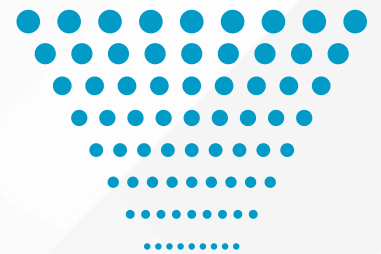




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# Brainfinity Class Guide



**brainfinity**  
COLLABORATIVE PROBLEM SOLVING CHALLENGE

# 1. Introduction to Brainfinity and its Benefits



## What is Brainfinity?

Brainfinity is an innovative educational approach that leverages the excitement of detective tasks to cultivate essential problem-solving skills in students. It goes beyond rote memorization, encouraging students to think critically, research effectively, and creatively synthesize information from various sources. By immersing students in real-life scenarios and challenges, Brainfinity fosters the development of functional knowledge that can be applied in both academic and real-world contexts.



## Why Brainfinity?

In today's rapidly evolving world, the skills required for success extend far beyond traditional academic knowledge. Brainfinity recognizes this and focuses on nurturing the 21st-century skills that are crucial for thriving in the modern era. These skills include:

- **Problem-Solving:** Equipping students with the ability to analyze complex situations, identify solutions, and make informed decisions.
- **Critical Thinking:** Encouraging students to question assumptions, evaluate evidence, and develop logical arguments.
- **Creativity:** Fostering innovative thinking and the ability to generate new ideas and approaches.





- Collaboration: Promoting teamwork and effective communication within a group setting.
- Digital Literacy: Enhancing students' ability to navigate and utilize digital tools and technologies.

## The Impact of Brainfinity

Brainfinity has been shown to have a profound positive impact on student engagement and learning outcomes. By presenting challenges in an interactive and captivating manner, Brainfinity sparks curiosity and motivates students to actively participate in the learning process. This active engagement leads to a deeper understanding of the subject matter and improved retention of knowledge. Moreover, the collaborative nature of Brainfinity problems fosters a sense of community and shared purpose among students, creating a more enjoyable and fulfilling learning experience.

Student engagement

Active participation

Deeper understanding

Improved retention





## 2. Understanding the Brainfinity Problem Types

The Brainfinity methodology encompasses a variety of problem types, each designed to engage students and foster the development of specific skills. The main categories include:



### **Logical Puzzles**

These problems stimulate logical and algorithmic thinking, crucial for problem-solving. They can be open-ended, encouraging discussions and critical thinking, or have unique solutions, emphasizing precision and verification. Examples include scheduling puzzles, weight loss calculations, and mobile app usage scenarios.

### **Detective Tasks**

These captivating problems immerse students in intriguing narratives, promoting exploration, collaboration, and the use of information technology. They can have unique solutions, fostering confidence and clear evaluation, or be open-ended, emphasizing creativity and decision-making. Examples involve journey planning, Santa's gift distribution, actor identification, and missing person investigations.

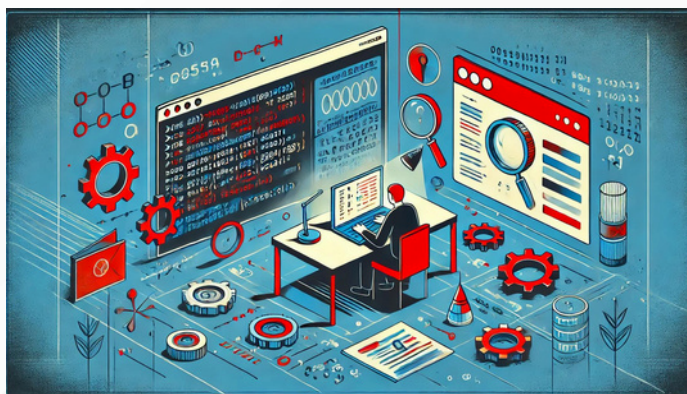




## **Deciphering**

These mentally stimulating challenges involve cryptanalysis, requiring students to decode messages and break codes. They enhance quantitative skills, divergent thinking, and creativity, often incorporating mathematical concepts. Examples include decoding hidden messages, Fibonacci sequences, and deciphering encrypted communications.

Each problem type serves distinct learning objectives, catering to different cognitive processes and skill sets. By understanding the characteristics and objectives of each type, teachers can effectively select and implement Brainfinity problems that align with their specific subject matter and desired learning outcomes.



# 3. Implementing Brainfinity in Your Subject

## Selecting the right problems

The true power of Brainfinity lies in its adaptability to various subjects and learning objectives. The key is to select problems that seamlessly integrate with your curriculum and resonate with your student's interests.

### ▶ **Alignment with Subject Matter**

Choose Brainfinity problems that complement the concepts and skills you are teaching in your subject. For example, in math, you might use logic puzzles that involve calculations or data analysis. In history, detective tasks based on historical events can encourage research and critical thinking.

### ▶ **Learning Objectives**

Consider the specific skills you want your students to develop. If you aim to enhance collaboration, opt for problems that require teamwork and communication. If you want to foster creativity, open-ended problems that allow for multiple solutions are ideal.

### ▶ **Students' Interest**

Take into account your students' interests and preferences. Brainfinity problems that connect to their hobbies or passions will naturally spark their enthusiasm and engagement.







# Integration Strategies

## ▶ Warm-up Activities

Use Brainfinity problems as engaging warm-up activities to activate prior knowledge and set the stage for the lesson.

## ▶ Main Lesson Integration

Incorporate Brainfinity problems into the core of your lesson to introduce new concepts, reinforce learning, or promote problem-solving skills.

## ▶ Assessment Tools

Utilize Brainfinity problems as formative or summative assessments to gauge student understanding and progress.

