics:** Measure and compare distances of spread.
- **Art:** Create visual representations of droplet patterns.

Research Question: *How do respiratory droplets spread during a sneeze, and how can barriers reduce their spread?*

Hypothesis: If a sneeze is not covered, droplets will spread widely. If a barrier is used, the spread of droplets will be reduced.

Materials

- ★ Flour (represents droplets carrying microbes)
- ★ Spoon or squeeze bottle (to simulate a sneeze)
- ★ Large dark sheet of paper or table surface
- ★ Measuring tape or ruler
- ★ Tissue, hand, or paper towel (as barriers)
- ★ Observation sheet

Variables

1. **Independent Variable:** Type of barrier used (none, hand, tissue)
2. **Dependent Variable:** Distance and area of flour spread
3. **Controlled Variables:** Same amount of flour, same force, same surface

Experimental Procedure

Part A: Uncovered “Sneeze”

1. Place the dark paper on the table.
2. Fill a spoon or bottle with flour.
3. Simulate a sneeze by quickly blowing or squeezing over the surface.
4. Observe how far and wide the flour spreads.

Part B: Covered “Sneeze”

1. Clean the surface.
2. Repeat the sneeze simulation while covering it with:
    - a hand

    - a tissue or paper towel
3. Observe and compare the spread.

Observations: Students observe that:

1. Flour spreads in many directions.
2. Small particles travel farther than expected.
3. Barriers significantly reduce spread.
4. Some particles still escape if the barrier is not used correctly.

Results: The largest spread occurs when no barrier is used. Using a tissue or covering reduces both distance and area of spread.

Scientific Explanation: Sneezing releases tiny droplets that can carry microbes. These droplets travel through air and land on surfaces. Barriers block or absorb droplets, reducing transmission.

Model Interpretation: This experiment is a **model**, not real germs:

- **Flour** represents droplets carrying microbes.
- **Sneezing motion** represents air pressure from a real sneeze.
- **Barriers** represent hygiene behaviors.

Conclusion: Microbes spread easily through droplets, even when we cannot see them. Simple actions like covering a sneeze can greatly reduce the spread and protect others.

Key Health Message: *Good hygiene is not just about protecting ourselves—it is about protecting everyone.*

Interdisciplinary Connections

Biology (Microorganisms, Transmission of disease),

Health Education, (Hygiene habits, Public health responsibility),

Civic Education (Caring for others, Community safety),

Mathematics (Measuring distances, Comparing quantities),

Art (Creating droplet-spread patterns, Visual storytelling)

Safety Notes

1. Do not inhale flour.
2. Clean surfaces after the experiment.
3. Emphasize that no real germs are used.

Reflection Questions

1. Why can germs spread even when we cannot see them?
2. Which barrier worked best?
3. How does this experiment relate to real life?
4. What hygiene rule will you remember?

Student Observation Worksheet

How Microbes Spread: A Sneeze Simulation Experiment

Name: _____
Date: _____
Class: _____

---

1. Experiment Title

How Microbes Spread: A Sneeze Simulation

---

2. Research Question

How do droplets spread during a sneeze, and how can covering a sneeze reduce the spread?

---

3. Prediction (Before the Experiment)

What do you think will happen when a sneeze is not covered?

☐ The flour will spread far
☐ The flour will stay in one place
☐ I am not sure

Explain your prediction:

4. Materials Used

Circle the materials used in the experiment:

1. Flour
2. Spoon / squeeze bottle
3. Dark paper or surface
4. Tissue / paper towel
5. Ruler or measuring tape

5. Observation – Part A (Uncovered Sneeze)

What did you observe when the sneeze was **not covered**?

☐ Flour spread far
☐ Flour spread in many directions
☐ Only a small area was covered

Describe what you saw:

Approximate distance of spread: _____

6. Observation – Part B (Covered Sneeze)

What did you observe when the sneeze was **covered with a tissue or hand**?

☐ Less flour spread
☐ More flour stayed close
☐ Almost no flour spread

Describe what you saw:

_____

_____

Approximate distance of spread: _____

_____

7. Results

Which situation caused the **most spread**?

☐ Uncovered sneeze
☐ Covered sneeze

_____

8. Scientific Explanation

Why did covering the sneeze change the result?

_____

_____

_____

9. Model Explanation

Fill in the meanings:

- Flour represents: _____
- Sneezing motion represents: _____
- Tissue or hand represents: _____

10. Health and Responsibility Reflection

Answer in complete sentences.

1. Why is it important to cover our mouth and nose when we sneeze?

---

2. How does this experiment help protect other people?

---

11. Real-Life Connection

Complete the sentence:

One hygiene rule I will remember after this experiment is _____.

---

12. Conclusion

What did you learn from this experiment?

☐ How germs spread
☐ How to protect others
☐ Both

Explain:

Teacher Observation (Optional)

- Student participated: ☐ Yes ☐ Somewhat ☐ No
- Student understood the model: ☐ Yes ☐ Partially ☐ Needs support

SCIENTIFIC EXPERIMENT # 6

Experiment Title: **Cotton vs Synthetic Sports Fabric Extended Experiment: Fabric Drying Under Different Conditions**

Type of Activity: Inquiry-based scientific experiment comparing textile materials under varying environmental conditions to understand drying time, comfort, and health implications

Grade Level: **Ages 9–14** (upper primary / lower secondary)

Learning Objectives

Scientific Objectives: Students will be able to:

1. Compare physical properties of cotton and synthetic fabrics.
2. Measure and compare drying time under different conditions.
3. Explain evaporation in relation to temperature and airflow.
4. Identify independent, dependent, and controlled variables.

Interdisciplinary Objectives: Students will be able to:

- **Physics:** Explain evaporation and heat transfer.
- **Biology / Health:** Understand thermoregulation and cooling.
- **Civic / Life Education:** Make informed clothing choices.
- **Mathematics:** Measure time, organize data, compare results.
- **Language:** Communicate conclusions using scientific reasoning.

Research Questions

1. *Which fabric dries faster: cotton or synthetic sports fabric?*
2. *How do temperature and airflow affect drying time?*

Updated Hypotheses

1. Synthetic fabric will dry faster than cotton under all conditions.
2. Higher temperature and increased airflow will reduce drying time for both fabrics.
3. Airflow will have a stronger effect on drying time than temperature alone.

