Computational Thinking

for education on-line

http://edu-computational-thinking.eu

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Collection of lesson plans

(click on the title to access the material)

Lesson Plan

Using CT analyzing Marathonas Battle

Summary

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1. Subject(s): The Battle of Marathon was an important event in ancient Greek history that took place in 490 BC. During the Persian Wars. This battle emerged as one of the most important victories of the Greeks over the Persians and had significant effects on Greek history.
2. Grade/Level: 6-8
3. Objective:
   Students will learn about the historical Battle of Marathon and apply computational thinking skills to analyze the key events and the strategies employed by the Greeks during the battle.
4. Time Allotment: 3 class periods

Materials & Resources

1. Whiteboard or chalkboard and markers/chalk
2. Computers or tablets with internet access
3. Maps of ancient Greece
4. Printed copies of primary sources (if available)
5. Software

Implementation

Step 1. (1st lesson)

: Introduction to the Battle of Marathon

1. Begin by discussing what students know about ancient Greece and the Persian Empire. Highlight the importance of the city-state of Athens in the context of ancient Greece.
2. Introduce the Battle of Marathon and its historical significance. Discuss the key events and figures involved.
3. Show a map of ancient Greece and the location of Marathon. Explain the geographical significance of the battle.
4. Assign reading materials, which may include primary sources or online articles about the Battle of Marathon, for homework.

5. Everything we know about the Persian wars and the battle of Marathon is given to us by Herodotus (485-410 BC) in his sixth book “ Erato”

   You can read the historical text and get more information at the link below :

   https://www.greek-language.gr/digitalResources/ancient_greek/library/index.html?author_id=153

Step 2 (2nd lesson)

Analyzing the Battle of Marathon

1. Begin the class by discussing the concept of computational thinking. Explain that it involves problem-solving, breaking down complex problems into smaller parts, and creating algorithms or strategies to solve them.
2. Reviewing the key events and figures from the Battle of Marathon.
3. Divide the students into small groups. Each group will be responsible for researching and presenting a different aspect of the battle, such as the Greek and Persian armies, the geographical terrain, and the strategies employed.
   1st Group
   Main protagonists (Darius - Miltiadis) present the events from their perspective
   Creating a Theatrical Speech – Dramatization
   2nd Group

Journalists where they reconstruct history – they make a timeline of events, they discover the important events and with the help of software, they make a map and the movements of the troops,
3rd GROUP
Historians has to analyze and interpret events driven by causes and effects.
They discover the critical points that determined the victory of the Athenians and discover the effects on Greek History

4. Have each group use computational thinking to analyze their assigned aspect. They should identify patterns, variables, and relationships within their topic.
5. After research and analysis, each group will present their findings to the class using visual aids like maps, diagrams, or charts.

Step 3 (3rd lesson)

Computational Thinking Activity

1. Each group present their findings
2. Each group will present their strategy to the class and explain the computational thinking processes they used.

Extension

- Have a class discussion about the lessons learned from studying the Battle of Marathon and applying computational thinking.
- Discuss the historical and modern applications of computational thinking in problem-solving and decision-making.
- Provide a hypothetical scenario related to the Battle of Marathon. For example, "You are an Athenian general planning the defense of Marathon. You have limited resources and need to come up with a strategy to defeat the Persian invaders. How would you approach this problem?"
- If time permits, you can extend the lesson by exploring other historical battles or events and analyzing them through a computational thinking lens.

Assessment

Assessment can be done through group presentations, class participation, and a reflection essay where students discuss the importance of computational thinking in understanding historical events and solving real-world problems.

The computational Thinking

In History

What is Computational Thinking?

It's a problem-solving approach that involves breaking down complex problems into smaller, manageable parts and creating algorithms or strategies to solve them.

Key Components of Computational Thinking:

- **Decomposition :**
  - Decomposition is the process of breaking down a complex problem into smaller, more manageable parts.
- **Pattern Recognition :**
  - Pattern recognition as the ability to identify similarities or common elements in different problems.
- **Abstraction :**
  - Abstraction as the process of simplifying a complex problem by focusing on the most important elements and ignoring irrelevant details.
- **Algorithm Design :**
  - Once a problem is decomposed, patterns are recognized, and unnecessary details are abstracted, we create a step-by-step plan or algorithm to solve it.

How can apply Computational Thinking in History ?

- **Decomposition**: Break Down Historical Events
  - Decompose historical events into smaller components, such as causes, key figures, consequences, and timeline.
  - Analyze the various factors contributing to a particular event, understanding the interplay of political, social, economic, and cultural elements.
- **Pattern Recognition**: Identify Trends and Patterns
  - Look for recurring themes and patterns in history, such as cycles of rise and fall of empires, revolutions, or social movements.
  - Recognize parallels and similarities between historical events, drawing comparisons between different time periods.
- **Abstraction**: Focus on Key Concepts and Ideas
  - Identify the essential elements of a historical narrative or argument, abstracting away from extraneous details.
  - Examine overarching concepts like power, conflict, resistance, and change, which underlie many historical events.
- **Algorithm Design**: Develop Analytical Methods
  - Create analytical frameworks and methodologies for studying history. For example, developing a step-by-step process to analyze primary source documents.
  - Design algorithms for answering historical questions, such as "What were the primary causes of a specific war?" or "What were the effects of a particular policy on a society?"

- **Data Analysis:** Apply Quantitative Methods
  - Use quantitative analysis to assess historical data, such as demographics, economic statistics, or census information.
  - Employ statistical techniques to draw insights from historical data, revealing trends and correlations.
- **Simulation:** Explore "What If" Scenarios
  - Use historical knowledge to create simulations or models to explore alternative outcomes if key events had unfolded differently.
  - Understand the potential impact of different decisions and policies on historical trajectories.
- **Debugging and Revision:** Refine Historical Interpretations
  - Continuously revise and improve historical narratives and interpretations by correcting errors, biases, or misconceptions.
  - Encourage critical thinking and the reevaluation of historical assumptions.
- **Computational Tools:** Utilize Technology
  - Make use of digital tools and resources for historical research, such as databases, digitized primary sources, and data visualization.
  - Leverage technologies like Geographic Information Systems (GIS) to map historical events and

Exploring The Battle of Marathon

- Break down the strategies employed by the Greeks into step-by-step algorithms.
- Identify patterns in the Persian and Greek strategies.
- Provide maps of the Persian campaign and the battlefield at Marathon.
- Mark key locations and analyze the geographical layout, including terrain and distances.
- Create a timeline of the event
- Create a simulation of the battle using software e.g “Alice”

Group Discussion and Reflection

- Have groups share their findings and analyses with the class.
- Facilitate a discussion on how computational thinking can be applied to historical events.
- Discuss the limitations and benefits of using computational thinking in historical analysis.

INTRODUCTION TO THE BATTLE OF MARATHON

- The Battle of Marathon was an important event in ancient Greek history that took place in 490 BC during the **Persian Wars**.
- This battle emerged as one of the most important **victories of the Greeks over the Persians** and had significant **effects on Greek history**

QUESTIONS

- What do you Know about Persian Empire and Ancient Greece ?
- What do you Know about Persian Wars ?
- What are the Key events and the figures involved?
- What are the effects in Greek history?

THE PERSIAN WARS

The Persian Wars were a series of conflicts between the Achaemenid Persian Empire and the Greek city-states that took place in the 5th century BCE..

There were two main phases of the Persian Wars: the Ionian Revolt (499–494 BCE) and the Greco-Persian Wars (490–479 BCE).

THE PERSIAN EMPIRE

Founding and Early Expansion:

• Founder: Cyrus the Great (ruled from 559 to 530 BCE) is often credited with founding the Achaemenid Empire.

• Cyrus expanded the empire through military conquests, incorporating the territories of the Medes, Lydians, and Babylonians.

• The empire was divided into provinces called satrapies, each governed by a satrap appointed by the king. Satraps were responsible for collecting taxes and maintaining order.

• The Persians believed in Ahuramasda, god of wisdom and truth. They were particularly interested in the truth. Herodotus, in fact, mentions that the children of the Persians learned from a young age "to ride horses, shoot bows and tell the truth".

Persian Wars and Further Expansion:

• Darius I (ruled from 522 to 486 BCE) further expanded the empire, including campaigns into the Indian subcontinent and Europe.

• Darius's attempt to invade Greece, including the famous Battle of Marathon, ended in defeat.

• Xerxes, son of Darius I, continued his father's military campaigns, including the invasion of Greece.

- The Persian Wars, fought against the Greek city-states, ended in defeat.

Decline and Fall:

The empire faced internal strife, including revolts and challenges to central authority.

In 330 BCE, Alexander the Great conquered the Persian Empire, marking its end. Despite the conquest, elements of Persian culture and administration influenced the Hellenistic world.

THE ANCIENT GREECE

Ancient Greece was a civilization that existed from the 8th century BCE to the 4th century BCE. It was located in the eastern part of the Mediterranean Sea, with its heartland centered on the Greek Peninsula.

City-States (Polis):

- Greece was not a unified nation but consisted of numerous independent city-states (polis), each with its own government, laws, and customs.
- Prominent city-states included Athens, Sparta, Corinth, Thebes, and many others.

Philosophy and Athenian Democracy:

- Ancient Greece produced some of the greatest philosophers in history, including Socrates, Plato, and Aristotle.
- Athens is often regarded as the birthplace of democracy. In the 5th century BCE, under leaders like Cleisthenes and Pericles, Athens developed a democratic system where citizens had a direct say in decision-making

Arts and Literature:

- Greek literature included epic poems like the "Iliad" and the "Odyssey" by Homer.
- Greek drama, with playwrights like Aeschylus, Sophocles, and Euripides, produced tragedies and comedies.
- Architecture and sculpture flourished, with examples such as the Parthenon on the Acropolis in Athens.

Alexander the Great and Hellenistic Period

- Alexander, a student of Aristotle, became king of Macedonia and went on to create one of the largest empires in history.

- His conquests spread Greek culture (Hellenistic culture) across Asia and into Egypt.

Decline:

- Internal conflicts, including the Peloponnesian War, contributed to the decline of the city-states.

- Greece eventually fell under the rule of various external powers, including the Romans.

Ancient Greece remains a foundational civilization in world history, known for its intellectual achievements, cultural richness, and enduring contributions to the development of human civilization.

EVENTS LEADING TO THE BATTLE OF MARATHON:

- The Persian Empire, under the rule of King Darius I, extended its control over the Ionian Greek city-states in Asia Minor.
- In 499 BCE, the Ionian Greeks, seeking independence, initiated the Ionian Revolt against Persian rule.
- Athens and Eretria supported the Ionians, marking the beginning of tensions between Greece and Persia.

- Darius, seeking revenge and aiming to expand Persian influence into mainland Greece, planned an invasion.
- Darius I, angered by Athenian and Eretrian involvement, sought to punish these Greek city-states for their defiance.
- He also sought to assert Persian dominance and demonstrate the consequences of defying the Persian Empire.

THE BATTLE OF MARATHON:

- **Persian Invasion (490 BCE):**
- In 490 BC strong Persian forces, commanded by generals Datis and Artaphernes,, sailing in the Aegean, anchored at Eretria, which they destroyed. They then headed to Marathon, where they camped.
- **Greek Defensive Strategy:**
- The Athenians sought help from the Spartans, who invoked religious reasons, resulting in the Spartan force arriving after the battle. The Athenians decided to confront the Persians at the point where the landing had taken place. Ten thousand Athenians and a thousand Plataeans who hastened to help them were to face the danger first. General Miltiades drew up his army, having further strengthened the extremities.
- As soon as the signal was given, the Athenians, to avoid the dense arrows of the enemy, rushed at a run. The downhill terrain they had chosen helped them reach their goal more quickly
- The Persians, when they saw them running towards them, were preparing to receive them, and for a moment thought that the Athenians had lost their senses. They were seen to be few in number and, in spite of this fact, rushing upon them, without even possessing cavalry and archers.
- Miltiades devised a bold strategy, launching a decisive attack on the Persian center after first weakening their flanks. This strategy, known as the "double envelopment," resulted in the Greeks successfully routing the Persian forces in the center.
- In the center of the front the Persians were victorious, but on one and the other wing the Athenians and Plataeans were victorious. .Unifying their two wings into one body, they fought the Persians who had achieved the breach in the center of the front.
- **Greek Victory:**

- Despite being outnumbered approximately 2 to 1, The Greeks achieved a remarkable victory, causing the Persians to retreat to their ships.

HISTORICAL SIGNIFICANCE:

1. **Defiance of Persian Power**:

The Greek victory at Marathon demonstrated that the seemingly invincible Persian Empire could be challenged and defeated.

2. **Boost to Greek Morale**:

The victory significantly boosted Greek morale and unity, fostering a sense of pride and confidence among the city-states.

3. **Symbol of Heroism and Sacrifice**:

The Battle of Marathon became a symbol of heroism and sacrifice, with the story of the Athenian runner Pheidippides delivering the news of victory before collapsing.

4. **Impact on Western Civilization**:

At Marathon, not only the freedom of the Athenians was judged, but also their democracy.

As the Athenians crushed the Persians, they reassured everyone but mostly themselves that democracy was a good polity - even in war.

The Battle of Marathon is often cited as a defining moment in the development of Western civilization, influencing ideas of democracy, freedom, and resistance against tyranny.

HERODOTUS

Everything we know about the Persian wars and the battle of Marathon is given to us by Herodotus (485-410 BC) in his sixth book " Erato"

You can read the historical text and get more information at the link below :

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Lesson Plan
The Industrial Revolution – Dimensions affected

Summary

1. Subject(s): Sociology
2. Grade/Level: 8
3. Objective: students will investigate the circumstances under which the industrial revolution began, find out what its impact was on various sectors. Then to determine if there is a parallel of the conditions with the conditions in the modern world.
4. Time allocation : 2 class period

Materials & Resources

1. Computers or tablets with internet access
2. Pen tablet with the appropriate software
3. Distance learning platform (CISCO Webex)
4. Interactive maps

Implementation

Step 1. (Day 1)

The temporal and spatial context – areas affected

- Students are asked to search the internet and answer the following questions:
    - What is the period of time that is characterized as the industrial revolution?

- What country did it originate from?
- Why it started from that country?
- What areas of life did it affect?

- The teacher writes the children's answers to the above questions on the pen tablet.
- The students are divided into groups and each group discusses one of the following topics
  - How the industrial revolution affected the technological sector?
  - How did the industrial revolution affect the economic sector?
  - How did the industrial revolution affect the social sector?
- Each group answers the above questions through examples they can find on the Internet and the teacher notes these examples on the pen tablet.

Step 2 (Day 2)

Industrial Revolution and modern world

- The course begins with a brief presentation of examples from the sectors affected by the industrial revolution. The teacher displays on the screen the file with the examples, as they were recorded with the help of the pen tablet.
- The teacher identifies an example for each area and asks the children questions
  1. Is there nowadays a technological explosion comparable to that of the industrial revolution period?
  2. Are there changes in the economic sector as significant as the money economy that developed during the industrial revolution?
  3. Does society today seem to be shaken by critical changes such as the period of the industrial revolution?
- The class again divides into groups (the same as last time) and discusses these questions
- Student groups describe in class their answers to the above questions.
- The professor asks the question "Are we living today in a period that resembles in some places the period of the industrial revolution?". Where is this due to? What are the similarities and what are the differences?

Extension

- Extending this two-hour unit, we could mention the intersections made in the field of biology and medicine during and shortly after the industrial revolution. Was the timing of these occurrences a coincidence?

Assessment

To assess the students, the teacher can assign them to watch the movie Modern Times with Charlie Chaplin and write an essay (500 words) in which they mention the elements of the industrial revolution that they recognize in the movie.

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Lesson Plan

Egypt “The Gift of the Nile”

Summary

1. Subject: Ancient History Egypt has been called the "gift of the Nile" since ancient times. The ancient Greek historian Herodotus, also known as the "father of History", attributed this characterization to her. Indeed, the presence of the Nile in the area of Egypt formed the basis on which the economy of the country was based since ancient times and, in general, the ancient Egyptian civilization, which was one of the oldest in the world.
2. Επίπεδο: 10-12 grade
3. Objective: Why is Egypt called "the gift of the Nile"? This online course attempts to answer this specific question, seeking to illuminate the reasons why the ancient Greek historian Herodotus was led to this conclusion about Ancient Egypt. The students will attempt to approach the problem through the principles of Computational Thinking, with the ultimate goal of realizing and interpreting the pivotal role that the Nile played in the history of Egypt.
4. Time Allotment: 1 class period

Materials & Resources

1. map of ancient Egypt from the 1st Lyceum textbook

   http://ebooks.edu.gr/ebooks/v/html/8547/2696/Istoria_A-Lykeiou_html-empl/indexI2_1.html

2. video clip from the National Geographic Double DVD "Egypt".

Implementation

Step 1. Indroduction – Formulation of the questions (5 min)

The teacher shows the students a map of Ancient Egypt and asks them to identify and name the area. Then he reads them the historical source in which Herodotus calls Egypt "a gift of the Nile" and formulates the question-"problem" that will concern the group: "Why does the historian Herodotus describe Egypt as a "gift of the Nile?""

Step 2. «Decomposition » of the problem (10 min)

The teacher urges the students, with the help of the map of Ancient Egypt, to identify the special characteristics of the Nile that could explain its characterization as a "gift" to Egypt. In particular, through questions, it prompts students to consider the following areas:

- Nile and other rivers (Pattern Recognition): compare the Nile with other rivers, anywhere in the world. Could other rivers be described as a 'gift' to a region? What is a river's greatest offering?
- Nile and geography: connecting the Nile with the geographical features of Egypt and determining the location of the river within the country.
- Nile and the division of Egypt: association of the Nile with the names given to the two geographical parts of Ancient Egypt, Upper and Lower Egypt (where is each located and why)?
- Nile and course-course: determining the course followed by the river from its sources in Ethiopia to its mouth.

Step 3. «Abstraction» (15 min)

In continuation of the discussion about the course of the Nile, the teacher shows a video showing the route of the river from the volcanic lands of Ethiopia to its mouth in the Mediterranean Sea. He then asks the students to point out various characteristics of the Nile, which they retained from what they saw and heard, and through them to determine the uniqueness of the river, that is, through the details to distinguish its essential feature, thanks to which Herodotus characterized Egypt "gift of the Nile". It is the property of the Nile to flood certain months of the year and, during the receding of its waters, to deposit the volcanic materials it carries from its sources in the form of mud, which makes the soil particularly fertile..

Step 4. Algorithm (10 min)

The teacher encourages the children to make an algorithm and record the steps the Nile takes until it turns from a simple river into a "gift" for Egypt.

Step 5. Summarize (5 min)

The teacher, with the help of the children, summarizes the main points of the lesson and repeats the "solution" given to the "problem" posed at the beginning.

Extension

The teaching can be extended by an attempt to apply the above Algorithm to another river case. The teacher, on the occasion of the Nile floods beneficial for Egypt, can raise the following question for discussion: "Are the floods of a river always beneficial for the lands?" What are the conditions for a river to be a "gift" for a region?" At this point, videos or images of catastrophic floods due to overflowing rivers, such as the recent ones in Thessaly, Greece, can be shown and students can discuss this aspect of the issue.

Assessment

Course assessment can be done through closed-ended interactive exercises (filling in the blanks, sorting pictures, etc.)

Lesson Plan

Biology – Monohybrid Crosses

Summary

1. Subject(s): Biology/Genetics
   Investigate genetic processes and analyse data to solve basic genetic problems involving monohybrid crosses.
2. Grade/Level:
   High school - 10^{th}, 11^{th} grades
3. Objectives:
   Students will learn appropriate terminology related to genetic processes, including allele, dominant, recessive, phenotype, genotype, heterozygous, homozygous, and zygote.
   • Students will learn about Punnett Squares for monohybrid crosses.
   • Students will complete Punnett Squares for monohybrid crosses
   • Students will be able to predict phenotypic and genotypic ratios for monohybrid crosses based on the Punnett Square.
4. Time Allotment: 60 minutes

Materials & Resources

• Computer

• Internet Access

• Projector

• Monohybrid Cross Review PowerPoint Presentation

• Solving Monohybrid Punnett Squares handouts

Implementation

Mendel's laws of inheritance should be discussed with students prior to this lesson. Students should understand appropriate terminology related to genetic processes, including allele, dominant, recessive, phenotype, genotype, heterozygous, homozygous, and zygote.

Step 1. Introduction (10 minutes)

This is a 5 E-model lesson that includes the following learning phases: Engage, Explore, Explain, Elaborate, and Evaluate.

The lesson starts with a refresher video for Monohybrids and Punnett Squares:

https://www.youtube.com/watch?v=i-0rSv6oxSY

Engage phase

The teacher facilitates students in the Engage Phase of the 5 E's lesson with the first handout- HANDOUT1: ENGAGE.

- The teacher will ask the students to volunteer reading each paragraph in the Engage: Freckles Introduction section.
- Students will work with a partner who is predetermined by the teacher. Students will appoint one person Partner A and the other person Partner B prior to completing Question 1-5.

Step 2. Implementation (30 minutes)

Explore phase

Students will then complete the Explore Phase handout – HANDOUT 2: EXPLORE.