## ▶ Extracurricular Activities

Offer Brainfinity challenges as part of after-school clubs or competitions to further enrich the learning experience.



# Adapting to Different Learning Styles

## ▶ Visual Learners

Provide visual aids, diagrams, or graphic organizers to support problem-solving.



## ▶ Auditory Learners

Encourage discussions, debates, and presentations to facilitate understanding.

## ▶ Kinesthetic Learners

Incorporate hands-on activities, simulations, or role-playing scenarios to engage learners.



## ▶ Differentiation

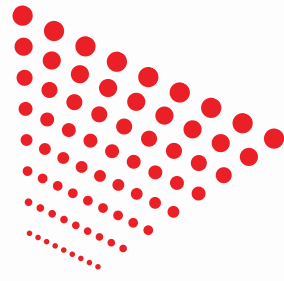
Offer varying levels of complexity or scaffolding to accommodate different student abilities.

By thoughtfully selecting and adapting Brainfinity problems, you can create a dynamic and inclusive learning environment that caters to the diverse needs of your students and maximizes their potential. Remember, the goal is to make learning fun, challenging, and relevant, empowering students to become confident and capable problem-solvers.





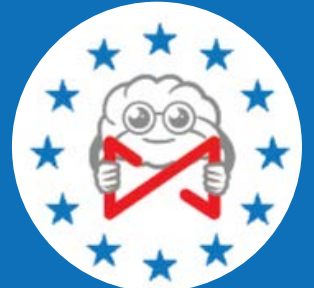
# 4. Engaging Students with Brainfinity



The success of Brainfinity in the classroom hinges on creating an environment that fosters active participation, collaboration, and reflection. Here are some tips to ensure your students get the most out of their Brainfinity experience:

## Creating a Stimulating Environment

- **Embrace the Detective Theme:** Set the stage for excitement by decorating your classroom with detective-themed elements. Encourage students to embrace their inner detectives as they tackle challenges.
- **Cultivate Curiosity:** Frame Brainfinity problems as mysteries waiting to be solved. Spark curiosity by highlighting the real-world relevance and intrigue of each challenge.
- **Encourage Risk-Taking:** Create a safe space where students feel comfortable taking risks and exploring unconventional solutions. Celebrate both successes and failures as learning opportunities.
- **Provide Choice and Autonomy:** Offer students a degree of choice in selecting Brainfinity problems or deciding how to approach them. This empowers them to take ownership of their learning.



## Encouraging Participation and Teamwork

- **Group Work:** Organize students into small teams to encourage collaboration and diverse perspectives. Assign roles within each team to ensure everyone contributes.
- **Active Facilitation:** Guide students without giving away answers. Ask open-ended questions to prompt critical thinking and encourage them to build on each other's ideas.
- **Celebrate Progress:** Acknowledge and celebrate milestones and achievements, both big and small. This reinforces positive learning experiences and motivates continued effort.



## Facilitating Discussions and Reflections

- **Debriefing Sessions:** After solving a Brainfinity problem, lead a debriefing session where students share their strategies, challenges, and insights.
- **Metacognitive Prompts:** Encourage students to reflect on their thinking processes. Ask questions like, "What strategies did you use?" and "How did you overcome obstacles?"
- **Connect to Real Life:** Help students see the connections between Brainfinity problems and real-world situations. This reinforces the relevance and applicability of their learning.

By implementing these strategies, you can transform your classroom into a hub of active learning and collaboration. Brainfinity is more than just problem-solving; it's about fostering a love for learning, critical thinking, and the confidence to tackle any challenge that comes their way.



# 5. Assessing Student Progress

The Brainfinity methodology offers a unique opportunity to assess student progress in a way that goes beyond traditional testing methods. By observing students as they engage with Brainfinity problems, teachers can gain valuable insights into their problem-solving skills, critical thinking abilities, and collaborative efforts.



## Methods for Evaluating Student Performance

- **Observation and Documentation:** Carefully observe students as they work on Brainfinity problems, noting their strategies, interactions, and thought processes. Document these observations to track individual and group progress over time.
- **Checklists and Rubrics:** Develop clear checklists and rubrics that outline the key skills and concepts being assessed. These tools provide a structured way to evaluate student performance and provide targeted feedback.
- **Self- and Peer-Assessment:** Encourage students to reflect on their own learning and provide feedback to their peers. This promotes metacognition and helps students develop a deeper understanding of their strengths and areas for growth.
- **Presentations and Discussions:** Have students present their solutions and engage in discussions about their problem-solving approaches. This allows for a deeper assessment of their understanding and communication skills.





## Providing Constructive Feedback

- **Focus on Strengths:** Begin by acknowledging and highlighting students' strengths and achievements. This builds confidence and encourages further effort.
- **Identify Areas for Growth:** Provide specific and actionable feedback on areas where students can improve. Focus on the process of problem-solving rather than just the final answer.
- **Offer Guidance and Support:** Suggest strategies and resources that can help students overcome challenges and develop their skills further.
- **Encourage Reflection:** Prompt students to reflect on their learning and set goals for future improvement.



## Using Brainfinity as an Assessment Tool

- **Formative Assessment:** Brainfinity problems can be used as formative assessments to monitor student learning throughout a unit or course. This allows teachers to identify areas where students may need additional support or adjust their instruction accordingly.
- **Summative Assessment:** Brainfinity problems can also be used as summative assessments to evaluate student learning at the end of a unit or course. The open-ended and collaborative nature of these problems provides a more authentic and comprehensive assessment of student skills and knowledge.







By incorporating these assessment strategies, teachers can effectively track student progress, provide meaningful feedback, and create a more engaging and impactful learning experience. Brainfinity problems not only serve as assessment tools but also as valuable learning opportunities that promote growth and development in key 21st-century skills.