Materials

1. Cotton fabric sample (same size)
2. Synthetic sports fabric sample (same size)
3. Water (measured quantity)
4. Measuring cup or spoon
5. Timer or clock
6. Fan (for airflow condition)
7. Two locations:
    a. Room-temperature area
    b. Warm area (radiator at a safe distance, sunny window or warm room)
8. Observation worksheet

Variables

- **Independent Variables:**

    - Fabric type (cotton / synthetic)
    - Environmental condition (temperature and airflow)

- **Dependent Variable:**
    - Drying time (minutes)
- **Controlled Variables:**
    - Fabric size
    - Amount of water
    - Surface used
    - Starting time

Experimental Procedure

1. Place both fabric samples on a flat surface.
2. Pour the same amount of water onto each sample.
3. Assign samples to one of the following conditions:
    - Room temperature, no airflow
    - Room temperature, airflow (fan)
    - Warm area, no airflow
    - Warm area, airflow
4. Start the timer.
5. Check the fabrics every 5 minutes.
6. Record when each fabric feels dry.

Experimental Design (Conditions)

Students test **four conditions**:

Condition	Temperature	Airflow
A	Room temperature	No airflow
B	Room temperature	Fan
C	Warm	No airflow
D	Warm	Fan

Each condition is tested with:

- Cotton fabric
- Synthetic fabric

Observation Table (Example)

Fabric	Condition	Drying Time (min)
Cotton	A	_____
Cotton	B	_____
Cotton	C	_____
Cotton	D	_____
Synthetic	A	_____
Synthetic	B	_____

Synthetic	C	_____
Synthetic	D	_____

Results (Expected Pattern)

1. Synthetic fabric dries faster than cotton in all conditions.
2. Both fabrics dry faster with airflow.
3. Warm + airflow = fastest drying.
4. Cotton benefits from airflow but still dries slower than synthetic.

Scientific Explanation

- **Temperature** increases evaporation by adding energy to water molecules.
- **Airflow** removes moist air from the fabric surface, allowing more evaporation.
- Synthetic fibers do not trap water, so evaporation happens more efficiently.

Evaporation increases with temperature and airflow. Cotton fibers trap water, slowing evaporation. Synthetic fibers allow water to evaporate more quickly due to reduced absorption and improved airflow.

Health and Practical Interpretation

- **Sports clothing** Synthetic fabrics are better for physical activity because they dry faster and help regulate body temperature (dry quickly, allow airflow, reduce cooling from wet fabric)
- **Health risk**:Wet cotton removes heat from the body, increasing the risk of chilling in cold or windy conditions.Proper sports fabrics help maintain stable body temperature.

Conclusion

Drying time depends on both material properties (fabric type) and environmental conditions (temperature, airflow). Synthetic sports fabrics combined with airflow provide the best conditions for staying dry and warm during physical activity.

Extension Questions (Higher Thinking)

1. Which variable had the strongest effect: fabric type, temperature, or airflow?
2. Why is airflow especially important during sports?
3. How does sweating connect to this experiment?

Interdisciplinary Connections

Physics (Evaporation, Heat transfer), **Biology / Health** (Thermoregulation, Hypothermia prevention), **Civic / Life Education** (Self-care and health decisions)**, Mathematics** (Time measurement, Data comparison tables), **Language** (Scientific explanation, Argumentation)

Safety Notes

- Do not place fabrics too close to heat sources.
- Do not wear wet fabrics during the experiment.
- Ensure fans are used safely.

Reflection Questions

1. Which variable had the greatest effect on drying time?
2. Why is airflow important during sport?
3. How can clothing choice affect health?

Student Observation Worksheet

Which Fabric Dries Faster? Cotton vs Synthetic Sports Fabric

Name: _____
Date: _____
Class: _____

1. Experiment Title

Which Fabric Dries Faster? Cotton vs Synthetic Sports Fabric Under Different Conditions

2. Research Questions

1. *Which fabric—cotton or synthetic—dries faster?*
2. *How do temperature and airflow affect drying time?*

---

3. Prediction (Before the Experiment)

Complete the table and explain your prediction:

Fabric	Condition	Prediction: Will it dry faster or slower?
Cotton	Room temp, no airflow	_____

Cotton	Room temp, airflow	_____
Cotton	Warm, no airflow	_____
Cotton	Warm, airflow	_____
Synthetic	Room temp, no airflow	_____
Synthetic	Room temp, airflow	_____
Synthetic	Warm, no airflow	_____
Synthetic	Warm, airflow	_____

Explain your reasoning:

_____

_____

_____

4. Materials Used

Circle the materials you used:

1. Cotton fabric
2. Synthetic sports fabric
3. Water
4. Measuring cup / spoon
5. Timer
6. Fan
7. Thermometer
8. Flat surface / tray
9. Observation worksheet

5. Observation Table Record the drying time for each fabric in each condition.

Fabric	Condition	Time until dry (minutes)	Notes / Observations
Cotton	Room temp, no airflow	_____	_____
Cotton	Room temp, airflow	_____	_____
Cotton	Warm, no airflow	_____	_____
Cotton	Warm, airflow	_____	_____

Synthetic	Room temp, no airflow	_____	_____
Synthetic	Room temp, airflow	_____	_____
Synthetic	Warm, no airflow	_____	_____
Synthetic	Warm, airflow	_____	_____

Graph Layout : Drying Time (minutes)

```
|
|       [Cotton]    [Synthetic]
|        |           |
|        |           |
|        |           |
|---------|------------|----------------> Conditions
         Room/NoAir  Room/Air  Warm/NoAir  Warm/Air
```

6. Results Analysis

Answer the questions:

1. Which fabric dried faster overall?

---

2. Which condition helped fabrics dry fastest?

3. How did airflow affect drying time?

4. How did temperature affect drying time?

7. Scientific Explanation

Why did one fabric dry faster than the other?

8. Practical / Health Interpretation

1. Which fabric is better for sports or physical activity?

2. How can wet clothing affect your health?

9. Reflection Questions

1. If you had to choose clothes for running on a windy, cold day, which fabric would you choose? Why?

2. How could this experiment help you make better clothing choices?

10. Conclusion

Complete the sentence:

This experiment teaches me that the right fabric and environmental conditions help _____.