Students will utilize the hands-on Scratch activity to explore the concept of genetic processes through monohybrid cross Punnett squares:

https://scratch.mit.edu/projects/894568430/

Students will continue to explore the Monohybrid Cross Simulation, while attempting to make connections with the following words: Alleles, Dominant, Recessive, Heterozygous, Homozygous, Parent Genotype and Phenotype, Zygote, Offspring Genotype and Phenotype, Probability

Explain phase

The teacher will facilitate the Explain Phase of the 5 E's with the next handout – HANDOUT 3: EXPLAIN and the Monohybrid Cross Review PowerPoint Presentation.

- The teacher will go over the Monohybrid Cross Review PowerPoint Presentation.
- Students should follow along highlighting words they do not fully grasp/understand, so they can look up the definitions, examples, and/or videos on the concept.
- Students will complete the Fill-In-The-Blank section of the Explain Phase on the 5 E Lesson handout – HANDOUT 3: EXPLAIN.

Extension (10 minutes)

Elaborate phase

In the Elaborate Phase, students will be challenged to extend/remix the Monohybrid Scratch program, https://scratch.mit.edu/projects/894568430/

by coding in various additional functions.

Students can view a list of additional coding functions in the handout: HANDOUT 4: ELABORATE.

https://scratch.mit.edu/projects/894522904/

Assessment (10 minutes)

Evaluate phase

In the Evaluate Phase, students will assess their computational understanding and abilities and teachers evaluate students' understanding of key concepts and skill development with the Punnett Square Monohybrid Cross Elaboration Scratch program, https://scratch.mit.edu/projects/894522904/

The Punnett Square Monohybrid Cross Elaboration Scratch program provides example code for including an introduction, changing the background, adding a sprite character, and adding a monohybrid cross question.

Furthermore, students can practice genetic problems on Monohybrid crosses:

Practice - simple genetics.docx

Practice - Skinny Pig Genetics

HANDOUT 1: ENGAGE

Engage: Freckles Introduction

Freckles are small, concentrated irregularly shaped spots of skin pigments called melanin. Freckles are dominant (F) and primarily controlled by the MC1R gene.

A person that is *heterozygous* for freckles would have a *phenotype* that shows freckles on their skin and possess the *genotype* Ff. This person could provide either the *dominant allele*, F, or the *recessive allele*, f, to their offspring through the sex cells, also called *zygotes*.

Choose a partner from your classmates and appoint one person Partner A, and the other person Partner B.

1. Look at your classmates (on the screen) and count how many people have freckles. __________

2. Determine Partner A's Phenotype: *Circle One* Freckles or No Freckles

3. Determine Partner A's possible Genotypes: _______________________.

a. If there is more than one possible Genotype, flip a coin to determine which Genotype to continue with: Heads → FF Tails → Ff

4. Determine Partner B's Phenotype: *Circle One* Freckles or No Freckles

5. Determine Partner B's possible Genotypes: _______________________.

a. If there is more than one possible Genotype, flip a coin to determine which Genotype to continue with: Heads → FF Tails → Ff

Each person's genotype represents the two alleles that they can pass on to their offspring!

HANDOUT 2: EXPLORE

Explore: Monohybrid Scratch Inquiry

Students will utilise the hands-on Scratch activity to explore the concept of genetic processes through monohybrid cross Punnett squares:

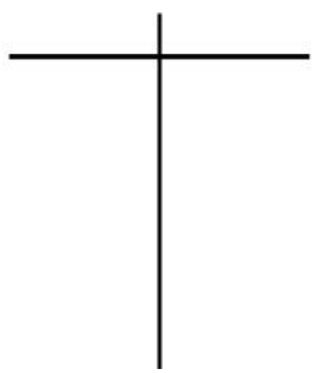
https://scratch.mit.edu/projects/274859804/

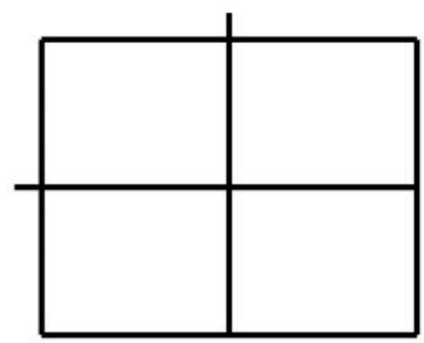
6. Complete the Monohybrid Cross Simulation with the freckles genotype information acquired with your partner in the previous handout.

7. On the left of the Punnett Square, put Partner A’s alleles. On the top, put Partner B’s alleles.

8. Use the Punnett Square to determine the genotype of the offspring between Partner A and B.

9. Use the T-Chart to list the genotypes and the probability of each phenotype, Freckles or No Freckles, in the 4 offspring.





10. Continue to explore the Monohybrid Cross Simulation, while attempting to make connections with the following words:

a. Alleles

b. Dominant

c. Recessive

d. Heterozygous

e. Homozygous

f. Parent Genotype and Phenotype

g. Zygote

h. Offspring Genotype and Phenotype

i. Probability

HANDOUT 3: EXPLAIN

Explain: Student Note accommodating Monohybrid Cross Review PowerPoint
Genetics: A field of biology that studies heredity, or the passing of traits from parents to offspring!
We can see that the labradoodle received the ______________ trait from its dad, the Labrador, and received the _____________trait from its mom, the Poodle!
Fill in the Blank Options: 1. Brown Colour 2. Hair Texture
Genes and Chromosomes
• The chromosomes are contained in the nucleus of the cell.

• Chromosomes are made of _______.

• Chromosomes are a long chain of ________.

• A gene is a segment of DNA that controls a ________________________ and two different forms of a gene are called ___________.

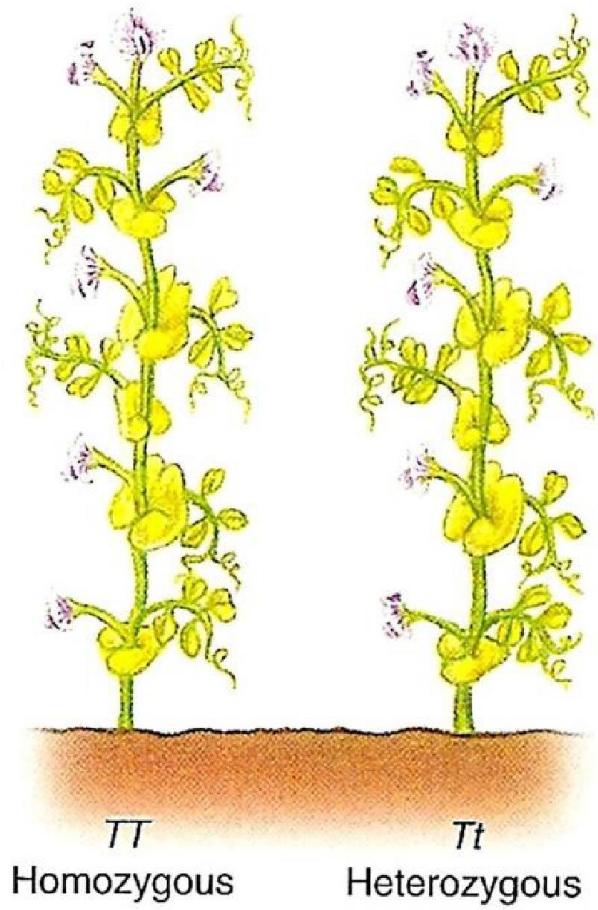
Hereditary Trait

• The characteristics that an organism has, such as ___________________, ______________, tall or short, skin color.
• ___________ must be present for a trait to show up in the offspring.
• One allele comes from the 1st parent and the other allele comes from the 2nd parent. When fertilization occurs, the new offspring, a ____________, will have ________________ for every trait.
If a parent has 2 alleles for a trait, how does the parent only pass 1 allele to their offspring?
Ideas:

- The answer is the cell division of ___________.
- _____________ is the cell division that forms _____________, which are _____________________ ____.

• During meiosis, the DNA is replicated and then separated into ___________________.
• This way, each __________ passes _______________ for each gene to their offspring → ________ ___________________.
• The capital letter, Y, represents a dominant allele.
• The lower-case letter, y, represents a recessive allele.

Genotype versus Phenotype



Genotype:
• Refers to the two alleles an individual has for a specific trait
• If identical, genotype is homozygous (TT, tt)
• If different, genotype is heterozygous (Tt)
Phenotype:
• Refers the physical appearance of the individual... The observable
expression of the genotype. ("what you see")
.

Probability

• If we know the genetic makeup of parents, we can determine what type of offspring they can produce.

• We can determine the probability of producing different types of offspring.

• Probability:

____.

Punnett Squares

• Punnett Squares are used to show allele combinations that might results from a genetic cross between two parents.
• The alleles of the first parent will be placed on the left, and the alleles of the second parent on the

top of the Punnett square.

• The possible gene combinations of the offspring will be placed inside the squares, representing zygotes.

• The letters represent the alleles.
A capital letter represents a ____________ allele.
A lower-case letter represents a ___________ allele.

Genotype	Phenotype
TT	Tall
Tt	Tall
tt	Dwarf

Fill in the Blank Options: 1. Recessive 2. Dominant

Question 1. The trait for being tall is dominant, T, over the recessive trait for being short, t.
A. What are the genotypes of the parents?
B. What are the phenotypes of the parents?
C. What are the genotypes of the offspring?
D. What are the phenotypes of the offspring?
E. What is the probability that each offspring genotype and phenotype will be present?

Question 2. In dogs, the allele for short hair (B) is dominant over the allele for long hair (b). Two short haired dogs have a litter of puppies. Some of the puppies have short hair and some of the puppies have long hair. Use the Punnett Square and T-Chart to answer the following questions.
A. What are the genotypes of the parents? ______________________ , ______________________

HANDOUT 4: ELABORATE

Elaborate: Monohybrid Scratch Extension
Extend/remix the Monohybrid Scratch program, https://scratch.mit.edu/projects/894568430/, by coding in various additional functions, such as but not limited to:
- Add an Introduction
- Change the Background
- Add a Sprite Character
- Add a Monohybrid Cross Question
- Label for Parent Genotypes
- Label for Parent Phenotypes
- Label for Zygotes
- Add Probability Calculator for Zygote Genotypes
- Add Probability Calculator for Zygote Phenotypes
- Add Explanation for What Has Occurred

Monohybrid Cross Review

Lesson Aims

- To revise and consolidate understanding of monohybrid crosses

You need to know these words

Haploid

Recessive

Gene

Genotype

Diploid

Dominant

F2 Generation

F1 Generation

Allele

Phenotype

Heterozygous

Homozygous

Things you need to know

Monohybrid inheritance

The pattern of inheritance of a pair of alleles where one is dominant and one is recessive.

ALSO REMEMBER: Dominant and co-dominant alleles should be represented by upper case letters and recessive alleles by lower case letters.

History

Gregor Mendel - The Father of Genetics

1. Monk who used science and maths to establish patterns in how traits were inherited
2. Year: 1857 – carried out early monohybrid cross.
3. He used the garden pea as his test subjects

Some Vocabulary

- Character - a heritable feature (e.g. flower colour)
- Trait - a variant of each character (e.g. purple or white)
- Cross Pollination - one plant fertilizes a different plant
- Self Pollination - a plant fertilizes itself
- True-Breeding - plants that over several generations only produce plants like themselves

Monohybrid cross.

- A cross between two parents who possess different forms of a gene referred to as a MONOHYBRID INHERITANCE.

Mendel's Experiments - Monohybrid Cross (pea plant cross).

- **Monohybrid Cross:** involved plants that differed for a single character: tall x short, purple flower x white flower, round seed x wrinkled seed.
- **P (Parental Generation):** True breeding plants
- **F1 (First Filial):** The offspring of the P generation --> they always displayed a single trait, the dominant one.
- **F2 (Second Filial):** The offspring of the F1 generation, self fertilized --> always had a 3:1 ratio.

Pea plant cross

Parent plant true breeding for round seeds X Parent plant true breeding for wrinkled

↓ Cross-pollination

First filial generation (F_1)– ALL ROUND SEEDS

↓ Self-pollination

Second filial generation (F_2) –
3 ROUND: 1 WRINKLED SEEDS

- Since wrinkled seeds were absent in the F_1 and reappears in the F_2, ‘something has to be transmitted undetected in the gametes from generation to generation. Today we call this a **GENE**. In this case it is a gene for seed shape, which has two **alleles**, round and wrinkled.

- Since the presence of round allele masks the presence of the wrinkled allele, round is said to be **DOMINANT** and wrinkled **RECESSIVE**.

Phenotypes and genotypes

Genotype

- An organisms genotype is its genetic constitution (i.e. Alleles of genes) that is inherited from parents.
- These instructions are intimately involved with all aspects of the life of a cell or an organism

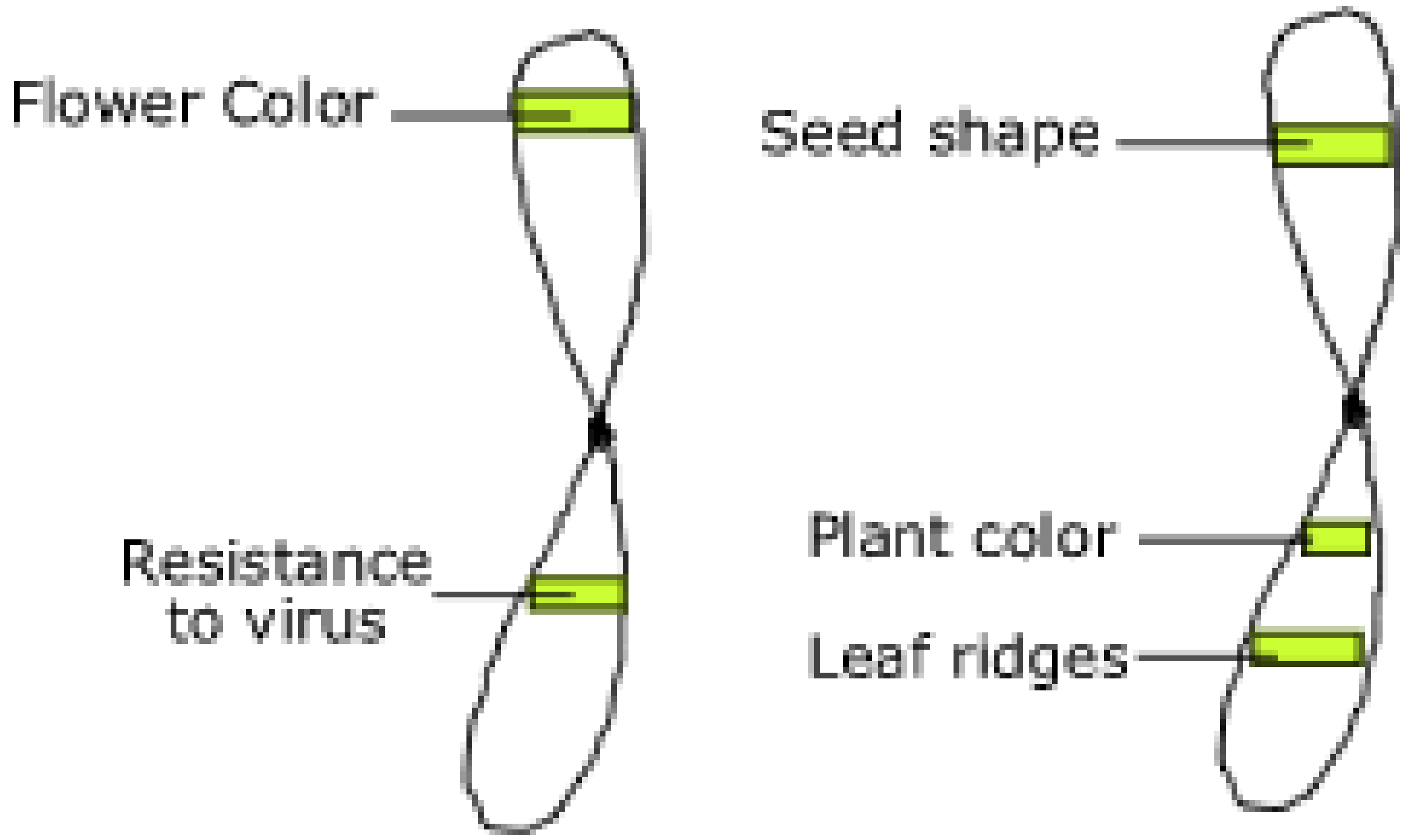
Phenotype

- An organisms phenotype is its appearance resulting from this inherited information (Genotype).
- This is anything that is part of the observable structure, function or behaviour of a living organism. e.g. Eye colour

Mendel’s Law of Segregation

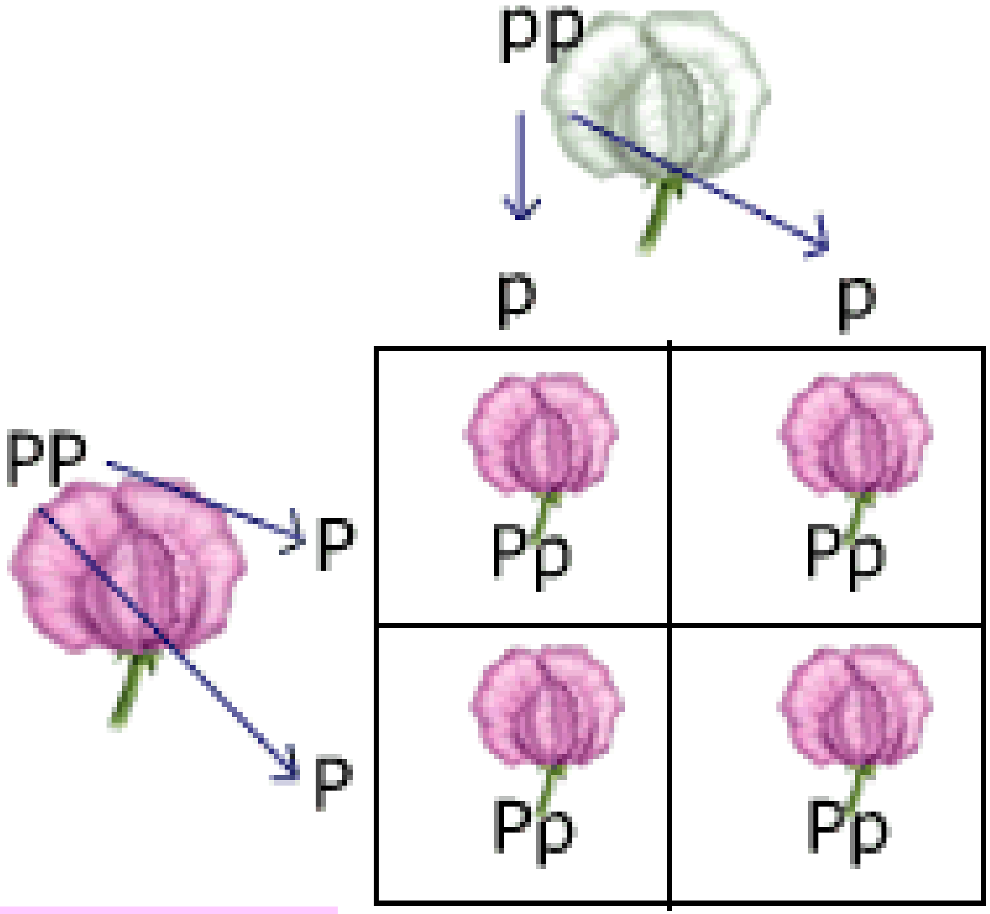
- States…The alleles of a gene exist in pairs but hen gametes are formed, the members if each pair pass into different gametes. Thus each gamete contains only one allele of each gene.
  - For example a Tt parent can produce both T sperm, and t sperm.

Locus - spot on the chromosome where an allele (gene) is located.



Punnet squares

A Punnett square is a representation of the ***law of segregation***, showing how gametes separate and then come together during fertilization.



ALSO REMEMBER: Dominant and co-dominant alleles should be represented by upper case letters and recessive alleles by lower case letters.

Homozygous and Heterozygous

- When an individual possesses two similar alleles of a gene (e.g. R and R or r and r), its genotype is said to be **HOMOZYGOUS** (true-breeding) and all of it's gametes are identical with respect to that characteristic.

- When an individual possesses two different alleles of a gene (e.g. R and r), its genotype is said to be **HETEROZYGOUS**. It produces two different types of gamete with respect to that characteristic.