## 6. Creating school curriculum-oriented Brainfinity problems

As already highlighted, Brainfinity problems are highly challenging and motivating for students, helping them develop essential skills for the modern age. Our problem database contains many such problems, but they do not cover all learning outcomes in school. This section will describe how a teacher can create a Brainfinity problem that leads to the achievement of a specific learning outcome. This can also be highly challenging and motivating for the teacher as well. In this way, the teacher becomes actively involved in the educational process in line with the recommendations of the Education 4.0 agenda, as a creative team member.



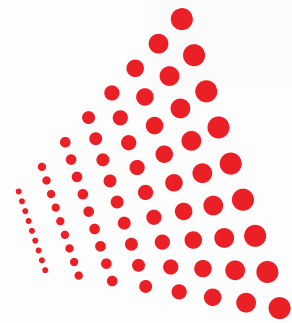
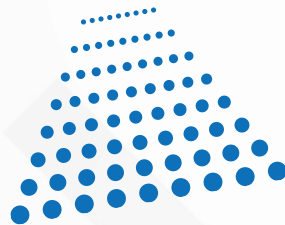
## 6.1 New type of Brainfinity problems – RDA



The simplest way to apply the Brainfinity learning system to the school curriculum is by introducing a research component through the so-called Research and Data Analysis Brainfinity problems (RDA). In these problems, students are required to research and analyze data in order to solve the problem. Solving these problems primarily develops data-handling skills, critical thinking, and a research-oriented mindset, while focusing less on problem-solving skills and creativity.

Although problem-solving skills, logical thinking, and creativity are not the primary focus when solving these problems, they are still applicable. RDA problems are easier to create compared to traditional Brainfinity problems, yet they can still be highly challenging and motivating. Additionally, data-handling skills, especially at the evaluation level, are crucial competencies in today's world.

Primarily due to their simplicity, this guide for creating Brainfinity problems oriented toward school content will begin with the creation of RDA problems



## 6.2 Steps in creating subject oriented RDA Brainfinity problems

Although these problems are easier to create than traditional Brainfinity problems, their creation still requires a significant level of creativity and extensive research. Therefore, it is important to break down this complex task for teachers into several smaller steps in the problem creation process.





## Step 1. Identification of learning outcomes

Brainfinity problems are designed to develop multiple skills simultaneously and typically cover various topics. Therefore, identifying learning outcomes actually means selecting one specific outcome to track, while acknowledging that several other learning outcomes may also be achieved in the process.



Throughout this process, we will follow the creation of a specific RDA Brainfinity problem. In this example, the focus is on the subject of mathematics, specifically spatial geometry, with the chosen learning outcome being: the student applies the formula for the volume of a cone.



## Step 2. Research

Once the learning outcome has been identified, the next step is research. This involves gathering relevant data, real-life contexts, and interesting scenarios that will make the problem engaging and meaningful for students.



For our example, this could include researching real-world applications of cone volume, such as calculating the volume of an ice cream cone, a traffic cone, or a water tank. The goal is to find data sources, measurements, or case studies that will provide students with a solid foundation for analysis.



The research base can include the internet, but also the real-world environment, especially in this case, where the subject is geometry. The author of the specific problem presented here noticed a pile of sand in the yard of the company where they work, whose shape resembled a cone.



### Step 3. Problem formulation

After conducting research, the next step is to formulate the problem in a way that is clear, engaging, and aligned with the identified learning outcome. The problem should be structured to encourage students to analyze data, think critically, and apply their knowledge in a real-world context.



In our example, based on the observed pile of sand, the problem could be formulated as follows:

"While walking through the yard of a construction company, you notice a pile of sand that closely resembles a cone. The company needs to estimate the volume of sand in order to determine how much more is needed for an upcoming project. Your task is to measure or find the necessary data and apply the volume formula for a cone to calculate the total amount of sand in the pile."

This formulation ensures that students engage in research, collect data, and apply mathematical concepts to solve a practical problem.







## Step 4. Narrative



A well-crafted narrative makes the problem more engaging and relatable for students. It provides context, sparks curiosity, and helps them connect the subject concepts to real-life situations.

The formulated problem ensures that solving it leads to the development of the selected learning outcome. While the problem is realistic, its initial narrative does not guarantee high student motivation. Additionally, if students are simply given the exact height and width of the sandpile, the problem becomes less challenging.

The idea is to provide students with an image and have them determine the necessary measurements themselves to estimate the volume. This approach makes the problem more engaging and demanding. The problem's author took it a step further by presenting it in video format, further increasing student motivation to explore and solve it.

Check this link to see how the problem was structured. The added elements make the problem even more challenging, and the number of learning outcomes it addresses has significantly expanded.

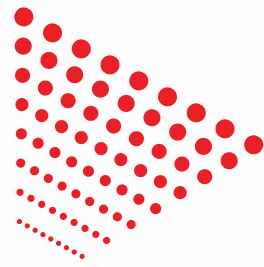
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$$\begin{aligned} & B \lim_{x \rightarrow 1} \frac{ctgx - 2}{2^{11} \times 3} Q'' \\ & \sum_{n=0}^{+\infty} \frac{x^n}{n!} \\ & \phi = \sqrt{\frac{\sum_{n=1}^n (x-m)^2}{n-1}} \\ & e = \cos x + t g y \\ & P = r^2 \cdot \pi \\ & \Delta t = T - \frac{3a}{x} \\ & (x-y)^2 \\ & y = 2x^2 + 3x \\ & \sqrt{x+a^2} \\ & \int (x \pm a^2)^c \\ & e = 2,7g \\ & A - C = \\ & S = \int_0^C 5t dt \\ & y = \frac{\Delta x}{\Delta z} \\ & \sin x \\ & (x+a)^2 = x^2 + 2ax + a^2 \\ & (x+y)^2 = \left(\frac{y}{2}\right)^2 x \end{aligned}$$





## Step 5. Identification of all learning outcomes



The created problem was designed with the goal of achieving a specific learning outcome, but Brainfinity problems typically develop multiple competencies. It is now important to identify all learning outcomes. As a guide, Anderson and Krathwohl's revised Bloom's taxonomy should be used (see: Krathwohl, D. R. (2002). A Revision Bloom's Taxonomy: An Overview. Theory into Practice. – [link](#)).