Teacher Observation (Optional)

1. Student participated: ☐ Yes ☐ Partially ☐ No
2. Student understood the variables: ☐ Yes ☐ Partially ☐ Needs support

SCIENTIFIC EXPERIMENT #7

Experiment Title

Seeing the World Differently: How Glasses and Filters Change Perception

Type of Activity: Hands-on scientific experiment exploring **vision, perception, and optical illusions** using glasses, color filters, and restricted fields of view.
Grade Level: Ages **10–14** (upper primary / lower secondary)
Learning Objectives

Scientific Objectives

1. Observe how different lenses and filters affect vision.
2. Explore **depth perception, color perception, and peripheral vision**.
3. Test hypotheses about how visual modifications affect task performance.

Interdisciplinary Objectives

1. **Biology / Zoology:** Understand how eye placement affects vision (e.g., predators vs. prey).
2. **Physics / Optics:** Learn about light, color, and lenses.
3. **Art / Design:** Explore color filters and 3D effects for creative outcomes.
4. **Civic / Health Education:** Understand how sunglasses protect eyes.
5. **Mathematics:** Measure distances and angles for visual tasks.
6. **Literature / Philosophy:** Understand how perspective shapes interpretation.
   Discuss the moral of "The Blind People and the Elephant."
7. **Life Skills/ SEL:** Connect visual perception experiments to real-life decision-making.
   Reflect on bias, assumptions, and the importance of multiple perspectives.

   Reflect on self-awareness and how others perceive you.

   Connect sensory perception to understanding social perspectives

Materials

- 3D glasses (red/cyan or standard)
- Sunglasses of various tints
- Transparent colored filters (red, blue, green)
- Small objects to place at different distances (blocks, cups, or printed patterns)
- Ruler or measuring tape
- Observation worksheets
- Blindfolds or partial covers for peripheral vision simulations
- Classical story handout or short reading

Variables

- **Independent Variables:** Type of lens/filter or vision restriction (3D, tinted, peripheral blocked)
- **Dependent Variables:** Accuracy in judging distance, color, or shape; speed of object recognition
- **Controlled Variables:** Same objects, same lighting, same distance

Experimental Procedure

Step 1: Story Introduction

- Read the story **"The Blind People and the Elephant."** A group of blind people touches different parts of an elephant and each concludes the elephant is something different: a wall, a rope, a tree trunk, etc.

- Discuss: What did each blind person experience? How did their limited perspective shape their conclusion?
- **Moral:** Each person's perspective is limited; to understand reality, multiple perspectives are needed.

Part A: 3D Glasses / Stereoscopic Vision

1. Place objects at various distances.
2. Students wear **3D glasses**.
3. Estimate distance or identify object size.
4. Record observations on perception differences.

Observation Focus:

How does 3D perception enhance or alter distance estimation?

Compare with unaided vision.

Part B: Sunglasses / Color Filters

1. Students wear **sunglasses** or **colored filters**.
2. Observe colored objects or patterns.
3. Record changes in color perception or brightness.
4. Discuss which colors appear stronger or weaker through different filters.

Observation Focus:

Which filters enhance certain colors?

How does tint affect clarity, comfort, or recognition?

Part C: Peripheral Vision Simulation

1. Cover part of the student's vision using blindfolds or narrow openings to mimic **lateral-only or front-focused vision**.
2. Place objects to the sides and front.
3. Ask students to identify objects without moving their heads.
4. Record success rate in seeing objects laterally vs centrally.

Observation Focus:

How does vision placement affect awareness?

Discuss why prey animals may rely on lateral vision and predators on frontal vision.

Observations

Students record for each trial:

1. Which objects were easy or difficult to see
2. Differences in depth perception or color perception
3. Time or accuracy differences
4. Personal reflections on visual experience
5. Compare this to how the blind people experienced only part of the elephant.

Results / Patterns

- ➔ 3D glasses improve depth perception but may distort color.
- ➔ Tinted lenses or filters alter color recognition.
- ➔ Peripheral vision restriction reduces lateral awareness, mimicking predator vs prey adaptations.

Scientific Explanation

- ★ **3D glasses** use color separation to trick the brain into perceiving depth (stereopsis).
- ★ **Colored filters** selectively block or pass certain wavelengths, altering perception.
- ★ **Lateral vs frontal vision** affects how much of the environment can be monitored at once; eye placement in animals reflects ecological adaptation.

Health / Practical Applications

- ★ Sunglasses protect eyes from UV damage.
- ★ Understanding visual perception is critical in sports, driving, and safety.
- ★ Knowledge of eye placement in animals helps understand behavior and survival strategies.

Transdisciplinary Connections

Subject	Connection
Biology / Zoology	Eye placement and field of view in animals
Physics / Optics	Light, color filters, lenses, and 3D perception
Art / Design	How colors and perception create illusions or visual effects
Health / Safety	UV protection, visibility awareness
Mathematics	Measuring angles, distances, and field of vision
Civic / Ethics	Understanding animal adaptations, environmental awareness

Reflection Questions

1. How did 3D glasses change your perception of distance?
2. Which colored filter made objects easiest or hardest to see? Why?
3. How did blocking peripheral vision affect your awareness of objects?
4. Why might animals have eyes on the sides vs. front of their heads?
5. How could understanding this help in real life (sports, driving, or safety)?

Johari Window Connection

Johari Window Overview:

1. **Open Area:** What you know about yourself and others know about you.
2. **Blind Area:** What others see about you that you don't realize.
3. **Hidden Area:** What you know but don't share.

4. **Unknown Area:** What neither you nor others know yet.

Procedure:

1. Students reflect on themselves: skills, habits, feelings.
2. Peers provide anonymous feedback on what they notice about that student.
3. Compare the student's self-perception to peers' feedback.

Link to Vision Experiment:

Just like the 3D or filtered vision experiment shows that **perspective changes perception of objects**, the Johari Window shows that **other people may perceive things about us that we don't notice ourselves**, and vice versa.

Students compare their **own observations of objects** with peers' observations.

1. How can perception be limited or biased?
2. How does this relate to self-awareness and social interactions?
3. How could misunderstandings arise if we only rely on one perspective?
4. How did your perspective of objects differ from your peers'?
5. How is this similar to how people perceive each other?
6. What surprised you about others' feedback?
7. How can understanding these differences help reduce misunderstandings or conflicts?
8. How can you "expand your Open Area" to improve communication and empathy?

Johari Area	Examples / Notes
Open	Things you and others know about you
Blind	Things others notice but you didn't
Hidden	Things you know but don't share
Unknown	Things neither you nor others know yet

Key Learning Points

1. Perception is subjective and influenced by filters, vision, and attention.
2. Awareness of how others perceive you can reveal your **Blind Area**.
3. Empathy develops when we **consider multiple perspectives**, like comparing multiple observations in the vision experiment.
4. Just as objects may appear differently through 3D glasses, people and situations may look different depending on your viewpoint.