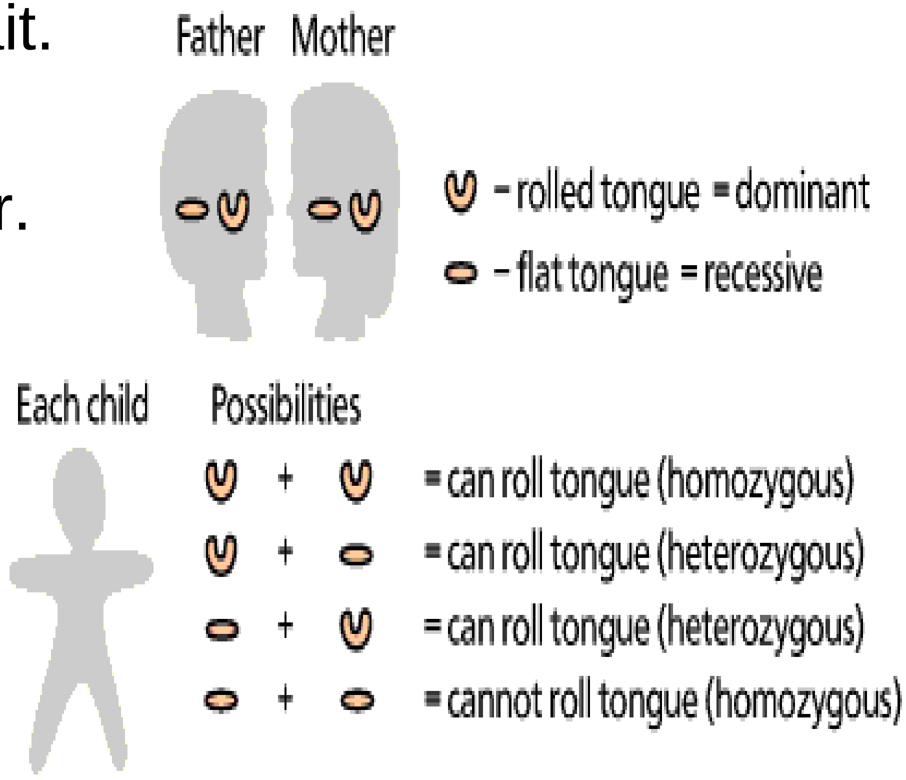
CAN YOU ROLL YOUR TONGUE?

Monohybrid Inheritance in Humans

- Tongue rolling is inherited as a simple Mendelian trait.
- R is the allele for roller
- r is the allele for non-roller.

	R	r
R	RR	Rr
r	Rr	rr

Genetics of tongue rolling



Name:____

Genetics Practice Problems

1. For each genotype below, indicate whether it is heterozygous **(He)** or homozygous **(Ho)**

AA _____	Ee _____	Ii _____	Mm _____
Bb _____	ff _____	Jj _____	nn _____
Cc _____	GG _____	kk _____	OO _____
Dd _____	HH _____	Ll _____	Pp _____

2. For each of the **genotypes** below determine what **phenotypes** would be possible.

P

Purple flowers are dominant to white
PP _____________
Pp _____________
pp _____________

Brown eyes are dominant to blue
BB ___________
Bb ____________
bb _____________

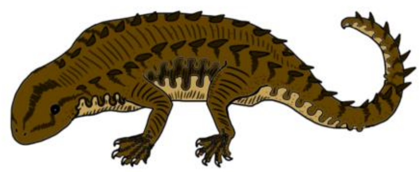
Round seeds are dominant to wrinkled
RR ______________
Rr ______________
rr _______________

Bobtails are recessive (to long tails)
TT ____________
Tt ____________
tt _____________

3. For each **phenotype** below, list the **genotypes** (remember to use the letter of the dominant trait)

Straight hair is dominant to curly
_____ straight
_____ straight
_____ curly

Tail spikes are dominant to plain tails
____ spikes
____ spikes
____ plain



4. Set up the Punnett squares for each of the crosses listed below. Purple flowers are dominant to white.

Rr x rr

What percentage will be purple? ______ What percentage will be white? ______

Rr x Rr

What percentage will be purple? ______ What percentage will be white? ______

RR x Rr

What percentage will be purple? ______ What percentage will be white? ______

Practice with Crosses. Show all work!

5. A TT (tall) plant is crossed with a tt (short plant).

What percentage of the offspring will be tall? ___________

6. Show the cross of a Tt plant and a Tt plant.

What percentage of the offspring will be short? ______
What percentage is tall? _______

7. A heterozygous round seeded plant (Rr) is crossed with a homozygous round seeded plant (RR).

What percentage of the offspring will be homozygous (RR)? _______

8. A homozygous round seeded plant is crossed with a homozygous wrinkled seeded plant. What are the genotypes of the parents?

__________ x __________

What percentage of the offspring will also be homozygous? ________
What is the genotype of all of the offspring? ___

9. **In pea plants purple flowers are dominant to white flowers**.

Two white flowered plants are crossed…

What percentage of their offspring will have white flowers? ________

10. A white flowered plant is crossed with a plant that is heterozygous for the trait.

What percentage of the offspring will have purple flowers? _______ White flowers? _______

11. Two plants, both heterozygous for the gene that controls flower colors are crossed.

What percentage of their offspring will have purple flowers? _________
What percentage will have white flowers? _________

12. In guinea pigs, the **allele for short hair is dominant**.

What genotype would a heterozygous short haired guinea pig have? ____

What genotype would a pure breeding short haired guinea pig have?____

What genotype would a long-haired guinea pig have? ____

Show the cross for two heterozygous guinea pigs.

What percentage of the offspring will have short hair? ________

What percentage of the offspring will have long hair?

____

Name: ______________________________________ Date: _____

Skinny Pig Genetics

The gene causing **hairlessness** in skinny pigs is a recessive gene and breeding two skinny pigs together will always result in all offspring being skinny pigs. Breeding a skinny pig to a standard haired guinea pig will result in offspring that all carry one copy of the gene, but none will express hairlessness

1. Complete the chart:

	Genotype	Phenotype
Normal, hairy guinea pig (homozygous)	**HH**	Hairy
Carrier guinea pig (heterozygous)		Hairy
Skinny pig (homozygous)		Skinny

2. A heterozygous pig is crossed with a skinny pig. What are the genotypes of the parents? ____ x _____

Show the crosses with a Punnett square

What percentage will be hairy

What percentage will be skinny?

3. Two heterozygous pigs are crossed. What are the genotypes of the parents? ____ x _____

What percentage will be hairy

What percentage will be skinny?

4. A homozygous hairy pig is crossed with a skinny pig. What are the genotypes of the parents? ____ x _____

What percentage will be hairy

What percentage will be skinny?

5. A homozygous hairy pig is crossed with a heterozygous pig. What are the genotypes of the parents? ___ x ____

What percentage will be hairy

What percentage will be skinny?

Lesson Plan

Chemistry - Patterns in the Periodic Table

Summary

1. Subject(s):
   Science – Chemistry
   In this lesson students study patterns in the organisation of the periodic table supplemented by the use of spreadsheet functions. Students will begin to see how pattern recognition can be used to understand natural phenomena. At the end of this lesson students should have a better understanding of periodic table and begin to see how pattern recognition is a scientific skill.
2. Grade/Level: 6^{th} to 8^{th} grade
   13 to 16 years old
3. Objective:
   Students should be able to predict generally where in the periodic table metals, metalloids and nonmetals are found.
   - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms;
   - Analyse and visualise data to create information and address complex problems; and model processes, entities and their relationships using structured data;
   - Analyse data and identify patterns through modelling and simulation.
5. Time Allotment: 85 minutes

Materials & Resources

Internet-connected computer

- Chrome browser (https://www.google.com/chrome/browser/desktop) recommended

Google Sheets (https://docs.google.com/spreadsheets/) or other spreadsheet

Lesson Vocabulary

Teacher's version of the Complete Periodic Trends sheet for an example of how a spreadsheet should appear upon completion of this lesson.

Implementation

Step 1. Warm-up Activity: Exploring tables (15 minutes)

In this activity, students will explore the organisation of two tables of the elements from the periodic table. Students will use pattern recognition to begin exploring the tables.

Activity:

The teacher leads the students through the following activity:

The periodic table is loaded with data on the properties of each element, organised into rows and columns. In two separate windows, open the Periodic Trends spreadsheet and the Periodic Table spreadsheet to begin to understand the organisation of the elements.

Q1: Study the data in the Periodic Trends spreadsheet. Which column does the spreadsheet appear to be sorted by?

Q2: Study the Periodic Table spreadsheet. Describe how the atomic numbers are organised on the periodic table.

Assessment:

A1: The atomic number column sorts the Periodic Trends spreadsheet.

A2: The atomic numbers display in order across the periodic table, increasing from left to right and top to bottom, with some exceptions in the sixth and seventh rows.

Step 2. Grouping (20 minutes)

In this activity, students will use the Periodic Trends spreadsheet to attempt to discover a relationship of atomic number to the three classifications of the elements. In doing so they will use pattern recognition.

Activity 1:

Take your students through the following steps:

1. In the Warm-up Activity you saw how the atomic numbers are organised in the periodic table. In the following activity, you will see how elements are grouped together in the table.

2. Each element in the periodic table can be classified into one of the following groups: metal, nonmetal, or metalloid.

3. While viewing the Periodic Trends spreadsheet choose *Make a Copy* in the *Files menu* to make your own copy of the spreadsheet.

4. Follow the instructions to colour code each element in your copy of the Periodic Trends spreadsheet, according to the three classifications.

5. Conditional Highlighting in Google Docs:

a. Highlight all the data in the *Classification* column

b. Under the *Format* menu, choose *Conditional Formatting*

c. Set the first button to *Text is exactly*

d. In the first text box type *nonmetal (must be spelled exactly as in the spreadsheet)*

e. Check the *Background* box

f. Choose a new colour for the background of all the nonmetals

g. Click on *+Add another rule*

h. Repeat the process for the metalloids using a different colour

i. By process of elimination, the elements that still have the original colour coded are all metals

Q1: Which type of element is most common, metal, nonmetal, or metalloid? Which is least common?

Q2: Was it easier to identify the metals, nonmetals, and metalloids before or after we used the conditional highlighting tool?

Assessment 1:

A1: The majority of the elements are metals.

A2: Answers may vary, however students should notice that once each type of element is highlighted with a different colour it is easier to recognize which elements belong to which classification.

Activity 2:

Have your students do the following activity:

The spreadsheet initially is sorted by atomic number. Follow these steps to re-sort it into groups of metals, nonmetals, and metalloids.

a. Highlight *all* the data on the spreadsheet (do not include the headers in the first row).

b. Go to the *Data menu* and select *Sort range*.

c. Sort the *Classification* column (*Column C*) `from a → z.`

Q3: Now that your data is sorted and highlighted, count how many metals, metalloids, and nonmetals are in the periodic table.

Q4: List the atomic number of each metalloid. Is there a clear pattern in these numbers?

Assessment 2:

A3: metals - 83, metalloids - 9, nonmetals - 18

A4: Atomic numbers of metalloids: 5, 14, 32, 33, 51, 52, 84; there is no clear pattern to the atomic number of metalloids.

Step 3. Discovering the pattern (20 minutes)

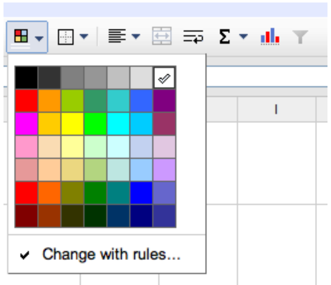
Activity:

Have your students do the following:

1. In a spreadsheet list, it is difficult to identify any patterns between the atomic number and the classification of an element into metal, nonmetal, and metalloid. However, when we study the arrangement of these elements in the periodic table we begin to notice a connection between an element's location and its classification.
2. While viewing the [Periodic Table] spreadsheet choose *Make a Copy* in the *Files* menu to make your own copy of the spreadsheet.
3. Look at your copy of the *Periodic Trends* spreadsheet to identify the atomic number of each metalloid. Change the background of the cells containing the metalloids in your

copy of the *Periodic Table* spreadsheet to match the colour that you used for metalloids on the *Periodic Trends* spreadsheet. Repeat this process for the nonmetals in the periodic table.

4. Instructions for colour coding the Periodic Table
    a. On the Periodic Table sheet, highlight a cell that contains a metalloid.
    b. In the toolbar above the periodic table, click on the *Text background colour* button and choose the colour that you used for metalloids in the Periodic Trends sheet. (see below)



    c. Repeat the process until all the metalloids are the same colour on the periodic table.
    d. Repeat the process for the nonmetals, using the colour you chose for nonmetals in the Periodic Trends sheet.

Q1: Describe the location of the metals, metalloids, and nonmetals on the periodic table**.**

Assessment:

A1: The nonmetals are located in the upper right hand corner of the table, followed to the left/below by the metalloids, and the remainder of the table is filled with metals.

Extension: Melting points (20 minutes)

In this activity, students will look for a relationship between the melting point of an element and its placement in the periodic table. All melting points are in kelvin. Students will discover a pattern relating melting point to element category as well as exceptions to the pattern.

Activity:

Walk through the following with your students:

In the Periodic Trends spreadsheet, highlight *all* of the data and sort it by melting point

(*Data→ Sort range→ Column D*).

Q1: What element has the lowest melting point? Which has the highest melting point?

Q2: Which type (classification) of elements tend to have the lowest melting points?

Q3: Does this pattern always hold? If not, name at least two exceptions to the general trend.

To easily identify the elements with the lowest melting points on the *Periodic Table* spreadsheet, choose a new font colour for the atomic number of all elements whose melting temperature is less than 500 degrees. One partner should read these numbers from the *Periodic Trends* spreadsheet while the other changes the font colour of these elements on the *Periodic Table* spreadsheet. If you find that these elements are grouped together, highlight them in groups to save time.

Q4: Describe the location of the elements with these melting points. Are they scattered randomly across the table or are they clustered together?

Q5: Which column of the table contains metals whose melting temperatures are closest to the melting temperatures of most nonmetals?

Q6: Which nonmetal is an outlier with a melting temperature far above 500 degrees? Does this element border the metalloids or is it surrounded by other nonmetals?

Assessment:

A1: Helium is at the top of the sheet with the lowest melting point, and at the end of the sorted list we have carbon with the highest recorded melting point.

A2: Most of the nonmetals are clustered at the top of the list with the lowest melting points, although there are several exceptions.

A3: No, although most nonmetals have lower melting points than most metals and metalloids, there are several exceptions. For example the metal Cs (cesium) has a lower melting point than the nonmetal S (sulphur), and the nonmetal C (carbon) has one of the highest melting temperatures of all.

A4: The elements with the lowest melting temperatures are clustered in one group on the right hand side of the table and then in another group on the left hand side. Students should notice that if we wrapped the periodic table around a cylinder these elements would all be grouped together.

A5: The elements in the first column of the left hand side of the table also have relatively low melting points, even though they are metals.

A6: Carbon is a nonmetal with a high melting temperature. It borders the metalloids; we see properties begin to shift as we get closer to different categories of elements.

Assessment: Summarising (10 minutes)

In this activity, students will review some key patterns in the periodic table. They will discuss how atomic numbers, metals, metalloids, nonmetals and melting temperature are arranged in the periodic table. Students will continue to use pattern recognition.

Activity:

Prompt discussion with the following:

Summarise all of the patterns/trends in how the elements are grouped in the periodic table. Consider the atomic numbers, the classification of the elements, and the melting points.

Answers will vary, however students should note the following:

- Atomic number increases across rows (left to right) and down columns
- Elements are grouped together as metals, metalloids, and nonmetals

Melting temperatures are lowest in the top right hand side of the table, and remain relatively low in the first column on the left hand side of the table as well.

Element	Atomic Number	Classification
He	2	nonmetal
H	1	nonmetal
Ne	10	nonmetal
F	9	nonmetal
O	8	nonmetal
N	7	nonmetal
Ar	18	nonmetal
Kr	36	nonmetal
Xe	54	nonmetal
Cl	17	nonmetal
Rn	86	nonmetal
Hg	80	metal
Br	35	nonmetal
Fr	87	metal
Cs	55	metal
Ga	31	metal
Rb	37	metal
P	15	nonmetal
K	19	metal
Na	11	metal
I	53	nonmetal
S	16	nonmetal
In	49	metal
Li	3	metal
Se	34	nonmetal
Sn	50	metal
Po	84	metalloid
Bi	83	metal
At	85	nonmetal
Tl	81	metal
Cd	48	metal
Pb	82	metal
Zn	30	metal
Te	52	metalloid
Sb	51	metalloid
Np	93	metal
Pu	94	metal

Mg	12	metal
Al	13	metal
Ra	88	metal
Ba	56	metal
Sr	38	metal
Ce	58	metal
As	33	metalloid
Yb	70	metal
Eu	63	metal
Md	101	metal
No	102	metal
Ca	20	metal
Es	99	metal
Cf	98	metal
La	57	metal
Pr	59	metal
Ge	32	metalloid
Ag	47	metal
Nd	60	metal
Pm	61	metal
Ac	89	metal
Au	79	metal
Sm	62	metal
Cu	29	metal
U	92	metal
Am	95	metal
Mn	25	metal
Be	4	metal
Gd	64	metal
Cm	96	metal
Tb	65	metal
Si	14	metalloid
Dy	66	metal
Ni	28	metal
Ho	67	metal
Co	27	metal
Y	39	metal
Fm	100	metal

Er	68	metal
Fe	26	metal
Sc	21	metal
Tm	69	metal
Pd	46	metal
Pa	91	metal
Lr	103	metal
Lu	71	metal
Ti	22	metal
Th	90	metal
Pt	78	metal
Zr	40	metal
Cr	24	metal
V	23	metal
Rh	45	metal
B	5	metalloid
Tc	43	metal
Hf	72	metal
Ru	44	metal
Ir	77	metal
Nb	41	metal
Mo	42	metal
Ta	73	metal
Os	76	metal
Re	75	metal
W	74	metal
C	6	nonmetal
Bk	97	metal
Unq	104	metal
Unp	105	metal
Unh	106	metal
Uns	107	metal
Uno	108	metal
Une	109	
Unn	110	

Element	Atomic Number	Classification	Melting
He	2	nonmetal	0,95
H	1	nonmetal	13,81
Ne	10	nonmetal	24,55
F	9	nonmetal	53,55
O	8	nonmetal	54,8
N	7	nonmetal	63,15
Ar	18	nonmetal	83,95
Kr	36	nonmetal	116
Xe	54	nonmetal	161,39
Cl	17	nonmetal	172,17
Rn	86	nonmetal	202
Hg	80	metal	234,31
Br	35	nonmetal	265,95
Fr	87	metal	300
Cs	55	metal	301,54
Ga	31	metal	302,92
Rb	37	metal	312,63
P	15	nonmetal	317,3
K	19	metal	336,8
Na	11	metal	371
I	53	nonmetal	386,7
S	16	nonmetal	392,2
In	49	metal	429,78
Li	3	metal	453,7
Se	34	nonmetal	494
Sn	50	metal	505,12
Po	84	metalloid	527
Bi	83	metal	544,59
At	85	nonmetal	575
Tl	81	metal	577
Cd	48	metal	594,26
Pb	82	metal	600,65
Zn	30	metal	692,73
Te	52	metalloid	722,72
Sb	51	metalloid	903,91
Np	93	metal	912
Pu	94	metal	913
Mg	12	metal	922
Al	13	metal	933,5
Ra	88	metal	973
Ba	56	metal	1002
Sr	38	metal	1042
Ce	58	metal	1071
As	33	metalloid	1090
Yb	70	metal	1092
Eu	63	metal	1095
Md	101	metal	1100
No	102	metal	1100
Ca	20	metal	1112
Es	99	metal	1130
Cf	98	metal	1170
La	57	metal	1191
Pr	59	metal	1204
Ge	32	metalloid	1211,5
Ag	47	metal	1235,08
Nd	60	metal	1294
Pm	61	metal	1315

Ac	89	metal	1324
Au	79	metal	1337,58
Sm	62	metal	1347
Cu	29	metal	1356,6
U	92	metal	1408
Am	95	metal	1449
Mn	25	metal	1518
Be	4	metal	1560
Gd	64	metal	1585
Cm	96	metal	1620
Tb	65	metal	1629
Si	14	metalloid	1683
Dy	66	metal	1685
Ni	28	metal	1726
Ho	67	metal	1747
Co	27	metal	1768
Y	39	metal	1795
Fm	100	metal	1800
Er	68	metal	1802
Fe	26	metal	1808
Sc	21	metal	1814
Tm	69	metal	1818
Pd	46	metal	1825
Pa	91	metal	1845
Lr	103	metal	1900
Lu	71	metal	1936
Ti	22	metal	1945
Th	90	metal	2028
Pt	78	metal	2042,1
Zr	40	metal	2128
Cr	24	metal	2130
V	23	metal	2163
Rh	45	metal	2236
B	5	metalloid	2365
Tc	43	metal	2477
Hf	72	metal	2504
Ru	44	metal	2610
Ir	77	metal	2720
Nb	41	metal	2742
Mo	42	metal	2896
Ta	73	metal	3293
Os	76	metal	3300
Re	75	metal	3455
W	74	metal	3695
C	6	nonmetal	3825
Bk	97	metal	
Unq	104	metal	
Unp	105	metal	
Unh	106	metal	
Uns	107	metal	
Uno	108	metal	
Une	109		
Unn	110		

1																	2
3	4											5	6	7	8	9	10
11	12											13	14	15	16	17	18
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
87	88	89	104	105	106	107	108	109	110								
				58	59	60	61	62	63	64	65	66	67	68	69	70	71
				90	91	92	93	94	94	96	97	98	99	100	101	102	103