The simplest approach is to use a table (here, it is particularly filled with learning outcomes related to the specific problem mentioned in the previous step). Once the table is completed, it can serve as a good indicator of how challenging the problem is. Specifically, the more learning outcomes appear on the right side of the table, the more challenging the problem becomes.

| The Knowledge Dimension | The Cognitive Process Dimension                         |                                                             |                                                          |                                                                                      |          |        |
|-------------------------|---------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------|----------|--------|
|                         | Remember                                                | Understand                                                  | Apply                                                    | Analyze                                                                              | Evaluate | Create |
| Factual Knowledge       | The student knows the formula for the volume of a cone. |                                                             |                                                          |                                                                                      |          |        |
| Conceptual Knowledge    |                                                         | The student recognizes the shape of the sandpile as a cone. |                                                          | The student analyzes which data are needed to determine the required number of bags. |          |        |
| Procedural Knowledge    |                                                         |                                                             | The student applies the formula to a real-world example. |                                                                                      |          |        |
| Metacognitive Knowledge |                                                         |                                                             |                                                          |                                                                                      |          | :      |

Table 1: Taxonomy Table





For practice, try to complete the table by adding other learning outcomes that are achieved through solving this problem. The best way to do this is by solving the problem as a team and engaging in a collaborative metacognitive discussion to identify everything you needed to do and learn in order to solve it. Keep in mind that a learning outcome can only be recognized through student activity.

Try to determine whether teamwork in this example influences the achievement of learning outcomes in the domain of metacognition. If your answer is yes, attempt to precisely formulate those outcomes.

Also, keep in mind that a single field may contain multiple learning outcomes.



## Step 6. Summary – Filling Out the Form

Once all the key elements of the problem have been defined, learning outcomes, research, problem formulation, and narrative, it is important to summarize everything by filling out a structured form. This form serves as a blueprint for the Brainfinity problem and ensures clarity and coherence. This form is presented in the following table.



|                                                |                                 |  |
|------------------------------------------------|---------------------------------|--|
| Team                                           |                                 |  |
| Title of RDA task                              |                                 |  |
| Main learning outcome                          | Subject                         |  |
|                                                | Formulation of learning outcome |  |
| Intro story (ut to 2000 characters)            |                                 |  |
| Formulation of the task (up to 500 characters) |                                 |  |
| Solution                                       |                                 |  |
| Difficulty                                     |                                 |  |
| Link to the Taxonomy Table (Table 1)           |                                 |  |
| Design Description                             |                                 |  |

Table 2: RDA task form

Keep in mind that problem design is crucial for motivating students to work on the problem. The design must be age-appropriate and engaging, ensuring that students find the challenge both accessible and stimulating





## 6.3 Logical puzzle



This is a type of task familiar to everyone who has completed basic training in creating Brainfinity problems. These problems primarily develop logical and algorithmic thinking but can be designed to align with specific subject-related learning outcomes.

## 6.4 Steps in creating subject oriented logical puzzles



As with the previous type of problem, we will follow general guidelines while also tracking the creation of a specific problem. This time, the problem is related to biology lessons, with the topic focusing on nutrition – specifically, vitamins in the diet.

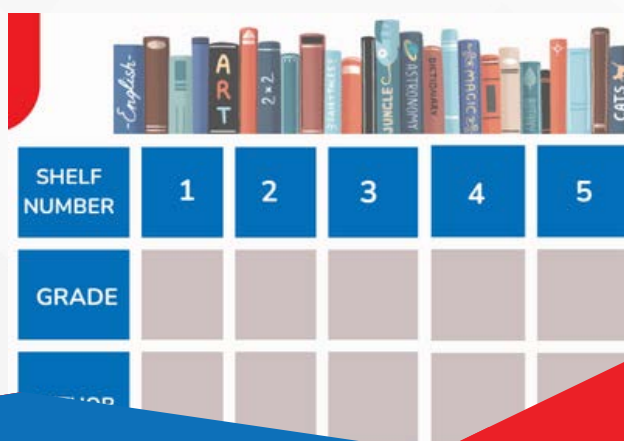


### Step 1. Identification of learning outcomes

The creation of all problems begins with selecting the learning outcomes we want students to achieve. This makes problem design significantly more challenging across all types of Brainfinity problems.

In the specific example we will follow, the learning outcomes are:

- Students recognize the importance of consuming fruit as a source of vitamins and minerals.
- Students identify which fruits are rich in essential micronutrients.





## Step 2. Identifying Key Concepts for Creating a Logical Puzzle



The next step in designing the problem is selecting the key concepts that will be used to create a logical puzzle. These concepts should align with the identified learning outcomes and be structured in a way that encourages students to think critically and systematically.

For our example on nutrition and vitamins in food, the key concepts might include:



Types of vitamins (e.g., Vitamin C, Vitamin A, Vitamin D)

Fruits rich in specific vitamins (e.g., oranges → Vitamin C, carrots → Vitamin A)

Health benefits of vitamins (e.g., Vitamin C → immune system, Vitamin A → vision)

Deficiency effects (e.g., lack of Vitamin C → scurvy, lack of Vitamin D → weak bones)

These elements will be used to construct a logical puzzle, where students must connect different pieces of information to arrive at a solution, reinforcing their understanding of the topic in an engaging and interactive way.