Empathy-Focused Conclusion: This experiment and the story of *The Blind People and the Elephant* show us that **our perception is always limited by our perspective**. Just as each blind person touched only one part of the elephant and misunderstood the whole, we often see only a small part of other people's experiences. By wearing 3D glasses, colored filters, or restricting our vision, we saw how reality can **appear different depending on how we look at it**. Similarly, in school or everyday life, we may judge others based on partial information — a rumor, a single action, or an assumption. This can lead to **misunderstandings, exclusion, or bullying**.

Putting ourselves **in other people's shoes** helps us to **expand our view** and see the "whole elephant" of their experiences. For example:

- ➔ A classmate who seems quiet may be struggling with confidence or family challenges.
- ➔ A student who acts out may be feeling hurt or excluded.

Conclusion:

True understanding and empathy require **seeing beyond our limited perspective**. Just as in our experiment, exploring multiple "views" lets us make fairer, kinder decisions — in science, in school, and in life.

Student Observation Worksheet

Experiment: Seeing the World Differently – Glasses, Filters, and Vision

Name: _____
Date: _____
Class: _____

1. Experiment Title

Seeing the World Differently: How Glasses and Filters Change Perception

---

2. Research Questions

1. *How do 3D glasses, colored filters, and sunglasses change the way we see objects?*
2. *How does restricting peripheral vision affect what we notice?*

3. Prediction (Before the Experiment)

Circle one or explain your own idea:

I think 3D glasses will make objects look closer / farther / the same.

I think colored filters will make objects look brighter / darker / different colors.

I think covering side vision will make it easier / harder to see objects.

Explain your prediction:

---

4. Materials Used

Circle the materials you used:

1. 3D glasses
2. Sunglasses
3. Colored filters (red, blue, green)
4. Objects at different distances
5. Ruler / measuring tape
6. Blindfolds / vision covers
7. Observation sheet

5. Observation – Part A (3D Glasses)

1. Look at objects at different distances while wearing 3D glasses.
2. Record your observations:

Object	Distance (cm)	How it looked without 3D glasses	How it looked with 3D glasses	Did it seem closer/farther?

Reflection:

6. Observation – Part B (Colored Filters / Sunglasses)

Filter Type	Object Color	Appearance Without Filter	Appearance With Filter	Notes / Differences
Red				

Blue

Green

Sunglasses

Reflection:

7. Observation – Part C (Peripheral / Lateral Vision)

1. Cover part of your vision to simulate restricted side vision.
2. Place objects to your sides and front.
3. Record which objects you could see:

Object Position	Seen with Full Vision? (Yes/No)	Seen with Restricted Vision? (Yes/No)	Notes
Left side			
Right side			
Front			
Other			

Reflection:

8. Results / Patterns

➔ Which type of glasses or filter changed your perception the most?

➔ How did restricting peripheral vision affect what you could notice?

➔ Did any object appear closer or farther than it really was?

9. Scientific Explanation

Explain why glasses, filters, and vision restriction changed your perception:

Hint: Consider **light, color, lenses, depth perception, and field of vision**.

10. Life / Biology Connection

1. How does eye placement affect animals' vision (side vs front eyes)?

2. Why might prey animals have lateral vision and predators have frontal vision?

3. How can understanding human vision and perception help us in sports, driving, or daily life?

11. Art / Creativity Connection (Optional)

Draw or color one object as it **appears differently** through a colored filter or 3D glasses.

12. Conclusion

Complete the sentence:

This experiment teaches me that _____,
and that _____.

Teacher Observation (Optional)

Criteria	Observed	Notes
Student followed instructions	☐ Yes ☐ Somewhat ☐ No	
Accurate recording of observations	☐ Yes ☐ Somewhat ☐ No	
Participation in reflection	☐ Yes ☐ Somewhat ☐ No	
Understanding of interdisciplinary connections	☐ Yes ☐ Somewhat ☐ No	

SCIENTIFIC EXPERIMENT #8

Experiment Title **Freezing Water and Expansion: Can Ice Push a Nail Out?**
Type of Activity: Hands-on, inquiry-based physical science experiment with visible effects of freezing and material expansion
Grade Level: Ages **10–14** (upper primary / early secondary)
Learning Objectives

Scientific Objectives: Students will be able to:

1. Understand and observe that **water expands when it freezes**.
2. Predict and record physical changes as water transitions from liquid to solid.
3. Measure forces created by expansion.
4. Relate freezing expansion to real-world phenomena (cracks in rocks/asphalt in winter).

Interdisciplinary Objectives: Students will be able to:

★ **Physics:** Explain thermal expansion and crystal structure arrangement.

★ **Earth Science:** Understand frost weathering and ice pressure in nature.

★ **Mathematics:** Quantify force or displacement and compare outcomes.

★ **Design / Technology:** Discuss materials and engineering safety (why spaces are left for expansion).

Research Question: *What happens to water's volume when it freezes, and can this expansion exert enough force to move a nail embedded in an apple?*
Hypothesis: If water expands when it freezes, then placing water around a nail in an apple and freezing it will cause the ice to push the nail upward or outward.

Materials

- ➢ Fresh apple
- ➢ Clean, straight **nail** (approx. 5–8 cm)
- ➢ Plastic cup or small container
- ➢ Water
- ➢ Freezer
- ➢ Ruler or calipers
- ➢ Observation notebook

Variables

1. **Independent Variable:** Presence of water freezing around the nail
2. **Dependent Variable:** Movement/displacement of the nail
3. **Controlled Variables:** Same apple size, same water volume, same freezing time, same temperature

Experimental Procedure

1. **Prepare the apple:**
   Push the nail into the center of the apple but leave about 1–2 cm exposed at the top. Record initial nail height.
2. **Add water:**
   Pour a small amount of water into the apple's core so it surrounds the nail. Ensure it doesn't drip out excessively.
3. **Freezing:**
   Carefully place the apple in a small container and put it in the freezer overnight.

4. **Observe changes:**
   After freezing, remove the apple and measure the position of the nail again.
   - Has the nail moved upward?
   - Measure displacement (in millimeters).
5. **Record and compare:**
   Note any deformations of the apple surface and position changes.