Element	Atomic Number	Classification	Melting
H	1	nonmetal	13,81
He	2	nonmetal	0,95
Li	3	metal	453,7
Be	4	metal	1560
B	5	metalloid	2365
C	6	nonmetal	3825
N	7	nonmetal	63,15
O	8	nonmetal	54,8
F	9	nonmetal	53,55
Ne	10	nonmetal	24,55
Na	11	metal	371
Mg	12	metal	922
Al	13	metal	933,5
Si	14	metalloid	1683
P	15	nonmetal	317,3
S	16	nonmetal	392,2
Cl	17	nonmetal	172,17
Ar	18	nonmetal	83,95
K	19	metal	336,8
Ca	20	metal	1112
Sc	21	metal	1814
Ti	22	metal	1945
V	23	metal	2163
Cr	24	metal	2130
Mn	25	metal	1518
Fe	26	metal	1808
Co	27	metal	1768
Ni	28	metal	1726
Cu	29	metal	1356,6
Zn	30	metal	692,73
Ga	31	metal	302,92
Ge	32	metalloid	1211,5
As	33	metalloid	1090
Se	34	nonmetal	494
Br	35	nonmetal	265,95
Kr	36	nonmetal	116
Rb	37	metal	312,63

Sr	38	metal	1042
Y	39	metal	1795
Zr	40	metal	2128
Nb	41	metal	2742
Mo	42	metal	2896
Tc	43	metal	2477
Ru	44	metal	2610
Rh	45	metal	2236
Pd	46	metal	1825
Ag	47	metal	1235,08
Cd	48	metal	594,26
In	49	metal	429,78
Sn	50	metal	505,12
Sb	51	metalloid	903,91
Te	52	metalloid	722,72
I	53	nonmetal	386,7
Xe	54	nonmetal	161,39
Cs	55	metal	301,54
Ba	56	metal	1002
La	57	metal	1191
Ce	58	metal	1071
Pr	59	metal	1204
Nd	60	metal	1294
Pm	61	metal	1315
Sm	62	metal	1347
Eu	63	metal	1095
Gd	64	metal	1585
Tb	65	metal	1629
Dy	66	metal	1685
Ho	67	metal	1747
Er	68	metal	1802
Tm	69	metal	1818
Yb	70	metal	1092
Lu	71	metal	1936
Hf	72	metal	2504
Ta	73	metal	3293
W	74	metal	3695
Re	75	metal	3455

Os	76	metal	3300
Ir	77	metal	2720
Pt	78	metal	2042,1
Au	79	metal	1337,58
Hg	80	metal	234,31
Tl	81	metal	577
Pb	82	metal	600,65
Bi	83	metal	544,59
Po	84	metalloid	527
At	85	nonmetal	575
Rn	86	nonmetal	202
Fr	87	metal	300
Ra	88	metal	973
Ac	89	metal	1324
Th	90	metal	2028
Pa	91	metal	1845
U	92	metal	1408
Np	93	metal	912
Pu	94	metal	913
Am	95	metal	1449
Cm	96	metal	1620
Bk	97	metal	
Cf	98	metal	1170
Es	99	metal	1130
Fm	100	metal	1800
Md	101	metal	1100
No	102	metal	1100
Lr	103	metal	1900
Unq	104	metal	
Unp	105	metal	
Unh	106	metal	
Uns	107	metal	
Uno	108	metal	
Une	109		
Unn	110		

Element	Atomic Number	Classification	Melting Temperature (K)
H	1	nonmetal	13.81
He	2	nonmetal	0.95
Li	3	metal	453.7
Be	4	metal	1560
B	5	metalloid	2365
C	6	nonmetal	3825
N	7	nonmetal	63.15
O	8	nonmetal	54.8
F	9	nonmetal	53.55
Ne	10	nonmetal	24.55
Na	11	metal	371
Mg	12	metal	922
Al	13	metal	933.5
Si	14	metalloid	1683
P	15	nonmetal	317.3
S	16	nonmetal	392.2
Cl	17	nonmetal	172.17
Ar	18	nonmetal	83.95
K	19	metal	336.8
Ca	20	metal	1112
Sc	21	metal	1814
Ti	22	metal	1945
V	23	metal	2163
Cr	24	metal	2130
Mn	25	metal	1518
Fe	26	metal	1808
Co	27	metal	1768
Ni	28	metal	1726
Cu	29	metal	1356.6
Zn	30	metal	692.73
Ga	31	metal	302.92
Ge	32	metalloid	1211.5
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Lu	71	metal	1936
Hf	72	metal	2504
Ta	73	metal	3293
W	74	metal	3695

Re	75	metal	3455
Os	76	metal	3300
Ir	77	metal	2720
Pt	78	metal	2042.1
Au	79	metal	1337.58
Hg	80	metal	234.31
Tl	81	metal	577
Pb	82	metal	600.65
Bi	83	metal	544.59
Po	84	metalloid	527
At	85	nonmetal	575
Rn	86	nonmetal	202
Fr	87	metal	300
Ra	88	metal	973
Ac	89	metal	1324
Th	90	metal	2028
Pa	91	metal	1845
U	92	metal	1408
Np	93	metal	912
Pu	94	metal	913
Am	95	metal	1449
Cm	96	metal	1620
Bk	97	metal	
Cf	98	metal	1170
Es	99	metal	1130
Fm	100	metal	1800
Md	101	metal	1100
No	102	metal	1100
Lr	103	metal	1900
Unq	104	metal	
Unp	105	metal	
Unh	106	metal	
Uns	107	metal	
Uno	108	metal	
Une	109		
Unn	110		

Lesson Plan

Biology – Exploring Cells through Computational Thinking

Summary

1. Subject(s): Biology/Cell Biology
2. Grade/Level: This lesson is designed for middle or high school students with a basic understanding of biology. It can be adapted for different age groups and proficiency levels.
   Middle school – 6^{th}, 7^{th} grades
   High school – 9^{th}, 10^{th} grades
3. Objectives:
   - In this online lesson, students will learn about the basic structure and function of cells while applying computational thinking skills.
   - Computational thinking involves problem-solving techniques that can be applied to various fields, including biology.
   - By the end of this lesson, students should be able to understand the structure of cells and use computational thinking to analyse and interpret cell-related data.
4. Time Allotment: 60 - 90 minutes

Materials & Resources

• Computer

• Internet Access

• Projector

- Videos
- Handouts
- Pen and paper for note-taking

Implementation

Step 1. Introduction to Computational Thinking (10 minutes)

- Define computational thinking as problem-solving techniques used in computer science.
- Discuss the relevance of computational thinking in biology, specifically in cell biology.
- Emphasize the importance of a systematic approach to analyzing and identifying cell types.

Step 2. Basic Cell Structure (15 minutes)

- Provide an overview of fundamental cell components: cell membrane, nucleus, organelles, etc.
- Use visuals, diagrams, and microscope images to illustrate cell structures.
- Establish a foundation for understanding the complexity of cell biology.

Step 3. Applying Computational Thinking (20 minutes)

- Introduce a problem-solving scenario: "Imagine you're a biologist trying to identify the type of cell you're observing."
- Break down the scenario into computational thinking steps:
- a. Decomposition (5 minutes): - Explain decomposition as breaking down the cell identification problem into manageable parts. - Provide examples and discuss the key components to consider.

- b. Pattern Recognition (5 minutes): - Emphasize the importance of identifying recurring features and characteristics in different cell types. - Illustrate with microscope images and examples.

- c. Algorithm Design (5 minutes): - Introduce algorithm design as creating a step-by-step plan for identifying cell types based on observations. - Develop a sample algorithm for a specific cell type.

- d. Abstraction (5 minutes): - Explore abstraction as simplifying complex problems by focusing on critical information. - Discuss its role in refining observations for clearer cell identification.

- Discuss the importance of breaking down complex problems and creating clear algorithms for problem-solving.

Step 4. Interactive Activity (20 minutes)

- Share a dataset of various cell images and descriptions.

- In groups or individually, students should use computational thinking to analyse the dataset and identify the cell types.

- Encourage students to apply the computational thinking steps mentioned earlier.

- Discuss the solutions as a class, emphasizing different approaches and insights

- Engage students in an interactive activity where they apply computational thinking to identify various cell types.

- Provide microscope images, data sheets, and prompts for discussion.

- Encourage collaboration and discussion among students.

Step 5. Conclusion and Recap (10 minutes)

- Summarize key concepts: computational thinking, cell structure, decomposition, pattern recognition, algorithm design, and abstraction.

- Connect the lesson to the real-world application of computational thinking in cell biology.

- Preview the homework assignment and upcoming lessons.

- Ask students to reflect on how computational thinking helped them analyse cell data.

Step 6. Resources and Homework Assignment (5 minutes)

- Share links to educational websites and videos for further exploration.
- Assign a homework task where students must research a recent scientific discovery in cell biology and write a short essay discussing how computational thinking contributed to the discovery.

Step 7. Assessment (5 minutes)

- Evaluate students based on their participation in the interactive activity and the quality of their reflections in the conclusion.
- Share a quiz to check their understanding

Step 8. Q&A, Discussion and Closing (5 minutes)

- Allow time for questions and answers.
- Facilitate a brief discussion on the importance of computational thinking in advancing scientific knowledge.
- Express appreciation for students' engagement.
- Remind students of the next steps and the continued application of computational thinking in biology.

- HANDOUT 1: ROZKŁAD
- Tytuł: Dekompozycja informacji o komórce w celu identyfikacji
-
- I. Wprowadzenie:
- W tym ćwiczeniu będziesz ćwiczyć pierwszy krok myślenia obliczeniowego, rozkładając posiadane informacje o różnych próbkach komórek. Ten krok jest niezbędny do identyfikacji i zrozumienia typów komórek.
- II. Instrukcje:
- 1. Identyfikacja kluczowych informacji:
- Spójrz na dostarczone próbki komórek i zidentyfikuj kluczowe informacje o każdej komórce. Weź pod uwagę następujące aspekty:
- Kształt: Jaki jest kształt komórki?
- Rozmiar: Jak duża jest komórka?
- Organelle: Czy w komórce znajdują się widoczne organelle?
- Charakterystyka: Czy są jakieś unikalne cechy lub właściwości?
- 2. Obserwacje i zbieranie danych:
- Zbadaj dokładnie każdą próbkę komórki i dokonaj szczegółowych obserwacji. Zanotuj zidentyfikowane informacje w poniższej tabeli.
- 3. Kryteria klasyfikacji:
- Zapoznaj się z kryteriami klasyfikacji dla różnych typów komórek. Pomoże ci to zrozumieć zebrane obserwacje.
- Komórki zwierzęce:
- Kształt:
- Rozmiar:
- Organelle:
- Charakterystyka:
- Komórki roślinne:
- Kształt:
- Rozmiar:
- Organelle:
- Charakterystyka:
- 4. Arkusz zbierania danych:
-

- Skorzystaj z poniższej tabeli, aby zapisać swoje obserwacje dla każdej próbki komórek. Wypełnij informacje na podstawie tego, co widzisz.

Próbka komórek	Kształt	Rozmiar	Organelles	Charakterystyka
Komórka A				
Komórka B				
Komórka C				

I. Wnioski:

Zrozumienie kluczowych informacji o komórce jest kluczowe dla jej identyfikacji. Proces dekompozycji jest pierwszym krokiem w myśleniu obliczeniowym, które pomaga systematycznie podchodzić do złożonych problemów.

Zachęcamy do przedyskutowania swoich obserwacji i porównania wyników z innymi uczestnikami zajęć.

HANDOUT 2: PATTERN RECOGNITION

Title: Pattern Recognition in Cell Identification

I. Introduction:

Pattern recognition is a critical skill in cell biology that helps us identify and categorize different cell types. By recognizing recurring features and characteristics, we can distinguish one cell type from another. In this activity, we will practice pattern recognition by examining various cell samples.

II. Instructions:

1. Examine Cell Samples: Carefully study each cell sample provided. Pay close attention to the following aspects:

Shape: What is the overall shape of the cell?

Size: How big is the cell? Is it relatively small or large?

Organelles: Are there any specific organelles visible within the cell?

Characteristics: Are there any unique features or characteristics that stand out?

2. Identify Patterns: For each cell sample, write down any patterns or distinguishing features that you observe. These may include similarities or differences in shape, size, organelles, or characteristics.
3. Make Comparisons: Compare your observations across different cell samples. Look for recurring patterns or features that help you group cells into categories.

III. Conclusion:

Pattern recognition is a fundamental skill that biologists use to identify and classify cells. By recognizing common characteristics and features, we can understand the diversity of cell types and their functions.

HANDOUT 3: ALGORITHM

Title: Algorithm Design for Cell Identification

I. Introduction:

In this step of our lesson, we will apply computational thinking to design algorithms for identifying different cell types based on our observations. Algorithms are step-by-step plans that guide us through problem-solving. By creating clear algorithms, we can streamline the process of cell identification.

II. **Key Concepts**:

Decomposition: Breaking down the problem into manageable parts.

Pattern Recognition: Identifying recurring features and characteristics.

Algorithm Design: Creating a step-by-step plan for problem-solving.

Abstraction: Simplifying the problem by focusing on critical information.

III. Algorithm Design Steps:

1. Observe and Record Data:
- Carefully examine the cell sample.
- Record observations regarding the shape, size, organelles, and any unique characteristics.
2. Identify Key Features:
- Look for key features that distinguish the cell type from others.
- Consider shape, size, organelles, and any unique characteristics.
3. Compare with Reference Data:
- Refer to reference data or known characteristics of cell types.
- Identify any patterns or matches between your observations and the reference data.
4. Categorize Based on Patterns:
- Categorize the cell based on the patterns and features you've identified.
- Determine whether it closely matches the characteristics of a known cell type.
5. Verify Classification:
- Double-check your classification to ensure it aligns with the key features you've observed.
- Review your observations to confirm that the classification is accurate.
6. Record the Cell Type:
- Once you are confident in your classification, record the identified cell type.

IV. Example Algorithm:

Cell Identification Algorithm for Nerve Cells

1. Observe and Record Data:
   - ➢ Note the elongated shape, approximately 15 µm in size, presence of a nucleus, and mitochondria.
2. Identify Key Features:
   - ➢ Key features include elongated shape, 15 µm size, presence of a nucleus, and mitochondria.
3. Compare with Reference Data:
   - ➢ Cross-reference observations with known characteristics of nerve cells.
4. Categorize Based on Patterns:

- Categorize the cell as a nerve cell based on the identified patterns and features.

5. Verify Classification:

- Review the observations to confirm that the classification as a nerve cell is accurate.

6. Record the Cell Type:

- Document the identified cell type as a "nerve cell."

V. Conclusion:

Algorithm design is a crucial skill in cell biology. By following clear, systematic steps, you can enhance the accuracy and efficiency of cell identification. Apply this algorithmic approach in our interactive activity to categorize various cell samples.

HANDOUT 4: ABSTRACTION

Title: Identifying a Cell Type through Abstraction

I. Introduction:

In this step, we will explore the concept of abstraction to simplify the process of identifying a cell type. Abstraction involves focusing on the most critical information and removing unnecessary details. By distilling complex data, we can streamline the identification process.

II. Key Concepts:

- **Abstraction**: Simplifying complex problems by emphasizing critical information.
- **Algorithm Design**: Creating step-by-step plans for problem-solving.
- **Computational Thinking**: Applying problem-solving techniques used in computer science.

III. Abstraction Steps:

1. **Decompose:**
    - Begin by breaking down the information you have about the cell (shape, size, organelles, etc.).
    - Identify the key components that contribute to the cell's identity.
2. **Identify Critical Information:**
    - Focus on critical information that distinguishes the cell type from others.
    - Ask yourself: What features are absolutely essential for identifying this cell?
3. **Eliminate Unnecessary Details:**
    - Remove unnecessary details that do not contribute significantly to the cell's identification.
    - Keep the information that is most relevant and distinctive.
4. **Create an Abstraction:**
    - Develop a simplified representation of the cell based on critical information.
    - This abstraction should capture the essence of the cell type without unnecessary complexity.

IV. Example Abstraction:

Cell Type: Red Blood Cell

1. **Decompose:**
    - Shape: Biconcave disc
    - Size: 7-8 µm
    - Organelles: Lacks nucleus and most organelles
    - Characteristics: Red color due to hemoglobin

2. **Identify Critical Information:**
    - Biconcave disc shape
    - 7-8 µm in size
    - Lacks nucleus and most organelles
    - Red color (hemoglobin)
3. **Eliminate Unnecessary Details:**
    - Exclude details about specific organelles as red blood cells lack most of them.
    - Focus on the distinctive biconcave disc shape and the absence of a nucleus.
4. **Create an Abstraction:**
    - Red Blood Cell Abstraction:
        - Shape: Biconcave disc
        - Size: 7-8 µm
        - Characteristics: Lacks nucleus, red color (hemoglobin)

V. Conclusion:

Abstraction is a powerful tool in simplifying complex problems. By distilling the essential features of a cell type, we create a clearer representation, making the identification process more efficient. Apply the concept of abstraction in our upcoming interactive activity to refine your cell identification skills.

ANIMAL CELLS video

https://www.canva.com/design/DAFy_WPWOCk/aHXQHGYFWHmKIu4FuLAgoA/watch?utm_content=DAFy_WPWOCk&utm_campaign=share_your_design&utm_medium=link&utm_source=shareyourdesignpanel

PLANT CELLS video

https://www.canva.com/design/DAFy_UbTFS0/YMZ-2KWBoyyjUJxLk0QNrQ/watch?utm_content=DAFy_UbTFS0&utm_campaign=share_your_design&utm_medium=link&utm_source=shareyourdesignpanel

You can watch the embedded video in a new tab

REFERENCE INFORMATION - "Decompose" step

1. Decomposing Information for Cell Identification

Cell Type: Red Blood Cell (Erythrocyte)

Key Information:

Shape: Biconcave disc

Size: Approximately 7-8 micrometres in diameter

Organelles: Lacks a nucleus and most organelles

Characteristics: Red in colour due to haemoglobin

2. Classification Criteria Explanation
   2.1. Animal Cells:
- **Shape**: Round or irregular
- **Size**: Varies, but generally smaller than plant cells
- **Organelles**: Nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus
- **Characteristics**: Lack cell walls and chloroplasts

   2.2. Plant Cells:
- **Shape**: Rectangular or boxy
- **Size**: Varies, but generally larger than animal cells
- **Organelles**: Nucleus, cell wall, chloroplasts, central vacuole
- **Characteristics**: Contain cell walls and chloroplasts

3. Sample Data Collection Sheet

Cell Sample	Shape	Size (µm)	Organelles	Characteristics
Cell A	Round	12	Nucleus, mitochondria	
Cell B	Irregular	20	Nucleus, endoplasmic reticulum	
Cell C	Square	30	Nucleus, cell wall, chloroplasts	
Cell D	Elongated	15	Nucleus, mitochondria	
Cell E	Biconcave disc	7-8	Lacks nucleus and most organelles	Red colour (haemoglobin)
Cell F	Spherical	10	Nucleus, lysosomes	

Quiz: Exploring Cells through Computational Thinking

Question 1: What is computational thinking, and why is it relevant in biology?

a. A type of computer programming language used in cell biology.

b. Problem-solving techniques used in computer science, relevant in biology for analyzing and identifying cell types.

c. A method for creating computer simulations of biological processes.

Question 2: What are the fundamental components of cells discussed in the lesson?

a. Nucleus, cytoplasm, and mitochondria.

b. Cell membrane, nucleus, and organelles.

c. DNA, ribosomes, and endoplasmic reticulum.

Question 3: In the context of cell identification, what does "decomposition" refer to?

a. Breaking down organic matter in cells.

b. Breaking down the cell identification problem into manageable parts.

c. Decomposing cells to study their structure.

Question 4: Why is pattern recognition important in identifying cell types?

a. It makes the cells look more visually appealing.

b. It helps identify recurring features and characteristics in different cell types.

c. It simplifies the process of cell staining.

Question 5: What is the purpose of an algorithm in the context of cell identification?

a. To confuse the observer with complex steps.

b. To create a step-by-step plan for identifying cell types based on observations.

c. To describe the structure of a cell.

Question 6: How does abstraction contribute to simplifying the cell identification process?

a. By adding more details to the observations.

b. By focusing on the most critical information and removing unnecessary details.

c. By making the observations more complex.

Question 7: What was the focus of the interactive activity in the lesson?

a. Studying chemical reactions in cells.

b. Applying computational thinking to identify cell types.

c. Observing the behavior of cells under a microscope.

Question 8: What is the homework assignment related to in the lesson?

a. Conducting experiments with cells.

b. Researching a recent scientific discovery in cell biology.

c. Memorizing the names of different cell types.

Question 9: In the example algorithm provided in the lesson, what is the last step?

a. Verify Classification.

b. Record the Cell Type.

c. Compare with Reference Data.

Question 10: Why is computational thinking considered a valuable skill in biology?

a. It is only useful in computer science, not biology.

b. It helps streamline problem-solving processes and contributes to scientific advancements.

c. It is required for writing computer programs related to biology.

Answers:

1. b
2. b
3. b
4. b
5. b
6. b
7. b
8. b

9. b
10. b

Feel free to adjust the questions or answers based on the specific emphasis and details covered in your lesson.

Lesson Plan

Summary

1. Subject(s):
   Writing short stories using computational thinking
2. Grade/Level:
3. Objective:

1. To understand the basics of computational thinking:
- To explain the basic concepts of computer thinking.
- Discuss how computers analyse and solve problems.

