brainfinity
COLLABORATIVE PROBLEM SOLVING CHALLENGE

TRAINING METHODOLOGY & IMPLEMENTATION SET

Co-funded by the European Union

PROJECT NR: 2022-1-PT01-KA220-SCH-000086691

INDEX

brainfinity
COLLABORATIVE PROBLEM SOLVING CHALLENGE

TRAINING METHODOLOGY

PART 1 - THEORETICAL PART

1.1 Introduction to Brainfinity teachers' training

Context

Welcome to the BRAINFINITY Teacher Training program, an innovative approach designed for teachers of students aged 11-14. It has been created within The Brainfinity Detectives - Collaborative Problem Solving Challenge - Strategic Partnership in School Education project co-funded by the EU Commission's Erasmus+ Program under Project Nr: 2022-1-PT01-KA220-SCH-000086691.This project brings together a diverse mix of participants, including schools, NGOs, companies, and training experts, spanning across Portugal, Slovenia, Bulgaria, and Serbia. Our goal is to empower educators with the skills and knowledge to foster problem-solving abilities in their students through the engaging and thought-provoking use of detective tasks.

This training program is rooted in the specific objective of educating teachers to create and implement detective tasks that encourage students to think critically, research effectively, and synthesize information from various sources. By doing so, we aim to stimulate the development of functional knowledge among learners. This approach aligns with the overall objectives of our project, which focuses on enhancing teachers' abilities to motivate and engage students, while also facilitating a reorganization of traditional teaching methods.

Recognizing the need for innovative and comprehensive methodologies in developing problem-solving skills, our Serbian partner has successfully piloted the Brainfinity methodology. This approach, which utilizes detective tasks to cultivate problem-solving skills, has shown promising results during its initial phase in 2020. However, we are adapting this methodology for international application to achieve a broader impact.

A unique aspect of this program is its focus on problem-solving skills through detective tasks, a method not extensively explored at the EU level. The program facilitates learning and enables teachers to develop the most effective strategies for their students. Continuous improvement is a key feature, with enhancements based on insights from pilot testing.

Objectives of the training

The Brainfinity teachers' training program aims to equip educators with the skills to enhance problem-solving and critical thinking in students aged 11-14 through interactive, detective-themed educational activities.

The BRAINFINITY teacher training will equip educators with diverse methods, tools, good practices, and real-life examples to implement in their classrooms. It includes clear instructions on how to integrate detective tasks into their teaching, covering aspects such as:

- Steps for creating engaging detective tasks.
- Essential requirements that these tasks must meet.
- Tailored training programs that guide teachers in formulating and implementing these tasks effectively.

By participating in this training, teachers will be well-prepared to bring a dynamic and interactive learning experience to their classrooms that captivates young minds and significantly boosts their problem-solving skills.

Anticipated outcomes

The Brainfinity teachers' training program is designed to enhance the educational landscape significantly. Key anticipated outcomes include teachers developing advanced skills in creating and implementing detective-themed problem-solving tasks, leading to more engaging and age-appropriate student challenges. This approach is expected to increase student engagement and interest in learning, particularly in problem-solving activities, making education more interactive and enjoyable.

Students will benefit from improved critical thinking and analytical skills, essential for academic and real-life problem-solving. The training also aims to boost teacher confidence and competence in facilitating these activities, fostering a collaborative spirit among students for group problem-solving tasks. Overall, this innovative approach is set to positively influence school culture, nurturing a love for learning and intellectual curiosity.

1.2 Teacher's skills required for this project

From the project's title, it may be inferred that teachers are expected to possess highly developed quantitative skills. While a strong foundation in quantitative knowledge, especially in working with data, is necessary for good performance in the Brainfinity competition, it is not expected that the teacher mentor be an expert in mathematics and related disciplines. For successful team leadership in the competition and the implementation of the Brainfinity Detectives project principles in regular teaching, it is most important for the teacher to develop key soft skills.

First and foremost, teachers must **understand the cognitive and affective processes** that students go through while solving problems. This understanding is crucial because it enables teachers to guide students more effectively, fostering an environment where critical thinking and problem-solving skills can thrive. **Participating in problem-solving team workshops is essential for teachers.** These workshops are designed to provide hands-on experience, allowing teachers to engage in solving problems themselves. This practical involvement helps teachers to identify the cognitive and affective processes they experience on a metacognitive level, which in turn enhances their ability to empathize with and support their students.