The structure of a logical puzzle consists of categories and items. If, in this case, we were to include only fruits, the vitamins and minerals they contain, and possibly their health benefits or diseases caused by deficiencies, our logical puzzle would turn into an RDA problem.

For the puzzle to develop logical thinking, there must be a connection that is not obtained through research alone. Instead, research and knowledge about fruit properties should be embedded within the clues of the puzzle.

This means that students should not simply match known facts but should logically deduce connections based on indirect hints. For example, instead of explicitly stating that oranges contain vitamin C, a clue might be:

"This fruit is often recommended to prevent colds and is commonly used in fresh juices."



By structuring the puzzle in this way, students will need to combine research with logical reasoning, making the learning process more engaging and thought-provoking.

The author of this specific problem chose three categories: personalities, flowers, and fruits. Additionally, personalities are divided into two subcategories: male and female.

The first idea for including flowers was based on the fact that rose hips contain a high amount of vitamin C. This then led to the idea of incorporating birthday gifts into the puzzle.





The selected flowers are: Roses, Carnations, Orchids, Gladioli. The following fruits have been selected: bananas, strawberries, pineapple, and peaches. The names of the personalities (two male and two female) are: Aleksandar, David, Sofia and Nataša.

With these elements in place, the logical puzzle will involve connecting people, flowers, and fruits based on indirect clues, ensuring that students engage in both logical reasoning and knowledge application.



### Step 3: Constructing the Logical Structure of the Puzzle



This section is covered in the basic Brainfinity problem-creation training. Depending on your inspiration, you can either create an entirely new puzzle or adapt an existing logical structure by renaming the categories and items.

#### Key Considerations for Puzzle Validation:

- Once a solution is found, double-check that it satisfies all given clues. If a clue contradicts the solution, modify the puzzle structure accordingly.
- Ensure the clues logically lead to a single unique solution. After adjusting the clues to fit your chosen categories (personalities, flowers, fruits), verify that they still allow only one correct answer.
- Test the puzzle with multiple people. Having different people solve the puzzle in its draft version will help confirm its clarity and solvability. If testers arrive at multiple answers, adjust the clues to eliminate ambiguities.







By carefully testing and refining the logical puzzle, you ensure that it remains both challenging and solvable, keeping students engaged while developing their logical reasoning and problem-solving skills.

In this specific puzzle, the clues are as follows:

- One of the men bought a flower that has thorns, and its fruit is very rich in vitamin C.
- Sofia bought a fruit that has more vitamin A than the fruit bought by the others.
- The other man bought a fruit that has more potassium than the rest of the fruits.
- The first man is David.
- The other man bought a flower that looks like a sword.
- Sofia bought carnations.



This logical puzzle is not too challenging. However, since logical puzzles are created for an entire classroom rather than just for those who wish to compete, the emphasis should be on motivation rather than difficulty. Nevertheless, the author of this puzzle made an effort to slightly complicate the last clue by referencing the old Yugoslav film 'Strangler vs. Strangler' (Daveitelj protiv daveitelja), in which one of the main characters is a radio host named Sofia, and carnations are a recurring motif throughout the film. The author incorporated these elements into the final version of the problem.





## Step 4. Narrative

We have already emphasized how important the narrative is for motivating students. Explore students' interests and talk to them about their current interests to make the narrative more relatable to them. It is also crucial to adapt the language to their slang. For all of this, it is important that, in accordance with the principles of Education 4.0, you become a creative part of the team alongside your students.

Of course, the narrative here should follow the logical structure of the puzzle, and it can also contain a hint for solving the problem. The author of this particular problem decided to present it in video format, which is another way to further motivate students. You can also tap into the creative potential of your students and work together with them to create a suitable narrative. [Here](#), you can see how the final problem with flowers and fruit looks.



## Step 5. Evaluation

Now that you have a finished problem, give artificial intelligence a chance to solve it without providing any additional hints. If the AI gives an incorrect answer or fails to solve it, your logical puzzle is ready for the next step. However, if the AI successfully solves the problem, revisit your clues and try to formulate them in a less structured way. Aim to craft clues that require a mental shortcut or associative thinking to be correctly interpreted. Once you make the necessary adjustments, test your problem again using artificial intelligence.





## Step 6. Identification of all learning outcomes

As with the previous type of problem, it is important to identify all learning outcomes achieved through problem-solving. The best way to do this is by having other teams solve your problem, allowing you to identify the learning outcomes through their activity. The outcomes should be added to Table 1. If you are not satisfied with the number of outcomes in the right half of the table, you can reformulate some clues so that more analysis or evaluation of the necessary data is required for solving the problem.







## Step 7. Summary – Filling Out the Form



The final table for the logical puzzle is very similar to the one for the RDA problem.

|                                      |                                 |  |
|--------------------------------------|---------------------------------|--|
| Team                                 |                                 |  |
| Title of logic puzzle                |                                 |  |
| Main learning outcome                | Subject                         |  |
|                                      | Formulation of learning outcome |  |
| Intro story (ut to 2000 characters)  |                                 |  |
| Clues (from 5 to 20)                 |                                 |  |
| Solution                             |                                 |  |
| Difficulty                           |                                 |  |
| Link to the Taxonomy Table (Table 1) |                                 |  |
| Design Description                   |                                 |  |



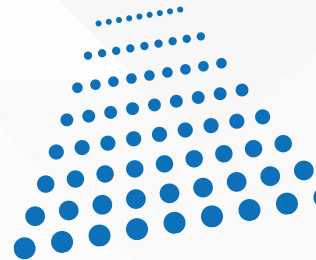


## 6.5 Detective task



Detective problems are the most creative and open-ended Brainfinity problems. As such, they are also the most complex to create. Experience shows that one of the biggest challenges in designing a detective task is maintaining focus. Due to their open nature, creators often struggle to stay focused on a single idea, jumping from one concept to another, especially when working in a team. The best advice is to latch onto the first idea and develop it to its fullest potential. If you are not satisfied with the result, then move on to considering the next idea. However, if you are satisfied, you can use the remaining ideas to create other problems.