2. Applying computational thinking to story making:
Demonstrate how computer thinking can be used to develop story ideas and structure.

3. Writing short stories:
- Practical exercises focused on creating short stories.
- Using the tools of computational thinking to generate ideas and analyse the plot.

4. Collaboration and presentation:
- Group work on online stories.
- Brief presentation of each story and discussion of how computational thinking was applied.

5. Time Allotment: 100 min.

Materials & Resources

- Access to the online lesson delivery platform.
- Multimedia presentation on computational thinking.
- Examples of stories using the process of computational thinking.
- Online tools for generating ideas (e.g. keyword generators).

Implementation

1. Introduction (10 minutes)

Greeting students and checking access to online tools.
Brief presentation of lesson topic and objectives.

2. Basics of computational thinking (15 minutes)

Explanation of basic concepts related to computer thinking.
Examples of problems that can be solved using computer thinking.

3. Application of computer thinking in story writing (20 minutes)

Discussion of how computer thinking can be a tool for generating ideas, character analysis and plot development.
Examples of stories that use elements of computational thinking.

4. Practical exercises (30 minutes)

Brief presentation of online tools for generating ideas.

Individual student work on short stories using computer thinking.

5. Collaboration and presentation (20 minutes)

Students share their stories in online groups.

Brief presentation of each story, highlighting elements of computational thinking.

6. Summary and homework (5 minutes):

Brief restatement of main concepts.

Extension

Homework: write a short essay on how computational thinking can be used to develop creativity in writing.

Assessment

- Activity of students during practical exercises.
- Quality and originality of the stories created.
- Ability to apply computational thinking to the story creation process.

The lesson should be interactive and create space for students' creativity while introducing them to the world of computer thinking.

Lesson Plan

Summary

1. Subject(s):
   Problem Solving in the World of Copyright
2. Grade/Level:
   Secondary School (grades 6-8)
3. Objective:
   To understand the importance of copyright in the digital world.
   To develop skills to deal with online copyright infringement.
   To think creatively and propose ethical solutions.
4. Time Allotment: 60 minutes

Materials & Resources

Access to a videoconferencing platform (e.g. Zoom, Google Meet)

Presentation on copyright and related issues (in digital form)

Examples of copyright infringement situations on the internet.

Implementation

1. Introduction (10 minutes)

Start the online lesson by welcoming students and explaining that today's lesson will be about dealing with copyright issues in the digital world. Introduce the objectives of the lesson.

2. Introduction to Copyright (15 minutes)

Give a short presentation on copyright, explaining what it is, what rights creators have and why it is important in the digital world.

3. Problem Analysis (30 minutes)

Divide students into virtual groups within the video conferencing platform.
Provide each group with a scenario of online copyright infringement, such as using an unauthorised image in a presentation or illegally downloading music.
Ask the groups to analyse their case and answer the questions:

What is the type of copyright infringement in this situation?
Who are the potential participants (victim and perpetrator) in this situation?
What could be the consequences of copyright infringement in this situation?
What steps can be taken to address the problem?

Each group presents their reflections to the rest of the class.

4. Creative Solutions (15 minutes)

Together with the students, discuss different strategies and creative solutions that can be used to address online copyright infringement.

Encourage students to share their ideas for solutions and work together to come up with the best solution for each scenario.

5. Summary and Homework (10 minutes)

Summarise the main points of the lesson, emphasising the importance of both copyright and creativity in solving problems in the digital world.

Extension

Give homework in which students have to find a real-life example of copyright infringement online and come up with their ideas for solving the problem.

Assessment

Assessment of students can be made on the basis of their participation in the analysis of the copyright infringement example, group activity and their ability to suggest creative solutions to problems.

Homework can be assessed on the quality of the analysis of the copyright infringement example and the suggested solutions.

Lesson Plan

Summary

1. Subject(s): Inclusive education: Inspiring similarities - basic needs.
2. Grade / Level:
3. Objective:

This lesson aims at understanding and accepting diversity among students by discovering similarities in their basic needs.

Lesson objective:

- To understand and appreciate diversity in a group.
- To make students realise that despite their differences, they have similar basic needs.
- To create an atmosphere of respect and acceptance among pupils.

4. Time Allotment: 60 min.

Materials & Resources

- Computers or devices with internet access.
- Video conferencing platform, e.g. Zoom or Google Meet.
- Cards with written basic needs.

Implementation

1. Introduction (5 minutes)

The teacher welcoming students and briefly introducing the topic of the lesson. Brief presentation on inclusive education and its importance.

2. Icebreaker – "Find a likeness" game (15 minutes)

Each pupil is given one card before the lesson with a basic need written on it (e.g. safety, acceptance, understanding).
Students have to find other students who have a card with the same basic needs.
Once partners are found, each pair presents their similarity.

3. Presentation (10 minutes)

The teacher presents a short film, story or poem that highlights the diversity in human needs and at the same time shows that despite our differences, we are all looking for the same basic things.

4. Discussion (15 minutes)

Open discussion about differences and similarities in needs between students.
The teacher can ask questions such as: "What basic needs do we all have regardless of our differences?"

5. Creative tasks (10 minutes)

Students are given the task of creating a short project (e.g. poster, presentation) illustrating how diversity in a group can be a strength and how the basic needs of different people can be met.

6. Presentations and reflections (5 minutes)

Each group presents their project.

Brief reflection on what the students have learnt and what lessons they have learnt.

7. Summary and homework (5 minutes)

The teacher summarises the main points of the lesson.

Assign a homework task, e.g. writing a short essay on how diversity can be an added value in inclusive education.

Extension

The teacher thanks the students for their participation and encourages further reflection on the lesson topic.

He invites students to ask questions or share their experiences before ending the lesson.

Assessment

Lesson Plan

Summary

1. Subject(s):

   Coders of the Virtual World

2. Grade/Level:

3. Objective:

1. To introduce students to the world of computational thinking through gamification.
2. To develop algorithmic thinking skills.
3. To use game elements to increase student engagement and motivation.

4. Time Allotment: 90 min.

Materials & Resources

- Computers with internet access.
- Video conferencing platform.
- Website or gamification platform (e.g. CodeCombat, Codingame).
- Task cards related to computer thinking.

Implementation

1. Introduction (10 minutes)

- Greeting the students and a short talk about the games they are interested in.
- Introduction to computational thinking and its importance in today's world.

2. Gamification: "Virtual World of Coding" (20 minutes)

- Introduce students to a website or gamification platform related to learning programming (e.g. CodeCombat).

- Create accounts on the platform for each student.

- Task: Students progress through several levels, solving simple programming tasks to earn points and promotions.

3. Analysis of results and discussion (15 minutes)

- Summary of pupils' experience with the game.
- Discussion of the difficulties they encountered and the skills they acquired while solving the tasks.
- Presentation of the concept of algorithmic thinking and how it relates to real-life situations.

4. Practical task: "Coder's project" (25 minutes)

- Prepare a set of cards with tasks related to computational thinking (e.g. laying out an algorithm to prepare a sandwich).

- Each student chooses one task and tries to complete it, presenting their solution on camera.

5. Joint feedback and revision (15 minutes)

- Students exchange ideas and feedback on solved tasks.
- Joint discussion on different approaches to the same problems.

6. Summary and homework (5 minutes):

- Short presentation summarising the main points of the lesson.
- Homework: Students are given a new task to solve on the gamification platform.

Extension

- This scenario aims to combine online games, computational thinking and gamification to create an interactive lesson that engages students and develops their programming skills.
- Encourage collaboration between students to exchange ideas and solutions.
- Make sure that students have access to the necessary tools and the gamification platform.
- Remember to vary the difficulty level of the tasks to accommodate the different abilities of the students

Assessment

Euclidian algorithm

(GCD – Greater Common Divisor)

Summary

1. Subject(s):

   This lesson is about the teaching of Euclidian Algorithm that finds the greatest common divisor (GCD) of two numbers. This algorithm was devised by Euclid in the mid-4th century BC, and it is referred to as the world's oldest algorithm.

2. Grade/Level:

   This lesson is dedicated for Junior Secondary School students (K11-K13). Students at Junior Secondary School have already taught, during the primary school period, a simple way to find the GCD. They know how to find the GCD of a series of small numbers (i.e., 6,8,12). But in case of big numbers (i.e., 3780 and 2940) students must apply another more complicated way. Thus, we propose the Euclidian Algorithm.

3. Objective:

   This online lesson aims to demonstrate a more general way of the greatest common divisor (GCD) calculation. Even though, students in primary school were taught an easy way to calculate GCD, at the level of secondary school, it is more useful to demonstrate what is the meaning of GCD and what is its practical usage in sciences and everyday life. Thus, in this lesson we demonstrate the advanced way of GCD calculation which is described by the Euclidian Algorithm. The proposed activities aim to prioritize the meaning of the GCD in students' everyday lives and studies.

4. Time Allotment: 150'

Implementation

1. Introduction (15 min)

   Teacher makes a short introduction giving the GDC definition, usage and importance. The teacher gives some examples of the everyday life and discuss with students the meaning of the GCD. The below examples are used only for discussion and not for the solving. These examples will be solved by students at the end of the lesson (activities).

   Examples:

   1.1. A florist has 32 roses, 56 daisies and 72 chrysanthemum. He wants to make one-of-a-kind bouquets that have of the three kinds of flowers. How many bouquets at most will she make? How many flowers of each type will each bouquet have?
   1.2. If we have 64 women, 52 men and 120 children, how many at most uniform groups we can divide them and how many will each have wives, husbands, children?
   1.3. A bookseller has 300 blue, 240 red, and 180 black pens on hand. He wants to put all these pens in caskets. How many identical boxes can he make at most, and how many blue, red, and black pens should he place in each?

2. Greater Common Divisor (GCD) calculation (30 min)

   The teacher makes a review to the simplest way of GCD calculation reminding them what they have already taught at primary school. This way is based on the estimation of divisors of all numbers. Thus, the teacher demonstrates the 1.1 example's solution with the florist. Rest examples could be proposed for homework.

   Solution:

   Since we have to share all flowers to equal parts, we must find the GCD. We start by specifying each flower's number divisors.

   D_{32}=1,2,4,8,16,32.

   D_{56}=1,2,4,7,8,14,28,56.

   D_{72}=1,2,3,4,6,8,9,12,18,24,36,72

   GCD (32,56,72) =8. So, it will make a maximum of 8 identical bouquets.

   To find how many flowers of each type a bouquet will have, we share the flowers with GCD (8).
   32:8=4 roses

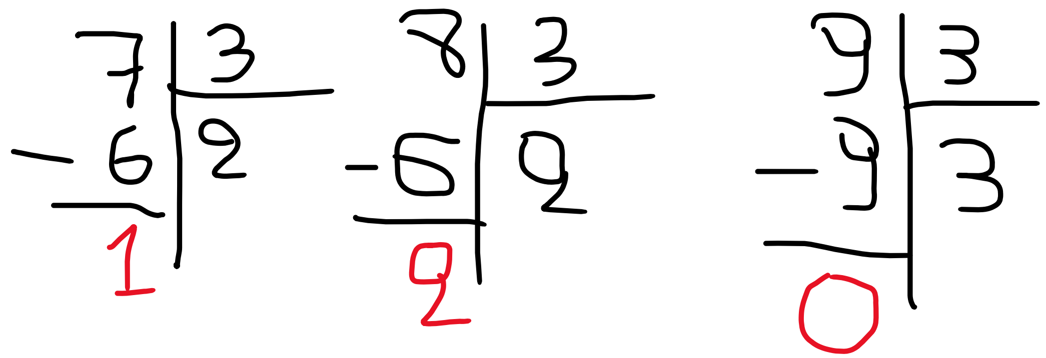
56:8=7 daisies
72:8=9 chrysanthemum

Thus, each bouquet will be composed of 4 roses + 7 daises + 9 chrysanthemum. Till now, students are getting a more solid aspect of the importance of GCD.

For more info, the teacher presents to students the next video showing the way of finding a number's divisors

3. The "mod" operation (25 min)

   The teacher needs to teach students about the ***mod*** operation. The ***mod*** operator gives the reminder of two numbers division. This is necessary for the Euclidian algorithm. Thus, the teacher explains the way the remainder of a division results. A simple example is seen below where with red color is the reminder of the divisions (aka the ***mod*** operator result):



6 mod 3 = 0

7 mod 3 = 1

8 mod 3 = 2

9 mod 3 = 0

….

4. The Euclidian Algorithm in action (30 min)

   The teacher presents to students the Euclidian Algorithm step-by-step. The teacher demonstrates the largest common divisor of 1272 and 795.

First, the teacher finds the reminder (using ***mod*** operator he/she demonstrated before) of the larger number divided by the smaller number. He/she will carry out a mod operation with the larger and the smaller number. The result of the mod operation is 477 (the remainder). Then, he/she carry out a mod operation with the previous divisor, 795 and the previous remainder, 477. The result is 318. He/she repeats the same operation, carrying out a mod operation with 477 and 318 and find 159. He/she carry out a mod operation with 318 and 159 and gets 0. In other words, 318 is divisible by 159. When the remainder is 0, the divisor of the last operation, 159, is found to be the greatest common divisor (GCD) of 1272 and 795.

5. Euclidian Algorithm with diagram (20 min)

   This lesson part is dedicated for the visualization of the previous topic. Namely, the teacher demonstrates the logic of Euclidian Algorithm by showing the previous example in the form of bricks. That is, the step-by-step Euclidian algorithm is depicted by a series of diagrams in which each step removes the part of bricks that exceeds the smaller number until reaches the zero (0).

6. Practice (20 min)

   Students are working on Euclidian Algorithm for the below numbers:

   1112 and 695 (solution: 139)

   3780 and 2940 (solution: 420)

Materials & Resources

https://thirdspacelearning.com/blog/what-is-the-highest-common-factor-explained/

https://www.splashlearn.com/math-vocabulary/greatest-common-divisor-gcd

https://www.youtube.com/watch?v=CWmTWxEjZ5A

Extension

After the online lesson, the teacher could talk with students about other important GCD applications. One common application of GCD is in simplifying fractions. Knowing the GCD of the numerator and denominator allows us to reduce a fraction to its simplest form. GCD is also used in cryptography, particularly in the RSA algorithm, which is used for secure data transmission.

Assessment

1. What is the GCD of next numbers?
    a. 24,32,40
    b. 24,36,96
2. Fill in the correct factor.
    a. **24:** 2 x __ x 2 x 3
    b. **36:** 2 x 2 x __ x 3
    c. **96:** 2 x 2 x __ x 2 x 2 x 2
    d. **1026:** 2 x 3 x 3 x __
    e. **45:** 5 x 3 x __
    f. **____ :** 2 x 2 x 2 x 3 x 11
3. mod operator
    a. 3 mod 2 = __
    b. 5 mod __ = 1
    c. 17 mod __ = 5
    d. 2 mod 5 = __
    e. 9 mod 13 = __
4. 1292 mod 795 = 477. Is it correct? ________
5. A rectangular floor measures 300 cm×195 cm. What is the largest square tiles that can be used to cover the floor exactly?
6. Solve problems 1.2 and 1.3 in terms of the given solution of 1.1

Arithmetic Sequences

Summary

1. Subject(s):

   This lesson makes an essential approach on the critical topic of Arithmetic Sequences. Makes a short introduction on the practical usage of an arithmetic sequence and then demonstrates an arithmetic sequence formula creation.

2. Grade/Level:

   This lesson is dedicated for Junior Secondary School students (K11-K13). This lesson is a continuation of what students have been taught at primary school with the creation of motif.

3. Objective:

   This lesson aids students in deeply understanding the meaning and the utilization of an arithmetic usage. Initially, the teachers give a practical example and goes to the generalization of the sequence formulating a general arithmetic sequence formula. Based on this formula, students can utilize the knowledge to calculation the progress or evolution of many phenomena.

4. Time Allotment: 100’

Implementation

1. Introduction (20’)

   Teacher makes an introduction on the topic of arithmetic sequences. Initially, gives the definition and a simple example with the number of Lego bricks gathered at a Robotic

Competition. Subsequently, makes a step-by-step approach specifies the terms of an arithmetic sequence.

2. Analyzing a sequence (25′)

   Teacher present to students more sequences and describes each sequence term such as the *first term*, the *common difference*, etc. Subsequently, discuss with students more everyday life cases of sequences such as the Fibonacci Sequence (see below at section 4). Students develop their own perception and suggest or devise more sequences.

   The teacher demonstrates the below arithmetic sequences:

   2,4,6,8,10 …

   1,4,7,10,13….

   5,10,15,20….

3. Making the arithmetic formula (25′)

   Teacher emphasizes the common elements of each previous demonstrated sequence and formulates a general arithmetic formula. This way goes from *the specific to general (**Generalization**)*. Teacher emphasizes that the formula is another expression of the sequence of numbers. The formula is the abstract way of expression of a phenomenon and simultaneously is the generalization of a notion. Even though, the priority of the lesson is the formulation of an arithmetic sequence, the teacher takes the chance and introduce to student's notions such as *abstraction* and *generalization*.

   The formula for finding the $\mathbf{n_{th}}$ term of an arithmetic sequence with ***a*** as the first term and ***d*** as the common difference is:

$$n_{th} = a + d*(n - 1)$$

4. Case study: Fibonacci sequence (20′)

   Now it is the time to deal with a more difficult and demanded example. The teacher introduces the Fibonacci sequence and demonstrates an example of rabbits' growth. This is the classic rabbit problem Fibonacci used to generate the sequence: 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144… The teacher ask students to work together in pairs and estimate the number of pairs they would have at the end of a period.

5. Practice (10′)

- For the below arithmetic sequences, find the missing terms.
    i. 2, 6, ___, 14, 18, …
    ii. 8, 7, 6, ___, …
    iii. ___, 7, 9, 11, …

- What is the common difference (pattern) on the above sequences?
    i. ____
    ii. ____
    iii. ____

Materials & Resources

https://study.com/academy/lesson/arithmetic-sequences-definition-finding-the-common-difference.html

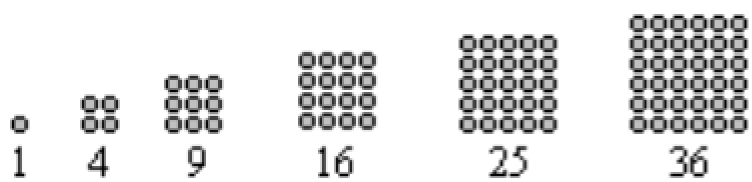
https://www.mathsisfun.com/numbers/fibonacci-sequence.html

http://edu-computational-thinking.eu

Extensions

After the successful completion of this lesson and considering that students have everything clear as far as he arithmetic sequences concerned, the teacher can proceed with **Square Numbers Series**: it is quite self-explanatory: 1,4,9,16,25,36,49…

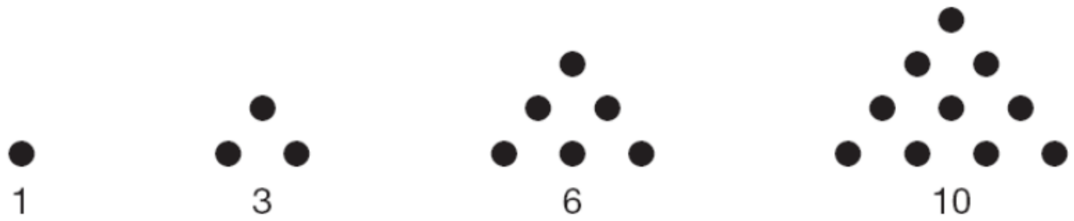
Pictorially, the square numbers can be represented as below:



Also, students are encouraged to work with the **Triangular number Series:** A triangular number or triangle number counts the objects that can form an equilateral triangle. The n_{th}

triangle number is the number of dots or balls in a triangle with n dots on a side; it is the sum of the n natural numbers from 1 to n.

Pictorially, the triangular numbers can be represented as below:



Assessment

The teacher prompts students to follow the Quizzes section.

At the end students submit their work.

Arithmetic Sequences

Handout 2.1

1) For the below arithmetic sequences, find the missing terms.
   a) 2, 6, __, 14, 18, …
   b) 8, 7, 6, __, …
   c) __, 7, 9, 11, …

Solution: a) 8, b) 5 c) 5

2) What is the common difference (pattern) on the above sequences?
   a) ___
   b) ___
   c) ___

Solution: a) 2+ b) 1- c) 2+

3) Match the below sequences with its Pattern

Sequence	Pattern
4, 11, 18, 25, …	Multiply the previous term by three
40, 20, 10, 5, …	Divide the previous term by two
100, 96, 92, 88, …	Add seven to the previous term
4, 12, 36, 108, …	Subtract four from the previous term

Solution:

Sequence	Pattern
4, 11, 18, 25, …	Multiply the previous term by three
40, 20, 10, 5, …	Divide the previous term by two
100, 96, 92, 88, …	Add seven to the previous term
4, 12, 36, 108, …	Subtract four from the previous term

4) Which of the below are not an arithmetic sequence?

   a) 4, 8, 12, 16, 20, 23, 28, 32, 36, 40, …
   b) 5, 10, 15, 20, 25, 30, 35, …
   c) 9, 4, 0, -5, -10, -15, …

Solution: a) NO (23) b) YES c) NO (0)

Trapezoid’s world

(How to find the formula to calculate the trapezoid’s area)

Summary

1. Subject(s):

   This lesson demonstrates some of the most important characteristics of trapezoids and concludes with a way of finding the general formula for calculating the area of any trapezoid.