Observations: Students should record: Whether the nail shifted / Changes in apple shape /Any cracking or splitting /Measurements of nail displacement

Results Students will likely find that:

1. Ice formation **expands inside the apple**, exerting force outward.
2. The nail may have moved slightly or become tighter/squeezed by the ice.
3. The apple may show cracking or bulging.
   This observable force is a direct consequence of **water's unique expansion upon freezing**.

Scientific Explanation: Water molecules form a crystalline lattice when freezing that **occupies a larger volume than liquid water**. Unlike most substances that contract as they solidify, ice expands — by about ~10 % — because the rigid structure holds molecules further apart. This volume increase generates pressure on the surrounding material.

Real-World Connections

- **Frost weathering:** Over winter, water in cracks expands and breaks rocks or asphalt.
- **Anthropology & engineering:** Expansion must be accounted for in building materials and bridge design.

Conclusion: The experiment shows that freezing water exerts measurable force due to expansion. This property has **practical implications** in nature, construction, and safety.

Interdisciplinary Connections

1. **Physics:** Molecular structure and phase changes
2. **Earth Science:** Weather effects and erosion
3. **Mathematics:** Measuring displacement and comparing data
4. **Engineering:** Material design for expansion allowances

Safety Notes

★ Use a **plastic container** to avoid breakage in freezer.

★ Handle frozen items carefully (cold burns).

★ Do not force nail by hand — use measurements only.

Reflection Questions

1. Why does water expand when it freezes?
2. How can this expansion cause damage outdoors in winter?
3. How does this relate to the video where freezing pushed objects?
4. How does ice expansion differ from most materials?

Note: This experiment was inspired by the documentary at https://www.youtube.com/watch?v=7jDei3xyC60

Student Observation & Graph Worksheet

Freezing Water: Expansion Forces & Driving a Nail

Name: _____
Date: _____
Class: _____

1. Experiment Title

Freezing Water and Expansion: Can Ice Push a Nail?

2. Research Questions

1. *How does water expansion during freezing generate force?*
2. *Can freezing water in an apple or container push a nail into a soft surface?*

3. Materials Used

Circle all materials you used:

- ➢ Fresh apple or small soft block (e.g., foam)
- ➢ Nail (approx. 5–8 cm)
- ➢ Spoon / knife (for making hole)
- ➢ Water
- ➢ Freezer
- ➢ Small container (to hold apple or block upright)
- ➢ Ruler or calipers
- ➢ Observation worksheet
- ➢ Protective gloves (optional)

4. Prediction (Before the Experiment)

Sample	Prediction: Will nail move?	Reason

Apple + water + nail	☐ Yes ☐ No	_____
Soft block + water + nail	☐ Yes ☐ No	_____

Explain your reasoning:

_____

_____

_____

5. Experimental Procedure

Step 1 – Prepare the sample:

1. Push the nail partway into the apple or soft block (leave 1–2 cm exposed).
2. Make a small cavity around the nail and pour in water.

Step 2 – Freeze:

1. Place the sample upright in a small container.
2. Put it in the freezer for several hours until fully frozen.

Step 3 – Observe nail movement:

1. Remove from freezer carefully.
2. Measure how much the nail has moved upward or driven deeper into a soft surface.
3. Note any cracking or deformation.

Step 5 – Record data:

1. Measure displacement in millimeters.
2. Note observations in table below.

6. Observation Table

Sample	Nail Position Before Freezing	Nail Position After Freezing	Nail Displacement (mm)	Notes / Observations
Apple	_____	_____	_____	_____
Soft block	_____	_____	_____	_____

---

7. Graphing Activity

Instructions:

- **X-axis:** Sample type (Apple / Soft Block)
- **Y-axis:** Nail displacement (mm)
- **Bars or points:** Use one color per sample

Optional extension: Compare multiple trials or temperatures.

Example Graph Layout (Sketch):

```
Nail Displacement (mm)
|
|        [Apple]     [Soft Block]
|         |             |
|         |             |
|         |             |
|-----------|---------------|------------> Sample Type
```

---

8. Results Analysis

1. Which sample caused the nail to move more?

---

2. How does freezing water generate force?

---

3. Did temperature or the amount of water affect movement?

---

4. How could this principle be used in real life (nature or engineering)?

---

9. Scientific Explanation

- ➢ Water expands when it freezes by ~10 %.
- ➢ This expansion exerts force in all directions.
- ➢ Ice in the apple or block can push a nail upward or drive it into a soft material.
- ➢ This demonstrates **mechanical work done by freezing water**.

10. Reflection Questions

1. Why does ice expand while most substances shrink when frozen?

---

2. How could this explain cracks in rocks, roads, or soil during winter?

---

3. How could engineers prevent damage from freezing water?

---

11. Conclusion

Complete the sentence: This experiment shows that freezing water can generate enough force to _____.

Teacher Notes / Safety

- Use **soft materials** for hammering simulation; do not hit nails into hard surfaces.
- Measure displacement carefully.
- Handle frozen samples carefully to avoid cold burns.
- Ensure group discussion about **real-life applications** (rocks, pipes, engineering).

Experiment Title **Can You Hammer a Nail with an Apple? Testing Normal vs Frozen Temperature**
Type of Activity: Hands-on inquiry-based physics experiment demonstrating how **temperature changes affect material hardness** and mechanical force.

Grade Level: Ages **10–14** (upper primary / early secondary)

Learning Objectives

Scientific Objectives" Students will be able to:

1. Compare material hardness at different temperatures.
2. Predict and measure the effect of freezing on the apple's rigidity.
3. Collect, analyze, and interpret quantitative and qualitative data.
4. Relate observations to the physical principle of **freezing water expanding and increasing rigidity**.

Interdisciplinary Objectives

1. **Physics:** Material properties, force, phase change.
2. **Biology:** Water content in fruit, cellular structure.
3. **Engineering / Life Skills:** Understanding mechanical work, safety, and tools.
4. **Mathematics:** Measurement of displacement or penetration depth.
5. **Language / Reflection:** Recording observations, drawing conclusions.

Research Question: *Can an apple at room temperature or frozen drive a nail into a soft surface?*

Hypotheses

1. A fresh (room temperature) apple is too soft to hammer a nail.
2. A frozen apple is rigid enough to drive a nail partially into a soft surface.
3. Freezing increases rigidity due to the solidification of water inside the apple.