Additionally, teachers should be adept at **identifying learning outcomes through problem-solving**. Recognizing these outcomes is vital for tailoring instruction to meet students' needs and for ensuring that the problem-solving activities are aligned with educational goals. Teachers preparing for Brainfinity mentorship need to independently organize themselves into teams and solve Brainfinity problems. This collaborative approach not only mirrors the student experience but also fosters a sense of camaraderie and shared purpose among teachers.

The continuation of the workshop involves a **critical self-assessment of solutions** and teamwork. Teachers will provide constructive feedback to other teams, focusing on both the solutions presented and the teamwork dynamics observed. This feedback loop is essential for **continuous improvement** and for **developing a reflective practice** among teachers. Following this, teachers in teams identify learning outcomes from their problem-solving activities. A thorough discussion about these outcomes takes place among all workshop participants, providing a platform for sharing insights and strategies.

In summary, while quantitative skills are beneficial, the emphasis of the Brainfinity Detectives project is on developing soft skills, understanding cognitive and affective processes, and fostering a collaborative and reflective practice among teachers. These elements are crucial for successfully leading student teams in the Brainfinity competition and for integrating problem-solving and critical thinking into everyday teaching practices.

1.3 Mentoring students in the arguing position process

A very important activity for teachers is coming up with Brainfinity problems. In this activity, teachers awaken their creativity and deepen their understanding of learning outcomes, which is crucial for Brainfinity competition mentors. It's important that the problems meet specific criteria, namely: they should be engaging for the intended age group, adequately challenging but not overly difficult, promote teamwork, require students to engage in research, act as a motivational force in the learning process, foster the development of crucial life skills alongside academic knowledge.

Mentoring students in the art of arguing positions is a crucial aspect of developing their critical thinking and communication skills. Arguing positions is not just about stating an opinion; it involves presenting a well-reasoned case, supported by evidence, to persuade others of a particular viewpoint. Here's an elaboration on the steps and practices involved:

Defining the Stance: It's essential for students to start by clearly articulating their position on a topic. This step involves understanding the core of what they are asserting and being able to succinctly state their viewpoint.

Gathering Relevant Information: Students should be encouraged to research their topic thoroughly. This means looking for information from reliable sources, understanding the context of the issue, and gathering facts that are pertinent to their stance.

Providing Evidence: The strength of an argument often lies in the evidence provided. Students should learn to back up their assertions with credible sources, including facts, examples, statistics, and expert opinions. This not only strengthens their argument but also demonstrates their understanding of the topic.

Considering Counterarguments: A critical aspect of arguing a position is acknowledging and addressing opposing viewpoints. This shows that the student has considered the topic from multiple angles and is prepared to discuss and refute counterpoints logically.

Maintaining Logical Structure: Organizing arguments in a coherent and logical manner is key. This involves structuring the argument in a way that is easy to follow and makes logical sense, leading the audience through the reasoning process step by step.

Using Persuasive Language: The choice of words and phrases can significantly impact the persuasiveness of an argument. Students should be guided to use language that is convincing, assertive, and resonates with their audience.

Being Open to Discussion: Effective argumentation is not just about presenting a case; it's also about engaging in dialogue. Students should be open to questions, willing to discuss different aspects of the topic, and able to engage in constructive debate.

Concluding Effectively: Summarizing the main points and reinforcing the stance at the end of the argument is crucial. A strong conclusion leaves a lasting impression and succinctly encapsulates the essence of the argument.

To practice these skills, a practical exercise like debating the popularity of different sports can be very effective. This exercise not only engages students in a topic that is often of personal interest but also challenges them to apply the steps of argumentation. By dividing them into groups and having them defend a particular sport's popularity, students are encouraged to research, gather evidence, and present structured arguments.

During the presentations and subsequent debate, the focus should be on distinguishing between mere opinions and well-supported arguments. It's also an opportunity to discuss the credibility of different data sources and the importance of using reliable information. This exercise hones their argumentation skills and fosters critical thinking, research skills, and the ability to engage in respectful and productive discussions.

For more practical exercises in developing students' skills needed for effective detectives' tasks solving, please refer to the Brainfinity Educational content (WP2)

PART 2 BRAINFINITY LOGIC PUZZLES AND TASKS

Brainfinity problems are designed to develop the most important skills of today's era, the era of the Fourth Industrial Revolution. These skills primarily include problem-solving, creative thinking, critical thinking, teamwork, communication, collaboration with artificial intelligence, data analysis, and the use of information technologies.