2. Grade/Level:

   This lesson is dedicated for Junior Secondary School students (K11-K13). This lesson is a continuation of what students have been taught at primary school as far as the calculation of rectangular, triangle and circle area calculation.

3. Objective:

   This online lesson aims to teach the way to find the generic formula for calculating any trapezoid’s area. The didactic approach is specified to the *decomposition* of the initial problem into individuals smaller. Thus, by following the way of calculating the area of each separate shape, we conclude with the final generic formula (*Generalization*) which is used to calculate the area of any kind of trapezoid.

4. Time Allotment: 70’

Implementation

1. Introduction (5’)

   The teacher makes a short introduction on what this lesson is about specifying the contents of the lesson.

2. What is a trapezoid (Characteristics and kind of trapezoids)? (20')

   In this section, the teacher demonstrates some of the most fundamental attitudes of trapezoids. Talks about the *bases, legs* and the *height* properties.

   Subsequently, the teacher presents some different types of trapezoids and emphasizes into the differences among them.

3. What is the height of a trapezoid? (25')

   In the next section, the teacher demonstrates one the most important property of a trapezoid: ***the height***. Students must know how to calculate the height because they will need it for the final area calculation formula. If students need more help on how to calculate the right triangle height, the teacher can tell them about the *Pythagorean Theorem*. For convenient, the teacher shows this short video tutorial: https://www.youtube.com/watch?v=uthjpYKD7Ng

4. How to calculate the area of a trapezoid? (30')

   This is the main section of the lesson. The teacher divides the initial problem (trapezoid's area calculation) into smaller separate (*decomposition*). Thus, he/she extract 3 shapes out of the initial one: two right triangles and one perpendicular rectangle. In order to calculate these areas, teacher adds the corresponding formulas (formulas for triangle and rectangular area calculation) and makes the mathematics.

   At the end, the teacher reaches to the final generic formula (generalization) which is seen below:

$$E = \frac{h}{2}(a + b)$$

5. A case study (10')

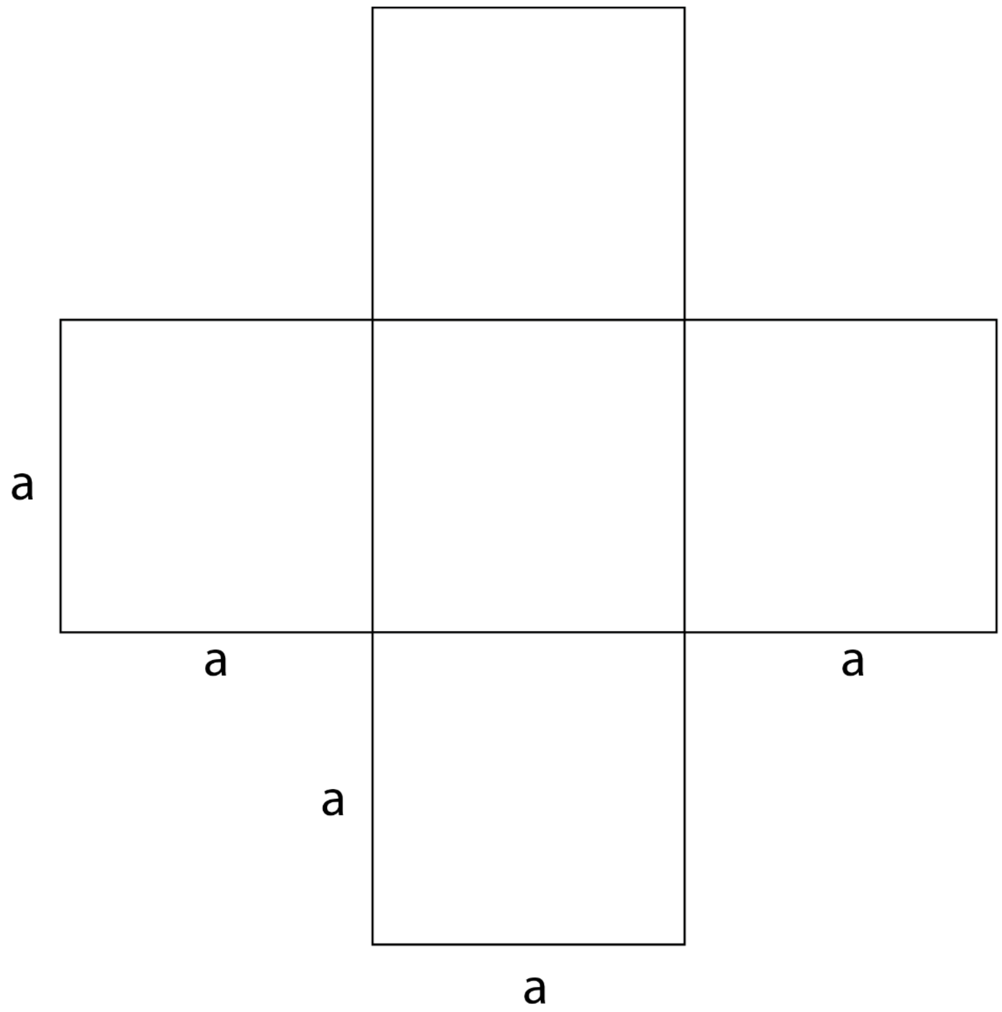
   The lessons conclude with a real example of using the previous estimated formula to calculate the area of a trapezoid with bases 12cm and 18cm and height 11cm. The area is 115 cm2.

Materials & Resources

- https://www.omnicalculator.com/math/trapezoid
- https://www.britannica.com/biography/Euclid-Greek-mathematician
- https://www.youtube.com/watch?v=uthjpYKD7Ng
- http://edu-computational-thinking.eu

Extensions

Students could try to find a generic formula of finding the area of the below similar shapes. This develops these two Computational Thinking concepts: generalization and abstraction. No matter what the asked shape is, students will be able to find the generic formula.



Solution: **E**$= \boldsymbol{5a^2}$

Assessment

At the end of the lesson, the teacher has to assess students knowledges.

3.2 What is a trapezoid?

Questions

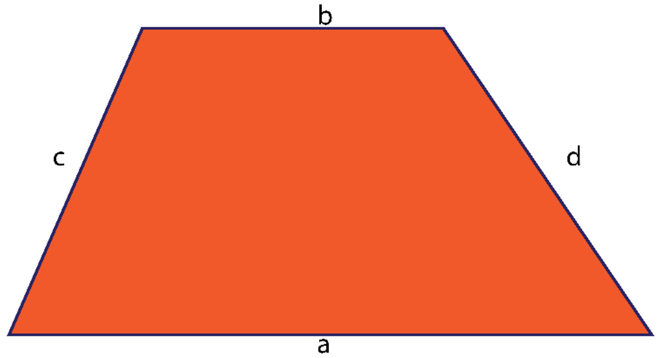
1. **Is a trapezoid a parallelogram?**

2. **Is a parallelogram a trapezoid?**

3. **Does every trapezoid have 2 pairs of opposite parallel sides?**

4. **Draw an isosceles trapezoid**

5. **Which of the below edges are called "legs"?**



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Computational Thinking for education on-line

ARTS: Learning Islamic Art with Geometry

Summary

1. Subject(s): Arts and Geometry, learning with Islamic art.

This activity aims to teach students about Islamic art and how it is created by following a pattern repetition of multiple geometric figures. Students will learn how geometric figures are used to create patterns and will create their own artwork. This not only deepens their understanding of the subject matter but also enables the transferability of the acquired skills to real-world scenarios and diverse professional settings.

2. Grade/Level:
   7-9 (12-15years old)

3. Objectives:

This online lesson aims to find an equilibrium between creativity and algorithmic design, challenging students to express themselves with geometric constraints. Unlike traditional approaches, computational thinking encourages students to break down complex designs into algorithmic steps, systematically recognize patterns, and visualize abstract artistic concepts into computational models. Indeed, this holistic approach provides students with a problem-solving mindset and skills, applicable beyond artistic expression in fields such as architecture, design, or technology where geometry and art play a crucial role.

During this lesson, students will learn to:

- Recognise patterns in the development of figures.
- Decompose the task into simpler sub-tasks to facilitate its resolution by using repetition figures.

- Develop their creativity through art.
- Discover the points of convergence between different subjects, in this case between mathematics, geometry, and art (with mandalas).

4. Time Allotment: 45 minutes

5. Lesson Summary:
   - Introduction: getting into Islamic Art and its connection to Geometry (10 minutes).
   - Explain phase: analysing Islamic Art (10 minutes).
   - Elaborate phase: creating a Basic Fourfold Pattern (20 minutes).
   - Assessment (5 minutes).

Materials & Resources

- Computer and Internet access

- PPT resource to conduct the lesson, "Geometric patterns in Islamic Art".
- Video for introduction by Broug, E. (2015). "The complex geometry of Islamic design". Retrieved from YouTube: The complex geometry of Islamic design - Eric Broug
- For the creation of the Hands-On Activity, you will be using Desmos Geometry. This online tool is a dynamic, interactive workspace that allows for explorations in measurement, construction, transformations, and more. Start with the video to the right, then get in shape with the tips below!
  - You can access using the following link: https://www.desmos.com/geometry?lang=es
  - Here you have a brief video tutorial on how to use this workspace: Desmos. (2017). "Desmos Geometry Tool: Overview". Retrieved from YouTube: https://www.youtube.com/watch?v=SgyWkglbHps&t=1s

- Worksheet 1
- Assessment Rubric for the Hands-on Activity: "*Assessment rubric*"
- https://padlet.com/europamediacreativa/geometric-patterns-in-islamic-art

Implementation

This lesson makes an essential approach to geometry as the branch of mathematics that deals with shapes, sizes, properties, and the spatial relationships of objects, through the basic rules of the ancient tradition of Islamic geometric design.

It makes a short introduction to the basic geometrical shapes and forms as well as the practical usage of these and symmetry in geometry. Then, it demonstrates the practical usage of geometrical forms in Islamic art. The teacher will use the attached PowerPoint as a basis and support for the lesson and also a Padlet to encourage joint work and to be able to visualize the activities that will be carried out in the course of the lesson. The following Padlet can be used as an example: https://padlet.com/europamediacreativa/geometric-patterns-in-islamic-art.

Step 1: Introduction (10 minutes)

The teacher will briefly explain Islamic art and its connection to geometry, he/she will share the screen projecting the PowerPoint to make it easier for students to follow the explanation. To activate student participation and as a motivational element towards the subject matter, the teacher will ask students if they've noticed intricate geometric patterns in mosques, buildings, or artwork, and discuss their observations. Then, the teacher will show the following video to introduce the complex geometry of Islamic design:

- Broug, E. (2015). “The complex geometry of Islamic design”. Retrieved from YouTube: The complex geometry of Islamic design - Eric Broug (duration of 5 minutes).

Step 2: Implementation (30 minutes)

2.1 Explain phase (10 minutes)

Analysing Islamic Art: Fourfold Patterns (10 minutes)

Based on the video above, the teacher defines tessellations as repeated patterns that completely cover a surface without any gaps or overlaps. Explains how tessellations can incorporate different geometric shapes, with the help of the PPT attached as supplementary material.

- The teacher asks students if they can see which is the geometric shape that is repeated in slides 6, 7, and 8 of the PPT. To encourage pupil activation teacher will use the Padlet, which can be freely edited and accessed.
- There you will find three multiple-choice questions related to slides 6, 7, and 8 of the PPT. Students will answer them as part of the assessment of the lesson.

Then, the teacher presents to students the concept of fourfold patterns already shown in the video, also known as quadrilateral patterns, as a common motif in Islamic geometric design. The teacher explains how these patterns are created by dividing a square or circle into four equal parts and then connecting points to form intricate designs.

2.2 Elaborate phase (20 minutes)

1. Application and Hands-On Activity: Creating a Basic Fourfold Pattern (15 minutes)

The teacher provides step-by-step instructions for creating a basic fourfold pattern. The teacher shares the screen and draws the following shapes: (5 minutes)

a. Start with a square.

b. Draw diagonals to divide the square into four triangles.

c. Add circles at the vertices of the square, intersecting the diagonals.

d. Connect the points where the circles intersect the diagonals to form the pattern.

Once students know the procedure to be followed, is their turn to create their fourfold pattern. The teacher gives specific instructions to create a pattern and use the repetition of it to create a tessellation. Students will have 10 minutes to do the activity.

2. Group Activity (5 minutes)

After 10 minutes, students upload their results to the common Padlet and the teacher selects one randomly and invites students to identify the geometric figures used as well as the patterns used for the creation done by one of their colleagues.

The whole group works on the mandala, identifying the sequence in which the pattern is made and the possible errors detected, revising the work done by each of them based on the comments made on the colleague's exercise.

The teacher will share with students Worksheet 1 to be completed by them for the next day answering questions about how they have done the work, which pattern have they chosen, and how can be used in a sequential order to create a tessellation. The teacher will assess through this worksheet student´s understanding of the topic and their ability to create a basic quadruple pattern.

Step 3: Conclusion and Assessment (5 minutes)

The teacher will summarize the key points to be covered in the lesson: Islamic art, its relationship with Geometry, the significance of fourfold patterns, and their creation process. Some questions for reflection might be:

- What are the characteristics of a tessellation?
- What geometric figures could we use to create them?
- How do we achieve the repetition of the figure multiple times?
- In what ways can we simplify the creation of Islamic geometrical art?

In the evaluation, the teacher evaluates learned concepts and acquired skills. This could be done by a questionnaire developed by the teacher or using a gamified platform. The dimensions to be assessed are:

- Knowledge acquired.
- Application of acquired knowledge.
- Skills and abilities
- Motivation towards learning
- General involvement in the training action

In addition, the teacher uses the multiple-choice questions answered in the Padlet and the Hands-on Activity to evaluate the knowledge, competencies, and skills acquired during the lesson. To evaluate the Hands-on-Activity the teacher is provided with a rubric "Assessment rubric Hands-On Activity" to evaluate the competencies acquired by the student and how the work has been carried out.

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RUBRIC FOR ASSESSING THE HANDS-ON ACTIVITY: CREATING A BASIC FOURFOLD PATTERN

APECTS	4. EXCELLENT	3. GOOD	2. NEED IMPROVEMENT	1. LOW PERFORMANCE
Creation process	The student has been able to follow the steps and create a basic pattern and add his own personal touch.	The student has been able to follow the steps and create a basic pattern and but not to add his own personal touch.	The student has not been able to follow all the steps and successfully create a basic pattern.	The student has not been able to create a basic fourfold pattern.
Creativity and originality	The idea and approach of the final outcome is singular and unique.	The idea and approach of the final outcome is singular but not unique.	The idea and approach of the final outcome is similar to other existing ones.	The idea and approach of the final outcome is a copy of others.
Explanation	Student can explain the followed procedure and the result using the concepts explained during the lesson.	Student can explain the followed procedure but has some difficulties when using specific concepts.	Student can barely explain the followed procedure and has difficulties when using specific concepts.	Student can´t explain the procedure and doesn´t understand the concepts learned during the lesson.

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Name:	Date:

Learning with Islamic Geometry

Worksheet 1

Answer the following questions once you have finished the Hands-On Activity.

1. Which of the three different patterns have you created, the Khatam, the octogram or the petal rosette? And why?

2. Which steps have you followed to get your results? Please list them.

3. How could you create a tesselation with the pattern that you have created?

MUSIC: Rhythmic sequences

Summary

1. Subject(s):

   In this lesson, students will explore the rhythmic sequences, and how they are structured and created by discovering the fractional elements that make up the music. They will learn how fractions are applied in musical notation to represent different rhythms and durations of notes in a piece of music.

2. Grade/Level:

   4th to 6th grade (11 to 14 years old)

3. Objectives:

   In this lesson, students will learn what the rhythm of music is and how it is created by using fractions. They will learn to:

   - Identify and analyze fractions as parts of a whole.
   - Recognize and identify elements of music (rhythm, tempo, melody, harmony, form, timbre, dynamics) using musical terminology.
   - Understand the notation of the notes, different note figures, their fractional representations, and their connection to the time signature and subdivisions of the measure.
   - Use musical language to create their musical sequences.
   - Create a rhythmic sequence using the fractional representations of notes.
   - Draw comparisons and parallels between musical language and programming.

4. Time Allotment: 45 min

5. <u>Lesson summary:</u>
   - Introduction: Key aspects of fractions and rhythm (10 minutes)
   - Engage phase: Analyzing a song (5 minutes)
   - Explain phase: Measuring music using fractions (10 minutes)
   - Elaborate phase: Programming their rhythm sequence (10 minutes)
   - Assessment (10 minutes)

Materials & Resources

- Computer with Internet access
- Pizza slices and fractions
- Measuring Music graphic
- Playing fraction pies
- Assessment rubric

Implementation

Step 1: Introduction (10 minutes)

The teacher will start by revisiting what fractions are. In mathematics, fractions are a way to represent parts of a whole.

The teacher will use decomposition to explain to students an easily recognizable object from their everyday life that can be divided into different parts, also known as fractions. For this purpose, the teacher will show the attached file (see "*Pizza Slices*") by sharing the screen with students. Using this image, the teacher will explain the following:

"*Imagine you have a pizza, and you divide it into slices. Each slice is a fraction of the whole pizza. For instance, if you have 3 slices of a pie and you share them with your friends, you've distributed 3/8 of the pie*." (5 minutes)

The next part of the introduction will consist of showing how these fractional elements are used also in music.

To show this, the teacher will play the video “What Is Music?”[1]. A clip retrieved from PBS Learning, specifically from the Music Arts Toolkit, “Doorways to Music: Music Basics”. Play this video from 3:02 to 4:12 and from 4:12 to 5:03. These sections of the video explain what Tempo and rhythm are. (Two minutes).

After viewing the selected parts of the video, a debate can be opened for a maximum of 5 minutes, in which the following questions can be raised:

- How fractions can be related to the rhythm and tempo of a song?
- How the sound can be influenced by rhythmic fractions?
- Does anyone know how fractions are used to generate rhythmic sequences?

Step 2: Implementation (30 minutes)

Once students have discovered that the rhythms of the songs we listen to are formed by using fractions it is time to delve into the world of musical notation, which is the system we use to visually represent musical rhythms and durations.

1. explore how notes and rests are notated,
2. the different types of note figures,
3. how they relate to fractions
4. their connection to the subdivisions of the musical meter.

To do so, the teacher reads and explains the following:

"*We are going to work with breaks in rhythm. The most common rhythmic structure in music that we are used to hearing is called 4-4 time. It is also called common time because it is … the most common.! If a piece of music is in 4-4 times, meaning that each measure has four beats or pulses. A beat is a small part of a piece of music, just as an inch is a small part of a rule or measure. Music is divided into beats and beats into bars.*"

[1] KET Education. 2021. “What Is Music? Music Arts Toolkit”. *PBS Learning Media*. Retrieved from https://www.pbslearningmedia.org/resource/ket-music-basics-overview-101/what-is-music-music-arts-toolkit/

This will be explained by the teacher, and it will also be written on the screen to make it clearer for students and let them think and internalize the explanation.

2.1. Engage phase (5 minutes)

The teacher suggests that the students work with a song so that the students are more motivated with the activity. It is recommended that the teacher looks for a song that they can easily recognize and whose metric allows them to easily visualize the rhythmic sequence, concretely to find a piece of music 4-4 times-, to facilitate the pattern recognition with the "*Measuring Music graphic*" that will be shown later.

The teacher plays the song for the students (3 minutes).

2.2. Explain phase (10 minutes)

Once the song is played, the teacher reads and explains the following:

"*The song that have listened to has its rhythm. The most common rhythmic structure in music that we are used to hearing is called 4-4 time. It is also called common time because it is the most common. f a piece of music is in 4-4 times, meaning that each measure has four beats or pulses. A beat is a small part of a piece of music, just as an inch is a small part of a rule or measure. Music is divided into beats and beats into bars*."

This will be explained by the teacher to make it clearer for students and let them think and internalize the explanation, it will also be written on the screen.

Then, the teacher indicates the file to be worked with (see "*Measuring music graphic*") and shares it on the screen.

Display the "Measuring Music" diagram and label the measures, clock, tempo, and rule parts. Say: "Notice that the piece of music described on the "Measuring Music" page has four quarter notes in the first bar. Each quarter note fills 1/4 of the time of the measure. Remember that "quarter" is another way of saying." 1". /4" and "quarter".

The teacher will explain while pointing at it on the screen: "See a half note on the second beat? A half note fills two beats or half the time of a beat. Remember that 'half' is another way of saying '1/2.'

2.3. Elaborate phase (15 minutes)

Once it has been explained notation of notes and how depending on the notation the rhythm changes, it is time for students to create their rhythmic sequence, considering the fractional value of notes.

- For the elaboration of their rhythmic sequence, the teacher shows the Playing Fraction Pies (part 1 of 3) - Connecting Music Notes and Pie Fractions[2] (3:19 minutes video). Following what is explained in the video, students will have 5 minutes to complete Handout 1.
- Once they have created their musical rhythm, students will utilize the hands-on Scratch activity to listen to the rhythm they have created, combining musical language with programming (5 minutes).
- The teacher asks students to voluntarily record the sound of their creation and show it to the rest of the class. Students will share their recordings and creations with the class by uploading them to a shared folder.