Materials

- ➢ Fresh apple(s)
- ➢ Small nails (≈5–8 cm)
- ➢ Soft wood block or foam block (to safely test hammering)
- ➢ Freezer
- ➢ Ruler or calipers
- ➢ Plastic tray or container
- ➢ Protective gloves and goggles
- ➢ Optional: small mallet for safe tapping simulation

Variables

Type	**Variable**	**Details**
Independent	Apple temperature	Room temperature vs frozen
Dependent	Nail penetration / displacement	Measured in mm
Controlled	Apple size, nail size, soft surface, amount of applied	All kept constant

force

Experimental Procedure

Step 1 – Prepare Samples

1. Take two apples of similar size.
2. Push the nail slightly into each apple, leaving 1–2 cm exposed.
3. Place one apple in the freezer for several hours until fully frozen.

Step 2 – Prepare Testing Surface

Place a soft wood or foam block on a flat surface.

Step 3 – Test Room Temperature Apple

1. Position the apple above the soft surface.
2. Gently tap the exposed nail with the apple (or simulate hammering safely).
3. Measure and record any nail displacement.

Step 4 – Test Frozen Apple

1. Remove frozen apple from freezer.
2. Repeat the tapping procedure above.
3. Measure and record nail displacement.

Observation Table

Apple Temperature	**Nail Penetration (mm)**	**Notes / Observations**

Room temp	_____	Soft apple, nail barely moved
Frozen	_____	Rigid apple, nail moved ____ mm, possible cracking

Graphing Activity

Instructions:

1. **X-axis:** Apple temperature (Room vs Frozen)
2. **Y-axis:** Nail penetration (mm)
3. **Bars / points:** Plot nail displacement for each condition
4. Compare results visually

Example Sketch:

```
Nail Penetration (mm)

|

|        [Room Temp]    [Frozen]

|            |           |

|            |           |

|            |           |

|--------------|-------------|----> Apple Temperature
```

Results Analysis

1. Which apple allowed the nail to move farther?
2. How does freezing water inside the apple affect hardness?
3. Did freezing make a measurable difference in the apple's ability to apply force?
4. How does this relate to natural phenomena (e.g., frost splitting rocks)?

Scientific Explanation

Water expands and solidifies inside the apple when frozen.

Frozen water increases the rigidity of the apple's structure.

This makes it possible for the apple to **exert mechanical force** and partially drive a nail into a soft surface.

Reflection Questions

1. Why is the fresh apple too soft to hammer a nail?
2. How could this experiment demonstrate the effects of temperature on material properties?
3. Can you think of any real-life situations where freezing increases rigidity and causes damage?

Safety Notes

- Never hit nails into hard surfaces. Use foam or soft wood.
- Wear gloves and goggles when handling frozen apples.
- Do not eat apples used in the experiment.
- Teacher supervision required.

Conclusion Template: This experiment shows that freezing an apple increases its rigidity, allowing it to exert force on a nail. At room temperature, the apple is too soft, so freezing **changes the material properties**, demonstrating how temperature affects hardness and mechanical work.

Student Observation & Graph Worksheet

Can You Hammer a Nail with an Apple? Room Temperature vs Frozen

Name: _____
Date: _____
Class: _____

1. Experiment Title

Testing Apple Rigidity: Can Freezing Help Hammer a Nail?

2. Research Questions

1. Can a fresh (room temperature) apple drive a nail into a soft surface?
2. Can a frozen apple drive a nail into a soft surface?
3. How does freezing change the mechanical properties of the apple?

3. Hypotheses

Apple Condition	Prediction: Will the nail move?	Reason
Room temperature	☐ Yes ☐ No	_____
Frozen	☐ Yes ☐ No	_____

4. Materials

Circle all materials used:

1. Apple (fresh and frozen)
2. Small nail (~5–8 cm)
3. Soft wood or foam block
4. Freezer

5. Ruler or calipers
6. Plastic tray or container
7. Gloves and goggles

5. Procedure Summary

1. Insert a nail into the apple, leaving 1–2 cm exposed.
2. Place one apple in the freezer until fully frozen.
3. Place the apple over a soft surface and gently tap the nail.
4. Measure nail movement in millimeters.
5. Record observations.

6. Observation Table

Apple Condition	Nail Position Before (mm)	Nail Position After (mm)	Nail Displacement (mm)	Notes / Observations
Room temperature	_____	_____	_____	_____
Frozen	_____	_____	_____	_____

7. Graphing Activity

Instructions:

I. **X-axis:** Apple Condition (Room Temperature / Frozen)
II. **Y-axis:** Nail Displacement (mm)
III. Draw **bars or points** for each apple condition based on your measurements.
IV. Use **one color for room temp, another color for frozen**.
V. Compare results visually.

Graph Grid (Sketch for Students):

```
Nail Displacement (mm)
|
| 10 |
|  9 |
|  8 |
|  7 |
|  6 |
|  5 |
|  4 |
|  3 |
|  2 |
|  1 |
|  0 |_____________________
      Room Temp      Frozen
```

8. Results Analysis

Answer the following:

1. Which apple condition allowed the nail to move farther?

---

2. How does freezing water inside the apple affect hardness?

---

3. Did freezing make a measurable difference in the apple's ability to apply force?

---

4. How does this relate to real-life situations (e.g., frost splitting rocks)?

9. Scientific Explanation

- Freezing water expands inside the apple, increasing rigidity.
- This allows the apple to exert force and move the nail into a soft surface.
- At room temperature, the apple is too soft to do this.

10. Reflection Questions

1. Why couldn't the fresh apple drive the nail?

2. What does this experiment teach about how temperature affects material properties?

3. Can you think of other situations where freezing increases rigidity and causes damage?

11. Conclusion Template

This experiment shows that freezing an apple increases its rigidity, allowing it to exert force on a nail. Room temperature apples are too soft to move the nail. Freezing changes the material properties, demonstrating the effect of temperature on hardness and mechanical work.

SCIENTIFIC EXPERIMENT #9

Experiment Title **Dice Games: Probability of Winning vs Losing and Social Awareness**
Type of Activity: Hands-on mathematics and social education experiment demonstrating probability, risk, and responsible decision-making.

Grade Level: Ages **11–15** (upper primary / lower secondary)
Learning Objectives

Scientific / Mathematical

1. Calculate theoretical probabilities for simple dice games.
2. Conduct experiments to determine experimental probabilities.
3. Compare experimental outcomes with theoretical probabilities.
4. Represent probability data visually with tables and graphs.

Social / Life Skills

1. Understand risk and expected outcomes in games of chance.
2. Develop awareness of gambling risks and consequences.
3. Reflect on responsible decision-making.