## 6.6 Steps in creating subject oriented detective task



In this section, we will also follow the creation of a specific problem in Geography. The topic is time zones.



### Step 1. Identification of learning outcomes

Choosing learning outcomes in this type of problem can actually aid in the creation process rather than being an obstacle, as is the case with logical puzzles. This is because selecting learning outcomes will help you stay more focused and avoid the trap of having too many ideas when designing a detective problem.

In the specific problem, the chosen learning outcome is: the student understands time zones and their connection to geographical location.





## Step 2. Brainstorming



This step is crucial in creating a Detective problem. It is assumed that teachers design the problem through teamwork. It is important to write down all ideas without judgment. At the end of the process, discard ideas that are too similar to others or those considered outliers – ideas that the team agrees do not contribute to creating a strong problem. This part is very delicate and serves as a true test of your teamwork skills.

The author of this problem worked alone, making this phase much more challenging. Various ideas were considered, all related to New Year's Eve, as the problem was created just before the holiday season. This highlights another recommendation: the problem should be relevant and timely. The ideas included: taking a flight that allows continuous New Year's celebrations, determining who will celebrate the New Year first and last, finding a place where half of the people will welcome the New Year earlier and the other half later, and understanding why the New Year is celebrated earlier in some places and later in others.



## Step 3. Action Research



Choose one idea and agree on what the solution to the detective problem would be. Start researching data related to your solution. Initially, each team member can conduct research individually and then summarize the findings together. Based on your research, construct a part of the story, then continue with further research. At this stage, do not focus on refining the narrative, your priority should be building the logical structure of the problem. Repeat the research-construction process until you are satisfied with the logical framework of the problem.





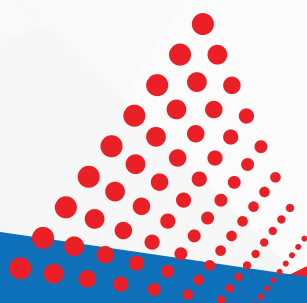
In this specific problem, the chosen idea was: Who will be the last to celebrate the New Year? Research revealed that the answer is Baker Island and Howland Island. Further investigation of these islands led to the discovery of a lighthouse on Howland Island. This lighthouse is dedicated to Amelia Earhart, the pilot who disappeared while attempting to become the first woman to fly around the world. This provides plenty of material to create an engaging detective story.



## Step 4. Narrative

Now, let your creativity run wild. The narrative in these problems is crucial, not only for motivating the solvers but also because it can either support or hinder the heuristic reasoning process. Certain words in the narrative can serve as hints, guiding solvers toward the correct path. Be mindful not to overextend the story—keep it concise and engaging. The narrative should not exceed 2,000 characters.

[On this link](#), you can see how the narrative is structured in this specific problem





## Step 5. Evaluation



And with this type of problem, it is important to check how artificial intelligence responds to it. Often, due to the nature of their work, teachers tend to construct problems with a "school-like" narrative, logically clear and structured, which makes it easier for artificial intelligence to solve them. If AI solves your problem too easily, try rewriting the narrative in a less formal way and incorporating key elements through associations. Once you've modified the narrative, check again how AI reacts to your problem.

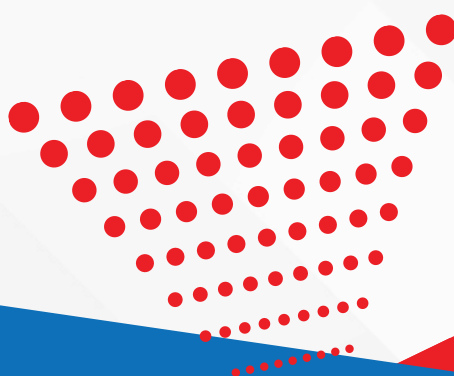
The author of this particular problem asked ChatGPT to solve it, and here is the response.

The problem is asking for the last place on Earth to enter the New Year. Based on the clue about the lighthouse and the lost friend who loved flying, the reference is likely to Amelia Earhart, the famous aviator who disappeared near Howland Island.

The last places to enter the New Year are Baker Island and Howland Island in the UTC-12 time zone. Since Howland Island has a lighthouse dedicated to Amelia Earhart, the correct answer is:

Howland Island.

Santa Claus, in the problem's narrative, is choosing to stay on Howland Island, enjoying hot chocolate while being the last to say goodbye to 2024. 🧑🌍





ChatGPT handled this problem well because the hints were very clear and straightforward. For this reason, the author moved on to another idea – where the New Year is celebrated first. There is more room for creativity here, and on Kiribati, there is a place called London that could serve as a starting point. The problem has now been reformulated as follows:

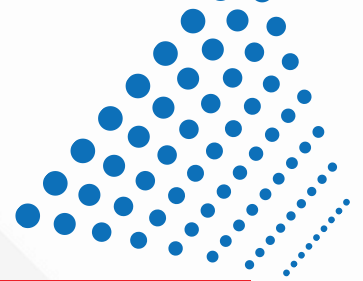
Eh, if I were in London right now, I would be the first to welcome the New Year. What a lovely village this London is. The last time I was there, I noticed something interesting. In 2015, the population of this London was the same as the year in which, on Pi Day, a German count was recorded in the U.S. patent book. He was a great inventor.