Finally, the teacher explains how the handout will be corrected and also explains which aspects will be considered.

Step 3: ASSESSMENT (5 minutes)

In the evaluation, the teacher evaluates learned concepts and acquired skills. This could be done by a questionnaire developed by the teacher or using a gamified platform.

The dimensions to be assessed will be:

- Knowledge acquired.

[2] Phil Tilga Music. 2021. “Playing Fraction Pies (part 1 of 3) – Connecting Music Notes and Pie Fractions”. *You Tube*. Retrieved from https://www.youtube.com/watch?v=JncJRWi5QpQ

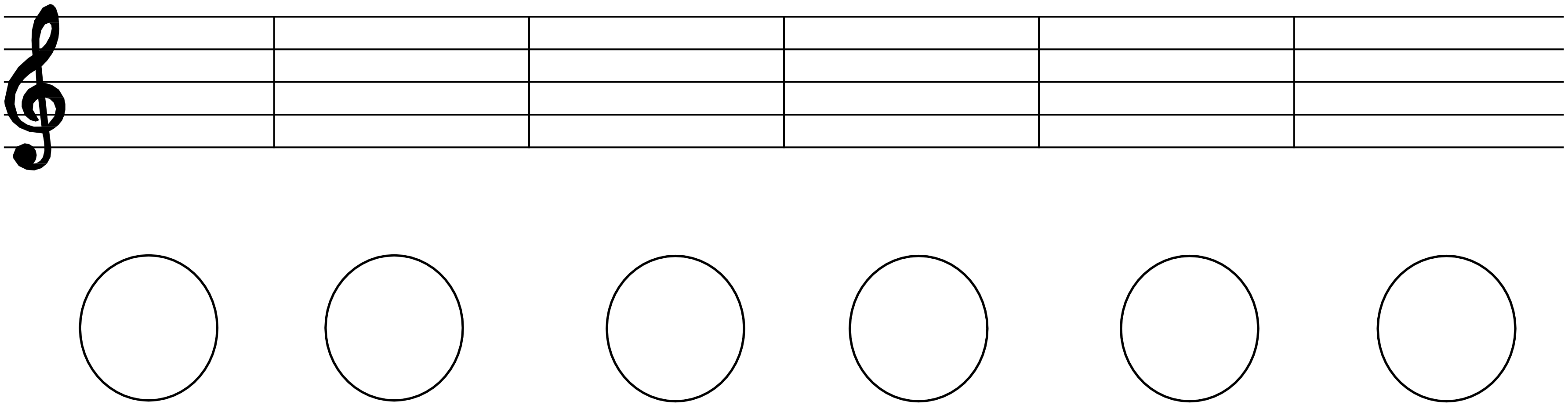
- Application of acquired knowledge.
- Skills and abilities
- Motivation towards learning
- General involvement in the training action

In addition, the teacher is provided with a rubric (see *Assessment rubric*) for the evaluation of the individual activity.

HANDOUT: PLAYING FRACTION PIES

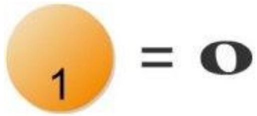
The Fraction Pie Rhythms activity connects your knowledge of fractions and equivalency to musical notes and rhythms

- Fill in this pentagram by creating your own musical rhythm, bearing in mind that the meter should be 4/4.
- Each note you place must be indicated with its fractional value as well as the piece of pie corresponding to its value.
- Indicate, using different colours, the slice of cake that corresponds to each note

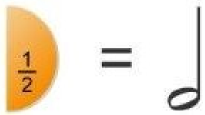


Here are the fractions for each musical note:

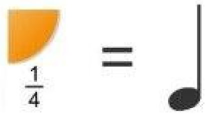
Fraction Note Description



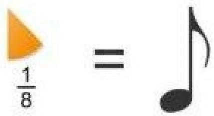
A whole pie equals a whole note. It will last four beats.



$\frac{1}{2}$ of a pie equals a half note. It will last two beats.



$\frac{1}{4}$ of a pie equals a quarter note. It will last one beat.



$\frac{1}{8}$ of a pie equals an eighth note. It will last a half of a beat.

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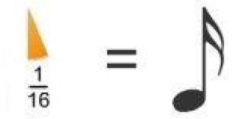
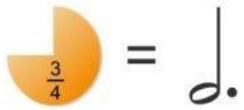


$\frac{1}{16}$ of a pie equals a sixteenth note. It will last a quarter of a beat.

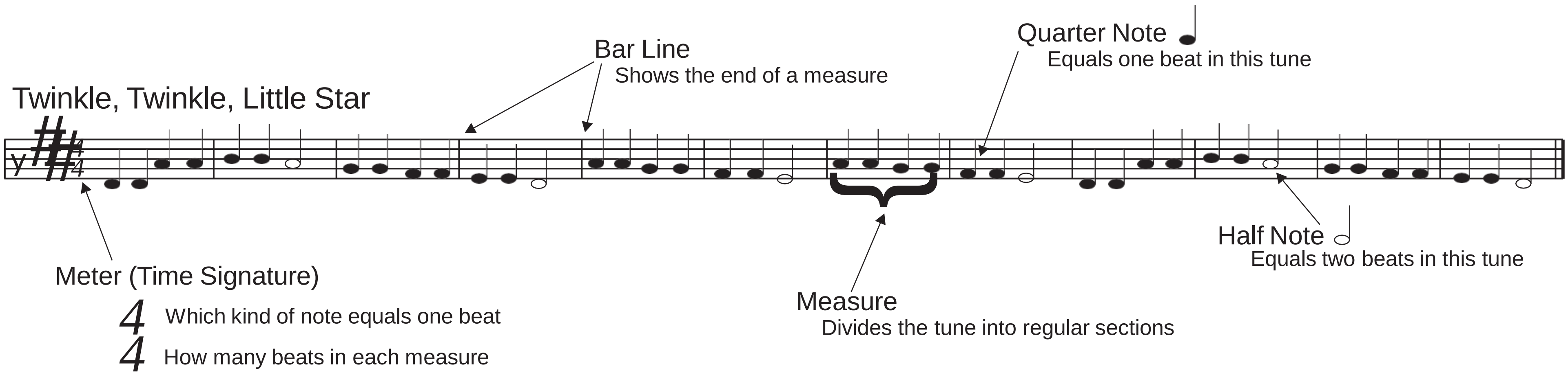
In addition, you may challenge yourselves by using one dotted note. A dot placed after a note increases its value by one half.

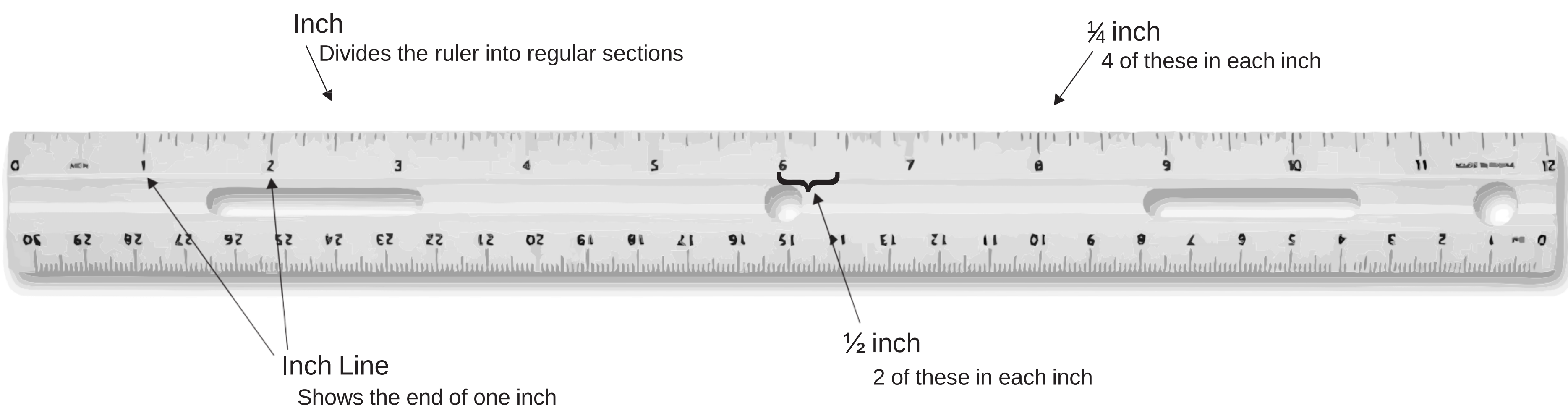


$\frac{3}{4}$ of a pie equals a dotted half note. It will last three beats, since its value equals a half note and a quarter note tied together.

From:
http://www.philtulga.com/pie.html

MEASURING MUSIC





Name ___________________________

Date _____________________________

Playing Fraction Pies Project Rubric

_____ Piece is composed of a **minimum** of 5 fraction pie pieces. (5 points) _____ Piece is composed of at least 2 different types of note values. (5 points) _____ Piece follows 4/4 time (is composed of note values adding up to one whole note, 4 beats).
(5 points)
_____Fraction pieces have been labeled with both note value and fraction value. (5 points)
_____Each pie is correctly colored considering the value of the notes. (5 point)
_____Piece contains a dotted half note. (5 points)

______ Total Points Earned (out of 35) _______ Letter Grade

ARTS: RADIAL SYMMETRY

Summary

1. Subject(s): Visual Arts and Radial Symmetry

In this interdisciplinary lesson, students will delve into the captivating world of radial symmetry through the lens of art paintings and computational thinking. By fusing visual arts with mathematics, students will not only explore the inherent beauty in symmetry but also develop computational thinking skills applicable across various disciplines. Through engaging activities, they will recognize radial symmetry in nature, decipher its patterns in art paintings, and apply computational methods to analyze and create symmetrical designs.

2. Grade/Level:
   6th to 8th grade (14 to 16 years old)

3. Objectives:

In this lesson, students will understand and acquire computational thinking skills in radial symmetry which will be later applied across various disciplines and real-world scenarios. The idea is to emphasize the role of computational thinking in analyzing and appreciating the symmetry found in art paintings, artworks, and nature. Indeed, the acquired computational thinking skills in this lesson will enable students to develop a problem-solving approach that will enhance their creativity and precision in Arts.

The lesson aims to:

- Approach symmetry as part of artistic and visual language
- Grasp the concept of radial symmetry and its significance in both artistic and natural contexts.
- Identify examples of radial symmetry in different art paintings.
- Differentiate between symmetrical and asymmetrical structures in paintings.

- Explore how radial symmetry is applied in art.
- Strengthen logical and spatial thinking.

4. Time Allotment: 60 min

5. Lesson Summary:

- Introduction (15 minutes)
- Implementation (40 minutes)
  - Engage phase: testing radial symmetry in a computer program (15 minutes)
  - Explain phase: radial symmetry around us and in art paintings (15 minutes)
  - Elaborate phase: how to identify a radial symmetry axis (10 minutes)
- Assessment (5 minutes)

Materials & Resources

- Computer with Internet access
- Digital Board
- Drawing software (e.g., Paint)
- Interactive online tools (Mentimeter, http://weavesilk.com/)
- Handout 1: Art Paintings and Symmetry
- Handout 2: Symmetry in Art
- Handout 3: Symmetry
- Icebreaker
- Assessment worksheet
- Google Forms

Implementation

Step 1. Introduction (15 minutes)

This lesson starts with an Icebreaker to introduce students to the contents of the lesson: “Think about the sentence”. The teacher sends each student a sentence related to the content of the activity and gives them a minute to reflect on it. Afterwards, participants will share their opinions in an orderly way. (See “Icebreaker” file).

This introductory activity is intended to introduce students in a dynamic way to what they will learn during the lesson.

Then, the teacher introduces and defines the concept of radial symmetry by sharing a PowerPoint presentation (see Annex 2, the teacher can adjust this presentation to the concrete scenario of their class) in which a dynamic introduction of radial symmetry is made including its fundamental aspects. Here, include aspects like geometric figures, human forms, elements of nature, and art paintings to engage students visually and conceptually.

Step 2. Implementation (40 minutes)

2.1 Engage phase (15 minutes)

Once the theoretical part has been contextualized, the teacher proposes a practical activity. Direct students to explore radial symmetry individually using the following online tool: http://weavesilk.com/ and encourage them to experiment for 5 minutes.

The teacher forms pairs and has students discuss the functions and types of symmetries allowed by Weave Silk for 2 minutes.

- What is the web for? What functions does it have? What types of symmetries does it allow to draw?

The teacher opens a discussion space for students to share their responses for 3 minutes. To do this, the teacher will use Mentimeter to create a Word cloud with students' responses. All students will join this online tool for presentation and will submit their responses, each time a student posts a reply, the following will appear on the screen so that students can see the answers of their classmates. Then, the teacher will summarize all the responses and choose those that are most appropriate.

In the following link, you can find an example of an empty presentation:
https://www.mentimeter.com/app/presentation/al1qxmrccb5861a4y37z6y59fbjcdse4/vfy8iv6s4owi/edit

Then, the teacher shares the screen with examples of objects related to everyday life and art paintings that allow pupils to empathize better with the subject by interpreting a reality that starts from their subjective reality.

"Look at the pictures and identify which ones can be divided into two equal parts, taking into account proportionality in shape and size". The teacher draws the symmetry line of those examples by asking the students to voluntarily answer how the teacher should draw the line (5 minutes). The teacher will share his or her screen on which, using a drawing program, he or she will draw the symmetrical lines, so that the students can see the process.

2.2. Explain phase (15 minutes)

- RADIAL SYMMETRY AROUND US (8 mins)

- The lesson continues with the teacher explaining how radial symmetry is identified in the world around us. The teacher will explain to students that all the questions that he/she asks during the explanation must be answered in the Google Forms that he/she shares with them, with this the teacher gets the students to remain attentive and to identify and analyze what radial symmetry is step by step.
- To this end, the teacher raises the following question: *Where do we see something in nature that radiates evenly from the center?* (Leave 1 minute for students to answer this in the Google Forms).
- The teacher projects a series of images on the screen showing images of objects such as snowflakes, spider webs, and flowers. After reviewing the images, he/she asks the following question: *Where do we see something in everyday life that radiates evenly from the center?*
  (Leave 1 minute for students to answer this in the Google Forms).
- Once students have been introduced to the concept of radial symmetry in general, guide students to identify and list properties of radial symmetry collaboratively. To do so, all students will make together a list of properties and qualities of radial symmetry to create a definition on the board. (Teacher can use a digital board and share screen) (5 minutes).

- RADIAL SYMMETRY IN ART PAINTINGS (6 minutes)

- This part of the lesson consists of leading analysis of famous art paintings showcasing evidence of radial symmetry. Therefore, the teacher will introduce art paintings from various cultures and periods to highlight the diversity of radial symmetry in artistic expression.
- The teacher shows students the art paintings below. Then the teacher will facilitate students with a Handout (see "Handout 1") where they will have to answer some questions regarding the paintings below. Students will work with a partner who is

predetermined by the teacher and will answer together the questions 1-3. The teacher will ask the students to voluntarily read their answers to the rest of the class.

2.3. Elaborate phase (10 minutes)

- How to identify a radial symmetry axis

In this section, students learn how to identify the radial symmetry axis through step-by-step explanations with visual aids. These steps will also be shared with students in a file so that they can come back to them if they need to. (5 minutes)

1. Observe Pattern of Design or Structures: Examine the object or design for repetitive patterns or structures that appear to rotate around a central point. Pay attention to any symmetry you can detect.

2. Locate the Central Point: Look for the central point around which elements appear to be symmetrically distributed. This point might be evident or require closer analysis.

3. Visualize Reflections: Imagine lines connecting the central point to the edges of the object or design. These lines represent axes of reflection along which radial symmetry is achieved.

4. Verify Symmetry: Visualize reflecting the elements along the axes of reflection. If the reflected elements match the originals perfectly, you are dealing with radial symmetry.

5. Check for Multiple Axes: Some objects may have multiple axes of radial symmetry. Make sure to examine all possible lines of symmetry and verify if elements reflect accurately along them.

6. Consider Overall Composition: Observe how elements are distributed throughout the object or design. If they are symmetrically organized around a central point, it's a clear indication of radial symmetry.

7. Use Visual Aids: If needed, you can use a transparent sheet of paper or a mirror to better visualize symmetry lines and how elements reflect.

Activity: To give students a chance to practice and apply their skills, have each student use a digital camera or mobile device to capture a picture of a symmetrical object near them.

Ask them to transfer the image to the computer and with a Drawing Software such as Paint, where students will draw the radial symmetry lines of the object. Once they have finished, they will upload their picture to a common Drive folder. They will have 5 minutes to do this activity. Afterwards, the teacher will choose one at random and discuss it with the whole class to go through the procedure step by step.

As an extension, students can create sounds, add interactivity, research the work of an abstract author they like generate works with his or her characteristics, create an introduction, etc.

The teacher can also use handouts to attract the participation of the students and to see that they have acquired the knowledge. (See “Handout 2” and “Handout 3”).

Step 3: Assessment (5 minutes)

In the evaluation, the teacher will evaluate learned concepts and acquired skills. This could be done by a questionnaire developed by the teacher or using a gamified platform.

The dimensions to be assessed will be:

- Knowledge acquired and its application.
- Skills and abilities

- Motivation towards learning
- General involvement in the training action

In addition, the teacher is provided with a rubric for the evaluation of the individual activity.

ART PAINTINGS AND SYMMETRY

See the following art paintings.

- Art Painting 1: “Starry Night” by Vincent Van Gogh

- Art Painting 2: “Guernica” by Pablo Picasso

Answer the following questions in pairs.

• How does "Guernica" use asymmetry to convey a sense of chaos and distress? Consider the placement of figures, shapes, and the overall composition.

• Explore the use of radial symmetry in "Starry Night." How does van Gogh incorporate elements of nature and imagination into a symmetrical structure?

• Compare the impact of asymmetry in "Guernica" with the calming effect of symmetry in "Starry Night." How does the composition contribute to the emotional experience of each painting?

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SYMMETRY IN ART

Symmetry means that one side matches or

mirrors the other side.

Draw a symmetrical picture

Asymmetry means both sides are not exactly the same. Designs can be asymmetrical but also balanced.

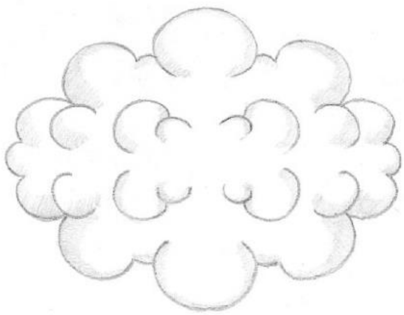
Draw an assymetrical picture

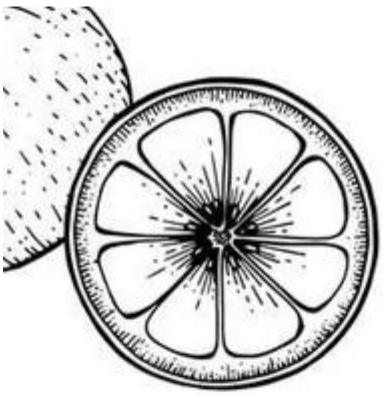
Radial symmetry means the same design radiates from a center point.

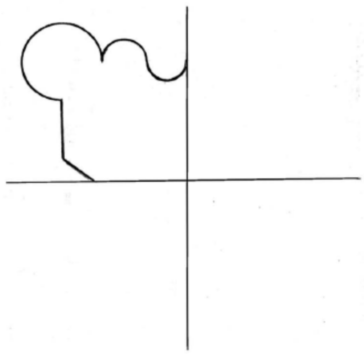
Draw a design with radial symmetry

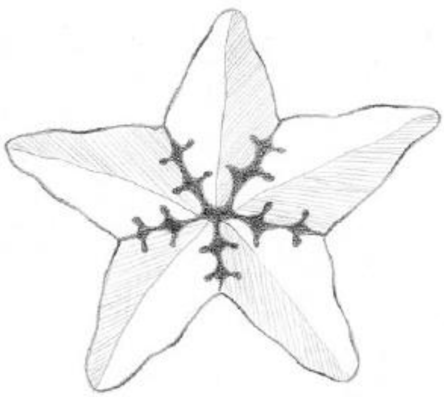
HANDOUT SYMMETRY

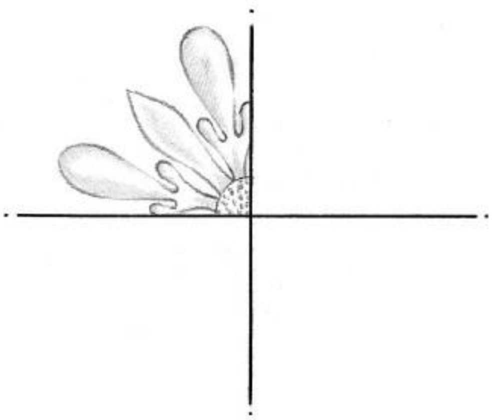
1. Find the axis of symmetry of the following figures. Then complete the unfinished figures along the indicated axes of symmetry.