Interdisciplinary Connections

- **Mathematics:** Probability, fractions, percentages, data analysis.
- **Social Education:** Gambling awareness, risk management.
- **Language / Reflection:** Explain reasoning, write conclusions.

Research Questions

1. What is the probability of winning vs losing in a simple dice game?
2. How closely does experimental probability match theoretical probability?
3. How does understanding probability help us make safer choices in life?

Hypotheses

1. *The probability of losing will be higher than the probability of winning.*
2. *Experimental probability will approximate theoretical probability more closely with more trials.*
3. *Understanding probabilities can help avoid risky gambling behavior.*

Materials

1. Standard six-sided dice (1 per student or group)
2. Tokens or counters (optional for scoring)
3. Ruler or calculator
4. Observation worksheet
5. Graph paper or online spreadsheet

Variables

Type	Variable	Details
Independent	Number of dice rolls	Each student/group chooses number of trials (e.g., 50–100)
Dependent	Outcome	Win or Lose
Controlled	Rules of the dice game	Same for all groups; same dice and surface

Example Dice Game

Single Die Game:

- Roll one die. Win if you roll a 6, lose otherwise.

Two Dice Game (optional):

- Roll two dice. Win if the sum is 7, lose otherwise.

Experimental Procedure

1. **Determine Theoretical Probability**
   - Single die: Probability of winning = 1/6 (~16.7%), losing = 5/6 (~83.3%)
   - Two dice: Probability of sum = 7 is 6/36 = 1/6 (~16.7%)
2. **Perform the Experiment**
   - Roll dice **50–100 times** per student/group.
   - Record each outcome as Win or Lose.
   - Count total Wins and Losses.
3. **Calculate Experimental Probability**
   - Probability of winning = Wins / Total Rolls
   - Probability of losing = Losses / Total Rolls
4. **Compare to Theoretical Probability**
   - Calculate difference between experimental and theoretical probabilities.
5. **Graph the Results**
   - X-axis: Dice outcome (Win / Lose)
   - Y-axis: Probability (%)
   - Use bars or points to represent both theoretical and experimental probabilities.

Observation Table (Sample)

Trial Number	Outcome (Win/Lose)	Cumulative Wins	Cumulative Losses
1	Win	1	0
2	Lose	1	1
3	Lose	1	2
…	…	…	…

Probability Comparison Table

Outcome	Theoretical Probability (%)	Experimental Probability (%)	Difference
Win	16.7	_____	_____
Lose	83.3	_____	_____

Graphing Activity

Instructions:

1. X-axis: Outcome (Win / Lose)
2. Y-axis: Probability (%)
3. Draw **two bars per outcome**: one for theoretical probability, one for experimental probability.
4. Use different colors for clarity.

Graph Grid Sketch:

```
Probability (%)
|
| 100 |
|  90 |
|  80 |        ▇ (Lose Exp)
|  70 |
|  60 |
|  50 |
|  40 |
|  30 |
|  20 | ▇ (Win Exp)
|  10 | ▇ (Win Theo)
|   0 |_____________________
      Win        Lose
```

Results Analysis Questions

1. Did the experimental probabilities match the theoretical probabilities? Explain any differences.
2. Which outcome was more likely to occur?
3. How does this experiment illustrate the concept of risk?
4. How could understanding probability help you avoid gambling losses?

Reflection / Social Awareness Questions

1. If you played a dice-based gambling game regularly, what do the probabilities tell you about expected losses?
2. Why do most gambling games favor the house?
3. How can understanding math and probability help you make responsible choices?

Conclusion Template: This experiment shows that losing is more likely than winning in dice games, both theoretically and experimentally. Understanding probability helps us recognize the **risk of loss**, supporting responsible decision-making and helping to avoid gambling behaviors

Simulating theoretical probabilities vs **expected experimental probabilities**

1. Theoretical Probabilities

Single Die Game (Win = 6, Lose = 1–5)

- Total possible outcomes = 6 (faces of a die)
- **Win (rolling 6)** = 1 outcome → 1/6 ≈ **16.7%**
- **Lose (rolling 1–5)** = 5 outcomes → 5/6 ≈ **83.3%**

Two Dice Game (Win = sum 7, Lose = sum ≠ 7)

- Total possible outcomes = 6 × 6 = 36
- Combinations summing to 7: (1,6), (2,5), (3,4), (4,3), (5,2), (6,1) → 6 outcomes
- **Win** = 6/36 ≈ **16.7%**
- **Lose** = 30/36 ≈ **83.3%**

Notice: Both simple games have the same theoretical win/loss ratio (~1:5).

2. Expected Experimental Probabilities

- Experimental probability will **approximate theoretical probability**, but small sample sizes will vary.
- Example for **50 dice rolls** (single die):

Outcome	Expected Number of Rolls	Expected Experimental Probability (%)
Win	50 × 1/6 ≈ 8–9 rolls	16–18%
Lose	50 × 5/6 ≈ 41–42 rolls	82–84%

For **100 rolls**, the approximation gets closer:

Outcome	Expected Number of Rolls	Expected Experimental Probability (%)
Win	100 × 1/6 ≈ 16–17 rolls	16–17%
Lose	100 × 5/6 ≈ 83–84 rolls	83–84%

Larger numbers of rolls reduce the effect of random variation, so the **experimental probability converges to theoretical probability**.

Key Teaching Point: Students should observe:

1. **Win is rare, lose is frequent** → illustrates risk in gambling.
2. **Experimental probability varies with small trials** → highlights the law of large numbers.
3. This allows **discussion of real-life gambling odds**, making probability directly meaningful.

Comparison with Real-Life Statistics

- According to studies on gambling and poverty:
  - **10–15% of families with gambling addiction fall into financial ruin**.
  - **Gambling contributes to a disproportionate share of personal bankruptcy cases**.
  - For example, in Europe, 1 in 5 problem gamblers lives below the poverty line, often causing debt, eviction, or family breakdown.
- This mirrors the dice experiment: **the odds are stacked against the player**, so repeated play almost guarantees loss over time.

Connection to Addiction

1. **Random Wins Encourage Repetition**
   - Even though losing is far more likely, occasional wins create a **"variable reward schedule"**, one of the most powerful mechanisms in addictive behavior.
2. **Illusion of Control**
   - Players often believe they can "predict" or influence outcomes, even when probability is fixed.
3. **Escalating Risk**
   - Losses motivate further bets to "recover" previous losses, leading to **losses compounding**.
4. **Social Consequences**
   - Families of addicted gamblers often face financial instability, stress, and social problems, mirroring the lesson from the classroom dice game: **probability works against sustained success in gambling**.