Years later, a music band jokingly took its name from him—or rather, from his invention. Although the name started as a joke, the band was anything but unserious. When I listen to them, I feel like I'm ascending to the sky.

Ah, it seems that the years have caught up with me—I talk too much. But that is to be expected from Santa Claus, ho-ho-ho! Your task is to unravel this riddle: tell me the name of the place being described, who the mysterious count is, and which music band is in question.



ChatGPT was consulted again, and here is its solution.



Let's solve the problem step by step.

1. London – Obviously, this is not the capital of the United Kingdom, since it's referred to as a "village." It is likely a smaller place named London.
2. Population in 2015 – The population number matches the year when "on Pi Day" (March 14), a German count was recorded in the U.S. patent book.
3. German count and patent – This points to Count Zeppelin (Ferdinand von Zeppelin), who is famous for his patents related to airships (zeppelins).
4. A band named after him – This clearly refers to Led Zeppelin, the legendary British rock band.
5. A London with the same population as 2015 – This refers to London in Canada (London, Ontario). Its population in 2015 was approximately 366,000, which corresponds to the year 1366, the birth year of Ferdinand von Zeppelin.

Answer:

Santa Claus is in London, Canada, not London, UK.

ChatGPT has partially solved the problem but did not take into account that Santa Claus would be the first to celebrate the New Year if he were in London. Additionally, the problem should emphasize that clear evidence must be provided to illustrate the solution



## Step 6. Identification of all learning outcomes

This step is not much different from identifying learning outcomes in the previous two types, so it will not be discussed further here.





## Step 7. Summary – Filling Out the Form

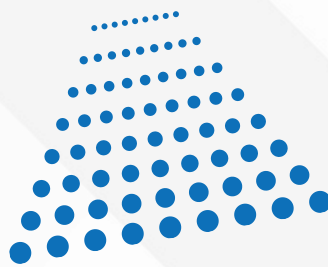


The final table for the detective task is below.

|                                         |                                 |  |
|-----------------------------------------|---------------------------------|--|
| Team                                    |                                 |  |
| Title of logic puzzle                   |                                 |  |
| Main learning outcome                   | Subject                         |  |
|                                         | Formulation of learning outcome |  |
| Intro story (up to 2000 characters)     |                                 |  |
| Task formulation (up to 500 characters) |                                 |  |
| Solution                                |                                 |  |
| Difficulty                              |                                 |  |
| Link to the Taxonomy Table (Table 1)    |                                 |  |
| Design Description                      |                                 |  |



## 6.7 Deciphering



This type of Brainfinity problem can be very easily used in teaching when introducing new lessons. For example, if you want to introduce new concepts. If, in physics or chemistry, you want to familiarize students with the concept of the atom, you can simply encrypt a text about it and tell students that by deciphering the text, they will learn details about what the world is made of.

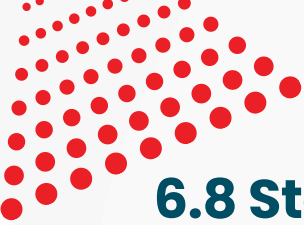
Here, the key learning outcome is not achieved directly through problem-solving, but rather by deciphering the text, which then leads to reading and achieving the primary learning objective. The process of deciphering itself is challenging for students, keeping them engaged with the text that gradually reveals itself before their eyes, making it more deeply ingrained in their memory.

Of course, this is an example where the primary outcome is at the lowest level of Bloom's taxonomy, but depending on the type of cipher used, higher-level outcomes can also be achieved, even if they are not directly related to physics or chemistry instruction.

It is much more challenging to create a cipher whose decryption directly achieves specific learning outcomes. The next section will demonstrate exactly that—how the application of a mathematical concept from elementary school can be used to break a cipher.







## 6.8 Steps in creating cipher whose decryption achieves specific learning outcomes

As previously mentioned, it is not easy to create a cipher whose decryption achieves a predetermined learning outcome. This requires significant inspiration and creativity. The simplest way to use this type of problem in teaching is in mathematics, as many mathematical concepts in arithmetic and algebra can be utilized to create a cipher.



### Step 1. Identification of learning outcomes

You typically won't decide to create a decryption-type problem right before selecting the learning outcome. Instead, you will choose this type of problem if the selected outcome inspires you to create a well-designed cipher.

The example we will follow here is a learning outcome in mathematics: The student applies the greatest common divisor in problem-solving



### Step 2. Research

After selecting the learning outcome, you begin an in-depth investigation into how the concepts within that outcome can lead to the creation of a cipher, whose decryption will fulfill the intended learning goal. It is highly likely that at some point, you may abandon this approach and shift towards creating a different type of Brainfinity problem that will still achieve the chosen outcome.

In this specific case, the research leads us to encryption using multiplication by a prime number, which you can learn more about in the video at the provided [link](#).





### Step 3. Creating cipher



Through the research process, you have arrived at an idea for creating a cipher whose decryption will lead to achieving the chosen learning outcome. Now, you must be very precise in designing this cipher to avoid any mistakes, which can be difficult to detect in this type of problem. Ensure that the encryption is unique—meaning different texts should not produce the same cipher, and there should be no text that cannot be decrypted.

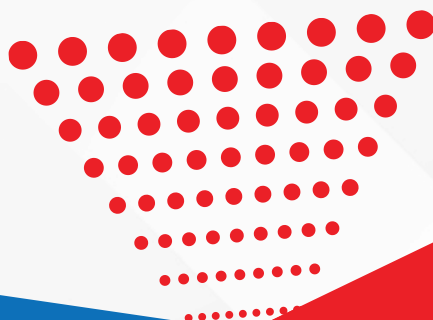
In this specific example, the idea is to first convert a word into a number and then multiply that number by a large prime number (the key), as explained in the video. This process presents two challenges: how to convert a word into a number and how to find a large prime number.