The problems are from real-life contexts or closely resemble real-life situations, and they are tailored to students' experiences and interests. The language used is familiar to students, and the context is intriguing, capturing their attention and prompting them to engage all their intellectual capacities.

Solvers are encouraged to utilize all possible resources, from assistance from friends and experts to the use of various applications and artificial intelligence.

There are several types of Brainfinity problems, and below are descriptions of their characteristics along with corresponding examples. They are grouped in two main categories: Logical Puzzles and Detective’s problems.

Logical puzzles:

- Open ended logical puzzle
- Logical puzzles with unique solutions

Brainfinity detectives' tasks:

- Brainfinity detective problems with unique solution
- Open-ended Brainfinity detective's problems
- Deciphering

The logic puzzles and tasks presented in the next sections serve as examples of this type of problems. Additional versions of these problems, designed for practice, are included in the booklet.

2.1 Open ended logical puzzle

These problems focus on the development of logical and algorithmic thinking. They represent the lower levels of higher-order thinking, yet it's crucial to develop them as they serve as powerful tools in problem-solving. Problems in this group are open-ended, meaning there are multiple solutions, but solutions may differ based on criteria not explicitly stated in the problem itself. This opens up the possibility for quality discussions about solutions, fostering the development of critical thinking and communication skills. It's best for such problems to closely resemble real-world issues, as problems of this type are often encountered in the job market and daily life. Problem 1 is an example of this type of problem.

Problem 1: Doctors Schedule

In the "Brain" hospital, there needs to be one on-call doctor at all times. They work in three shifts: morning, afternoon and night.
To ensure that there is always a doctor on call, a weekly on-call schedule needs to be created.
There has to be one doctor in each shift. The hospital has five doctors available for on-call duties. Each doctor has a list of days when they are available for on-call duty and some special requirements. This is shown in the table.

DOCTOR	AVAILABLE TIME SLOTS
Anton	Friday, Saturday and Sunday
Bogdan	Every day in the morning and afternoon, never at night
Vasilije	Every day except night shifts on the weekend
Goran	Every day, all shifts
Damir	Every day, all shifts, but at most two night shifts

In addition, the following rules must be followed:

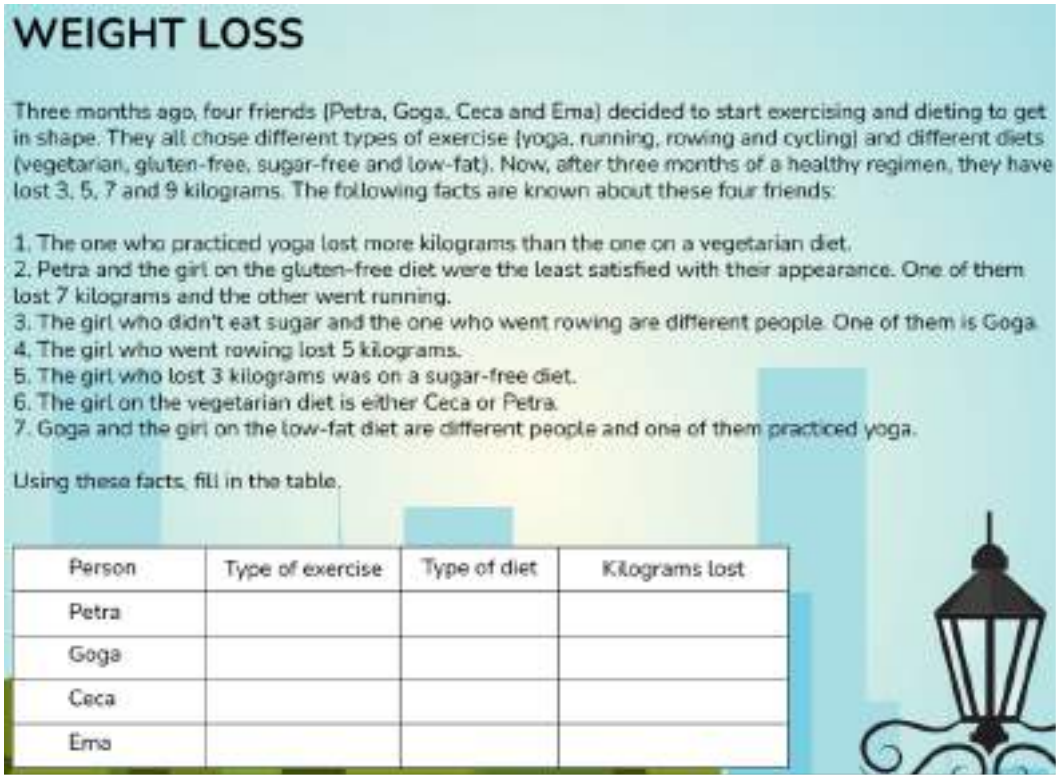
1. A doctor can have at most one on-call duty per day.
2. A doctor can be on call only when they have an available slot (see the table).
3. If a doctor works a night shift, then the next day they must be off or work another night shift.
4. A doctor can work a shift on both weekend days or neither.