Teaching Integration

- **Mathematics / Probability:** Students calculate odds and compare experimental vs theoretical outcomes.
- **Social Education:** Discuss consequences of poor odds and addictive behavior.
- **Reflection Questions for Students:**
  - How does the probability of losing compare to the probability of winning?
  - Why might people continue gambling even when odds are against them?
  - How could understanding probability help someone avoid the financial and social consequences of gambling?
  - How do rare wins contribute to addiction?

Dice Classroom Example vs Real Gambling Odds

- Classroom dice example: 1 win on 6 sides → **1/6 ≈ 16.7%**. This is useful for teaching probability and risk in a safe, hands-on way.
- Real gambling: Odds are much worse. Examples:
  - **Slot machines**: Return-to-player (RTP) often 85–95%, meaning **you lose 5–15% of your money on average per play**; probability of hitting the jackpot is extremely low (often **0.01–0.001%**).

- ➢ **Lottery (6/49)**: Probability of winning top prize ≈ 1 in 14 million ≈ **0.000007%**.
- ➢ **Roulette (single number)**: 1/37 ≈ 2.7% chance (European roulette).
- ➢ The 16.7% classroom dice example is **intentionally higher** to make the activity feasible and illustrative in a short lesson. Real gambling odds are dramatically lower, which is why gambling is financially risky.

Why Real Gambling is Addictive Despite Low Probability

- ➔ **Variable reward schedule**: Even rare wins trigger strong psychological reinforcement.
- ➔ **Illusion of control**: Players think strategy or timing can influence outcomes.
- ➔ **Escalating risk**: Loss chasing increases stakes and losses.

Even if your "win probability" is 0.01%, the occasional reward **keeps the brain engaged**, leading to addictive behavior.

Emulating real life gambling probabilities

1. Single Die Probabilities

- Rolling **a 6 on one die** → 1/6 ≈ 16.7%
- To **decrease probability**, require **multiple successful rolls in a row**.

2. Two 6s in a row

- Probability = (1/6)×(1/6)=1/36≈2.78%(1/6)×(1/6)=1/36≈2.78%

This is already **lower than 5%**, a realistic "rare win" for classroom simulation.

- Students roll **one die twice per trial**.
- Win only if **both rolls are 6**.
- Lose otherwise.

This emulates the "rare jackpot" effect of gambling, while still using dice in class.

3. Alternative Approaches (~5% Win)

Method	Probability	Practicality
Roll **6 twice in a row**	1/36 ≈ 2.78%	Slightly low; may need many trials
Roll **6 on one die OR another 6 on second die**	1 – P(no 6s) = 1 – (5/6)^2 ≈ 30.6%	Too high for rare-win simulation
Roll **6 three times in a row**	(1/6)^3 ≈ 0.46%	Too rare for classroom

Best compromise: **two 6s in a row (≈2.8%)**, or **two successes out of 12-sided dice** if you want slightly higher (~5%).

4. Classroom Dice Game Example (≈5% Win)

Game Rules:

1. Each student rolls **one die twice per turn**.
2. **Win** if both rolls are 6.
3. **Lose** for any other combination.
4. Record results over **50–100 trials**.

Expected outcomes (50 rolls):

- Wins ≈ 50 × 2.78% ≈ 1–2 wins
- Losses ≈ 48–49 losses

Optional social twist: Each “loss” costs a token, and “win” earns several tokens to simulate gambling risk/reward.

Student Worksheet: Dice Games – Win vs Lose Probability

Name: _____
Date: _____
Class: _____

1. Experiment Title

Dice Games: Probability of Winning vs Losing

2. Research Questions

1. What is the probability of winning vs losing in a simple dice game?
2. How do experimental results compare to theoretical probabilities?
3. How can understanding probability help us make safer decisions in life?

3. Hypotheses

Outcome	Prediction	Reasoning
Win (roll a 6)	☐ Yes ☐ No	_____
Lose (roll 1–5)	☐ Yes ☐ No	_____

4. Materials

- ★ Standard six-sided dice (1 per student/group)
- ★ Tokens or coins (optional)
- ★ Observation table
- ★ Ruler / calculator
- ★ Graph paper

5. Dice Game Rules

1. Roll **one die**.
2. Win if you roll a **6**.
3. Lose if you roll **1–5**.
4. Repeat for **50 rolls** (or more for larger sample).

This simulates a simple gambling-like game with a **16.7% win probability**.

6. Observation Table

Roll #	Outcome (Win / Lose)	Cumulative Wins	Cumulative Losses
1			
2			
3			
…			
50			

7. Probability Comparison Table

Outcome	Theoretical Probability (%)	Experimental Probability (%)	Difference
Win	16.7	_____	_____
Lose	83.3	_____	_____

Instructions:

- Experimental probability = (Number of Wins or Losses ÷ Total Rolls) × 100
- Compare your results to the theoretical probability.

8. Graphing Activity

Instructions:

1. X-axis: Outcome (Win / Lose)
2. Y-axis: Probability (%)
3. Draw **two bars per outcome**: one for **theoretical probability**, one for **experimental probability**.
4. Use different colors for clarity.

Graph Grid:

```
Probability (%)
|
| 100 |
| 90  |
| 80  |        ▇ (Lose Exp)
| 70  |
| 60  |
| 50  |
| 40  |
| 30  |
| 20  | ▇ (Win Exp)
| 10  | ▇ (Win Theo)
| 0   |_____________________
      Win        Lose
```

9. Results Analysis Questions

1. How often did you win vs lose?

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2. Did your experimental probabilities match the theoretical probabilities? Explain any differences.

3. Which outcome was more likely to occur?

4. How could this experiment help you understand risk in real-life gambling situations?

10. Reflection / Social Awareness

1. Why do games with low odds of winning appeal to some people?

2. How does the low probability of winning relate to financial loss in gambling?

3. What strategies could help people avoid risky gambling behaviors?

11. Conclusion Template

This experiment shows that losing is more likely than winning in dice games. Understanding probability helps us **recognize the risks** of gambling and make informed, responsible decisions. Experimental probability may vary from theoretical probability, especially with small sample sizes, but overall demonstrates that **the odds are stacked against the player**.

1

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