The second problem is much easier. We can simply use a reliable mathematical tool, such as Wolfram Alpha, to find a large prime number—for example, the millionth prime number.

The first problem is more complex. The most straightforward approach is to replace each letter with its position in a given alphabet, such as the English alphabet. However, this creates an issue: "12" could represent the letter L, but it could also represent two letters, A and B (1 and 2). This means the encryption would not be unique.

There are two ways to solve this:

1. Use special markers to indicate where one letter ends and another begins.
2. Represent each letter using a fixed two-digit format (e.g., A = 01 instead of 1), ensuring that every letter is always represented by exactly two digits.





By applying the second method, the encryption remains consistent and unambiguous, making decryption possible without confusion.

The issue with the second method is that numbers can start with zero, which destroys uniqueness. To solve this, we would need to add a prefix digit before each number to prevent it from starting with zero. However, the author of this problem chose the first method instead.

The first idea was to insert a "0" or "00" between letters. The author opted for "00" because it makes the separation between letters more visually noticeable. For example, encrypting the word "Brainfinity" using this method results in: 200180010090014006009001400900200025

Now, we still need to find a large prime number. The millionth prime number is 15485863.





## Final encryption process:

Multiply the number representing the encrypted word by 15485863, and the word is now securely encoded.

## Connection to the Greatest Common Divisor (GCD):

If the message contains multiple words, then 15485863 becomes a common divisor of all the numbers representing the encrypted words. This means that finding the GCD of the encrypted words will reveal the prime number used for encryption, making it possible to decode the message systematically.



## Step 4. Narrative



Now that the cipher has been created, it is necessary to come up with a **good narrative**, preferably a **mysterious one**, to **motivate students** to solve the problem. The text being translated should match the narrative.

In this example, the text could start like this:

"Anti-problem-solving agents have managed to intercept a message about an important project aimed at developing problem-solving skills in young minds."

The intercepted message could be: "**Brainfinity detectives.**"

To proceed with the rest of the text, we first need to **encrypt these two words.**

The first word, "**Brainfinity**", has already been converted into numbers, so we just need to **multiply that number by the key**, the prime number **15485863.**





This gives us the result:

**3099960211592574565136572461148574259746575.**

Now, we also need to encrypt the word "**detectives.**"

In the first step, we convert it to:

**40050020005003002000900220050019.**

After multiplying it by the key, we get:

**620209122944735803574666684364447381397.**

The text can then continue as follows:

*"The message consists of two numbers:*

*3099960211592574565136572461148574259746575 and*

*620209122944735803574666684364447381397. What does this message mean?"*



When dealing with **decryption problems**, there is always a possibility that the cipher is too complex and that hints are necessary to solve it.

You can always prepare **hints** in advance and provide them to students **when needed**.

Possible hints for this problem include:

- **Hint 1:** The millionth prime number is the key.
- **Hint 2:** These numbers have something in common.

You can **formulate the hints** in any way you like and give them to students if they get completely stuck on the problem.





## Step 5. Evaluation

As with the previous types of problems, you should check whether artificial intelligence can directly solve the problem. This will happen if you have used a well-known cipher, such as the **Caesar cipher**. In this example, artificial intelligence is powerless.

In this particular example, it is necessary to examine what the greatest common divisor provides us. We can check this using a mathematical application, such as Wolfram Alpha. The following image shows the result.

```
gcd(620 209 122 944 735 803 574 666 684 364 447 381 397,  
3 099 960 211 592 574 565 136 572 461 148 574 259 746 575)
```

Result

15 485 863

Additionally, it is important to **test** the problem before using it in the classroom by sharing it with your colleagues or other individuals and observing how they solve it.

This can help you **reformulate the narrative** and create **new hints** to improve the problem-solving experience.





## Step 6. Identification of all learning outcomes

This step is not much different from identifying learning outcomes in the previous two types, so it will not be discussed further here.



## Step 7. Summary – Filling Out the Form

The final format for decryption problems differs slightly from the previous format. Pay special attention to accurately entering the encryption rules. Also, when filling out the outcome table, keep in mind that multiple outcomes related to quantitative skills, especially arithmetic and algebraic skills, typically appear.



|                                         |                                 |  |
|-----------------------------------------|---------------------------------|--|
| Team                                    |                                 |  |
| Title of deciphering task               |                                 |  |
| Main learning outcome                   | Subject                         |  |
|                                         | Formulation of learning outcome |  |
| Intro story (up to 1000 characters)     |                                 |  |
| Encrypted text (up to 2000 characters)  |                                 |  |
| Task formulation (up to 200 characters) |                                 |  |
| Encryption rules                        |                                 |  |
| Decrypted text                          |                                 |  |
| Difficulty                              |                                 |  |
| Link to the Taxonomy Table (Table 1)    |                                 |  |
| Design Description                      |                                 |  |

Table 5: Deciphering task form





# 7. Additional Resources and Support

## Online Platforms and Resources

- Brainfinity Website: Visit the Brainfinity website for additional information and resources.
- Brainfinity social media (Instagram, Facebook): Connect with us to learn even more about the project.
- Brainfinity Collaborative Problem Solving Challenge Online Resource Hub: Get access to quick information that you can use when working on the methodology.

We are committed to supporting you on your Brainfinity journey. Don't hesitate to reach out if you have any questions or need assistance. Together, we can empower students to become the problem-solvers and creative thinkers of tomorrow.



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