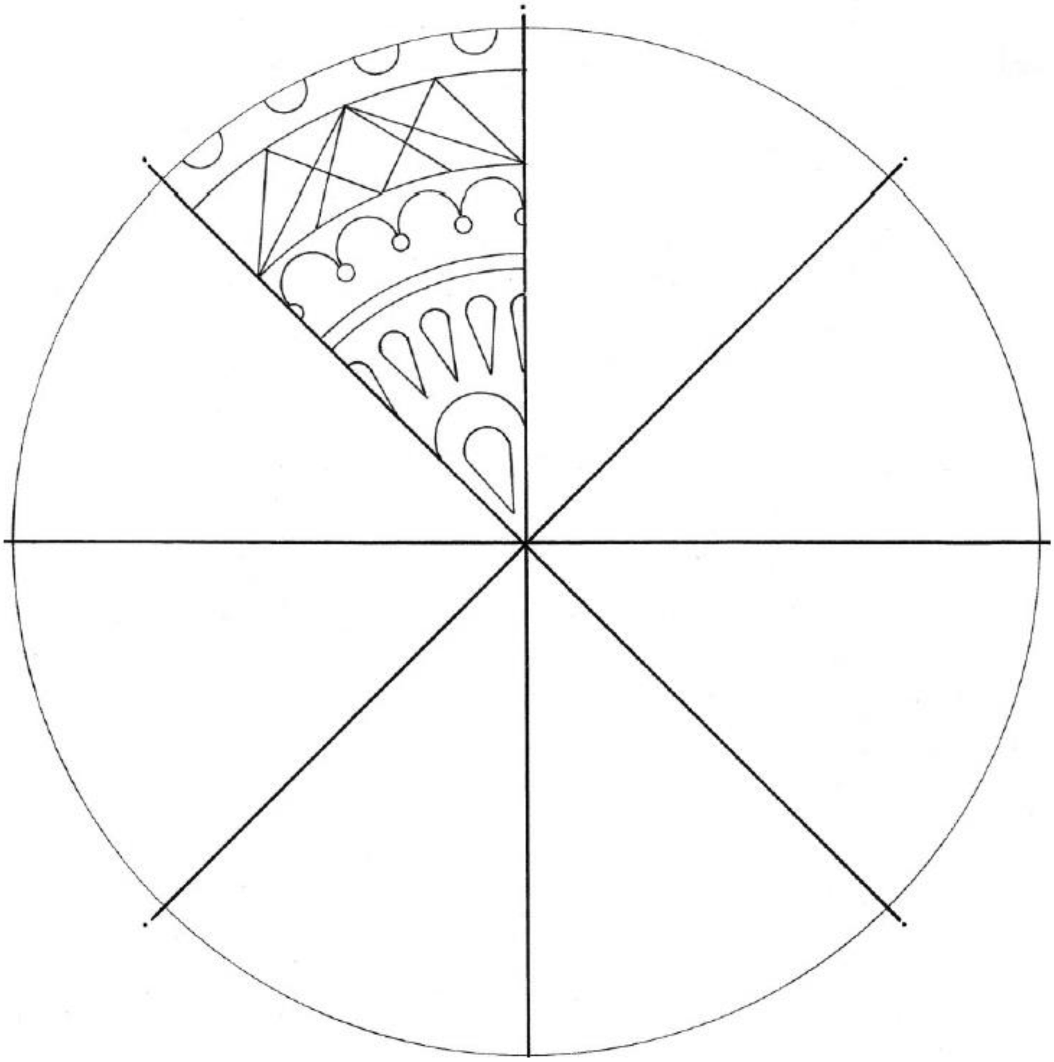








2. Complete the stained glass window following the radial symmetry. Then decorate it with coloured markers.



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ICEBREAKER

“Think about the sentence”

"Symmetry is all around us. Can you name something in this room that is symmetrical?"

"The beauty of nature often relies on symmetry. Can you think of examples in nature that exhibit radial symmetry?

"Have you ever seen a mandala? They are impressive examples of radial symmetry. What does the word 'mandala' suggest to you?"

"Imagine you have a magic mirror that can create symmetry in any object. What object would you choose and why?"

"If you were an artist, how would you use symmetry to create a unique work of art?"

"Think about your favorite place in nature. Is there any symmetry-related feature in that place?"

"Symmetry can be found in music, especially in classical compositions. Can you think of a musical piece that evokes symmetry for you?"

“Have you ever created something symmetrical or noticed anything special related to symmetry in your life?"

"Symmetry can be calming and harmonious. If you could create a tranquil space based on symmetry, how would it be?"

"Imagine you are a designer tasked with creating a logo for a symmetrical brand. What elements would you incorporate into the logo?"

"Symmetry is like a secret code in art and nature. Can you think of any famous artworks or natural phenomena that hide this secret code?"

"Symmetry isn't always perfect. Can you share an example where imperfect or broken symmetry adds character or interest to something?"

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Radial symmetry

Visual arts and maths

Computational Thinking
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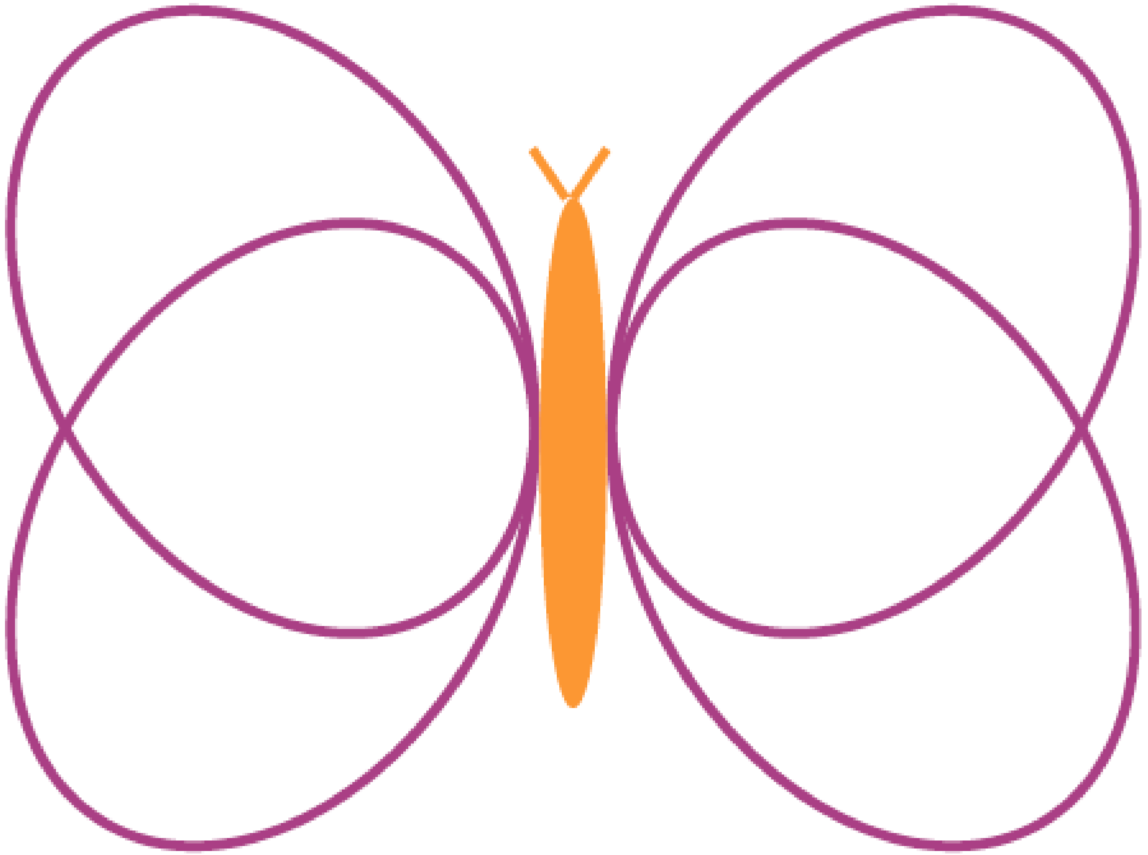
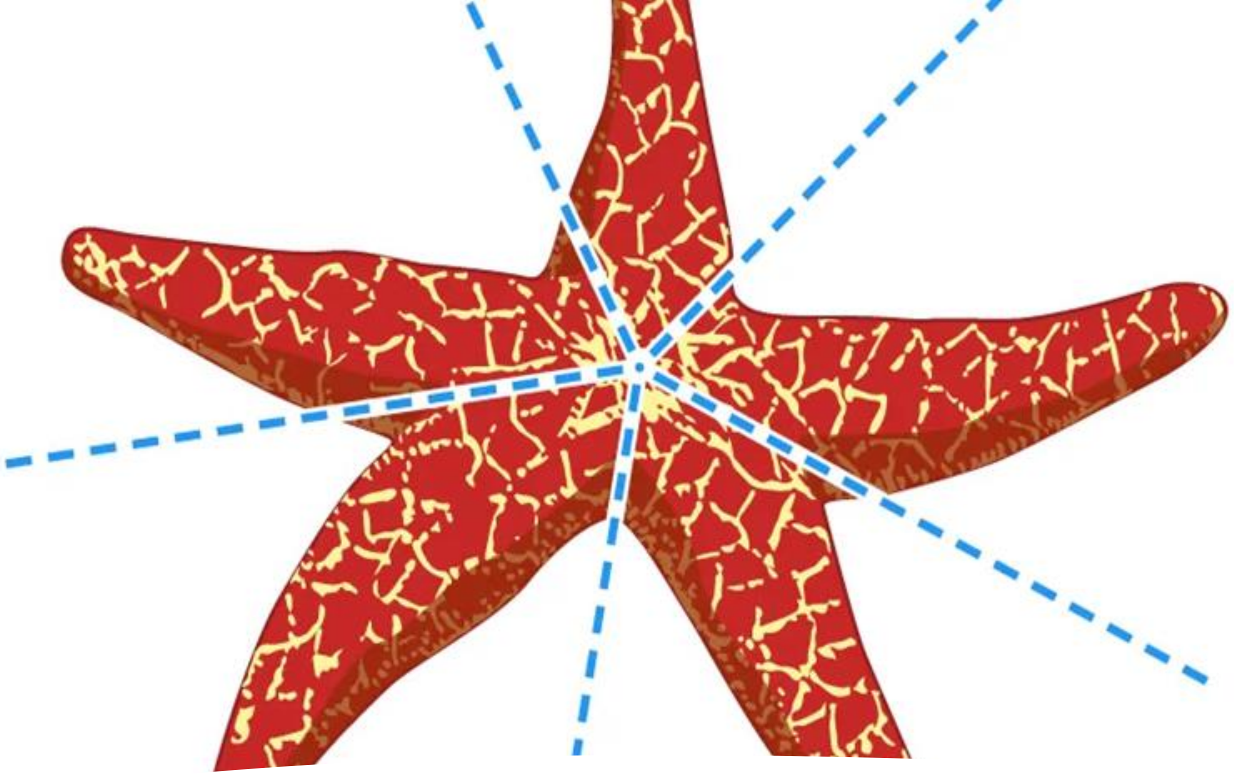
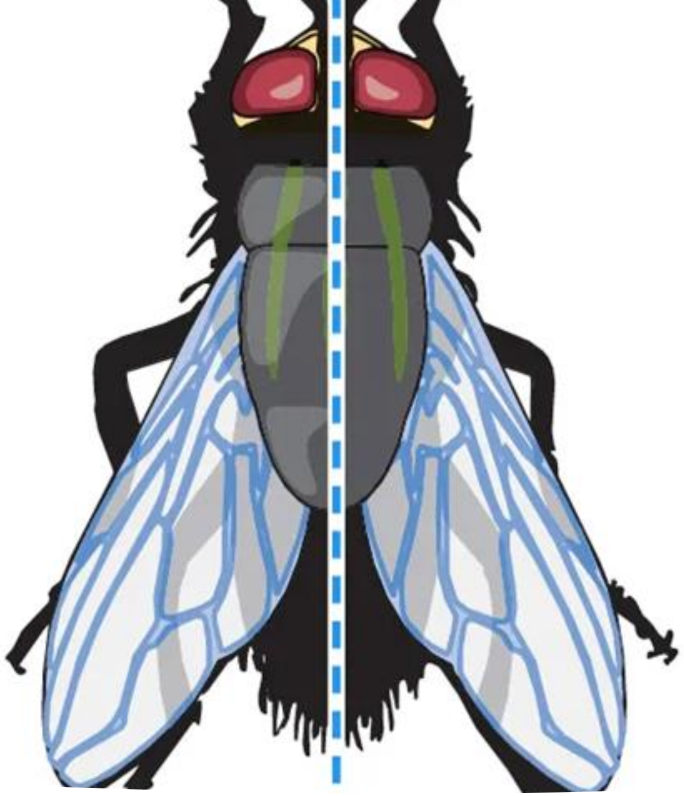
What is symmetry?

- Symmetry is a fundamental concept that refers to a balanced and harmonious proportion of parts or elements in a system. It is a property or quality of having parts that are arranged in such a way that they mirror each other, creating a sense of balance, proportion, and order. Symmetry is found in various aspects of mathematics, science, art, and nature.





Radial Symmetry



Bilateral Symmetry

Types of symmetry

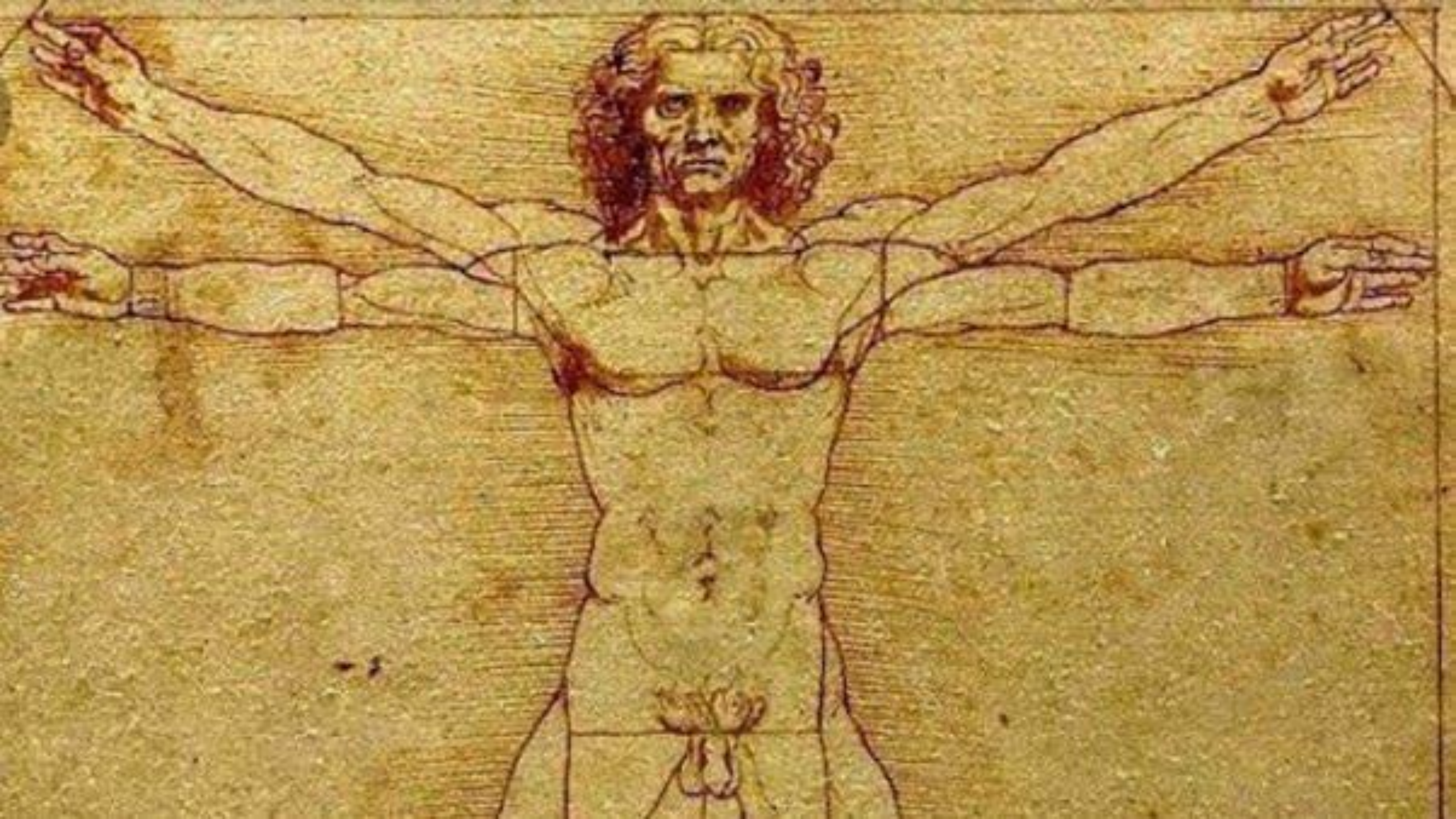
- **Bilateral Symmetry:** Objects or organisms exhibit bilateral symmetry if they can be divided into two equal halves along a single plane.

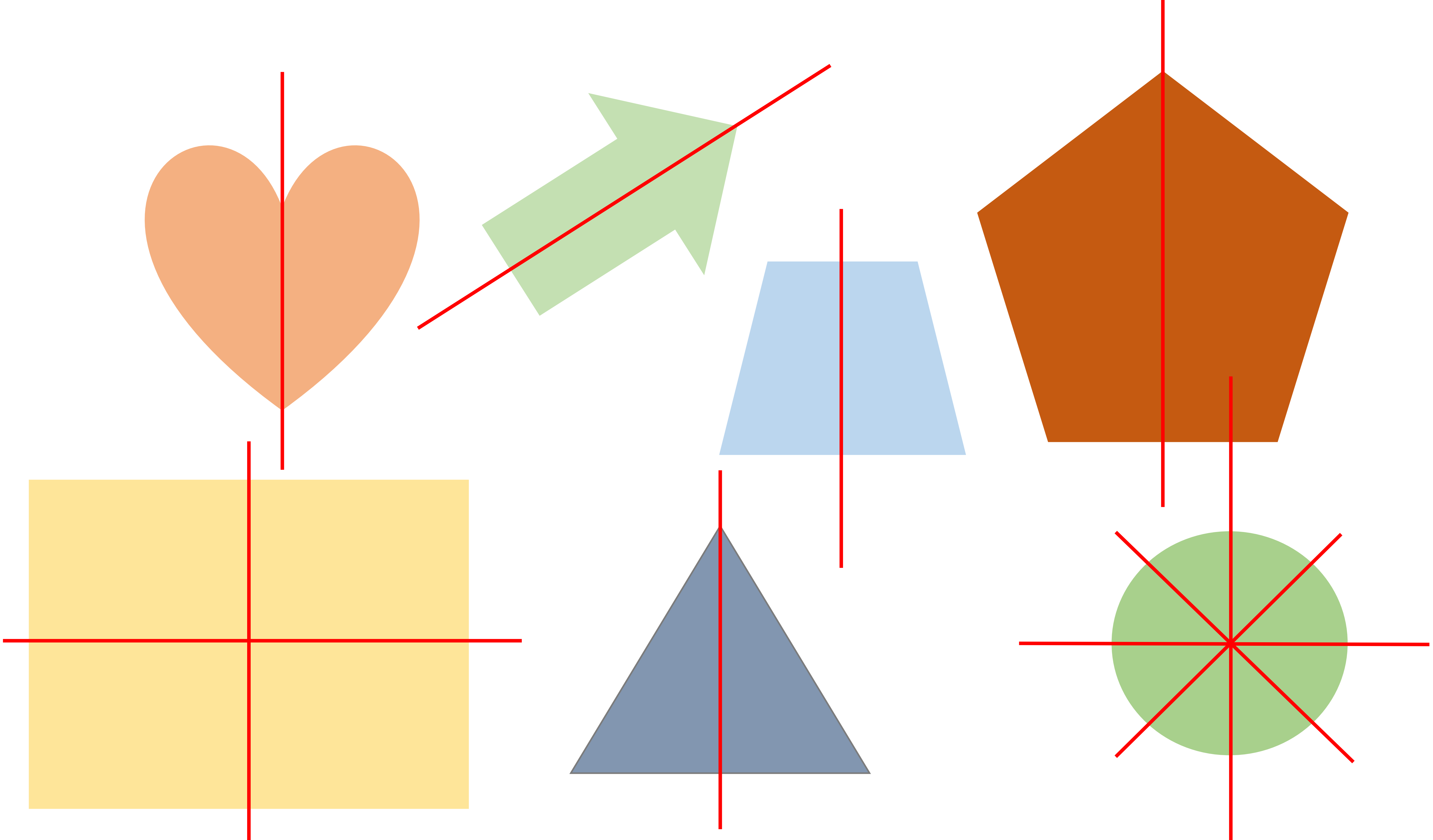
- **Radial Symmetry:** Radially symmetric objects or organisms can be divided into multiple identical parts radiating from a central point, often seen in natural organisms like starfish or flowers.

Symmetry around us:

Nature, humans, art







Symmetry around us: buildings