Your task is to create an on-call schedule while adhering to all the rules mentioned. Please also write about your approach to solving the problem, whether you used any app and if there are multiple solutions.

2.2 Logical puzzles with unique solution

Like problems from the previous type, these problems also develop algorithmic and logical thinking, with a greater emphasis here. They have a unique solution, and it's easy to verify whether the solution obtained is correct, i.e., whether it satisfies all the criteria (clues). These are problems of the so-called Einstein puzzles, which you can learn more about at the following link. You can find more problems of this type at the following link, where you can choose the difficulty and size of the problems. Please note that the problems on this link may not have the best-structured narrative, but they can be useful for further enhancing your logical and algorithmic thinking. Problems 2 and 3 are examples of this type of problem.

Problem 2: Weight Loss



Problem 3: Mobile Apps

Anita is writing a blog about mobile applications that were released in 2022. For this purpose, she collected data on five applications: Bubble Bombs, Castle Crunch, Flowcarts, Peter Parka and Wizard World. Unfortunately, when she was near completion, her account for the "Gamezio" database was suspended, and she could no longer access data on these applications. She remembers that all of them were released in different months, from March to July, and these are all applications developed by different companies: Apptastic, BeGamez, Digibits, Novio and Vortia. Luckily, she had some information on paper. She organized that information and here it is for you:

- These applications had 3.1 million, 5.5 million, 6.8 million, 7.2 million and 8.9 million downloads by the end of 2022.
- The application released in April did not have 5.5 million downloads.
- Bubble Bombs was developed by the company Novio.
- The application with 7.2 million downloads was not developed by the company Vortia.
- The application developed by the company Apptastic was released one month before the Flowcarts application.
- BeGamez did not develop Castle Crunch.
- Castle Crunch and the application developed by the company Apptastic are different applications. One had 7.2 million downloads and the other was released in April.
- The application with 5.5 million downloads was not developed by the company BeGamez.
- The application with 3.1 million downloads was not released in May.
- In May and June, applications developed by Wizard World were released with 6.8 million downloads.
- Flowcarts and the application with 7.2 million downloads are different applications and neither was released in June.
- The application with 3.1 million downloads was not released in April.
- The application with 5.5 million downloads was not developed by the company Novio and one of these two was released in March.

Your task is to connect the applications with the companies that developed them, with the number of downloads and the month they were released by filling in the following table:

Month	App name	Company	Downloads
March			
April			
May			
June			
July			

2.3 Brainfinity detective problems with unique solution

These problems have proven to be the most engaging for students and represent the core of the Brainfinity project. They are detective problems with very interesting contexts closely aligned with students' interests. These problems challenge students to explore and collaborate as a team to solve them.

In addition to logical and algorithmic thinking, they also develop associative thinking, collaboration with artificial intelligence, and the use of information technologies. Many of these problems also develop quantitative skills.

The closed nature of the solutions has its pros and cons. On the downside, it limits creativity, but on the upside, solvers can be confident they've found the correct solution, and evaluation is straightforward. This closed nature allows these problems to be transformed into escape room-type challenges.

Even in team-building activities within companies, collaborative solving of such problems is recommended, but it's challenging to find these problems online. Developing these problems is one of the main goals of this project. The following problems illustrate this type.

Problem 4: Journey

Dear Brainfinity participants, we're sending you on an interesting journey.
First, head to Brighton.

A giant fingerprint will show you the way to the golden crescent.
Go to the end of the road and you'll encounter a king.
He hasn't always been called that.

His previous name is the same as the name of a great scientist who died three years after the king.

In the summer of the same year the scientist passed away, the world of fun gained a very interesting place.

If you haven't been there, you should go immediately, virtually, of course, and send us a photo from that place along with evidence that we directed you there.

Problem 5: Santa Claus

Problem 6: Actor

Problem 7: Lost Friend

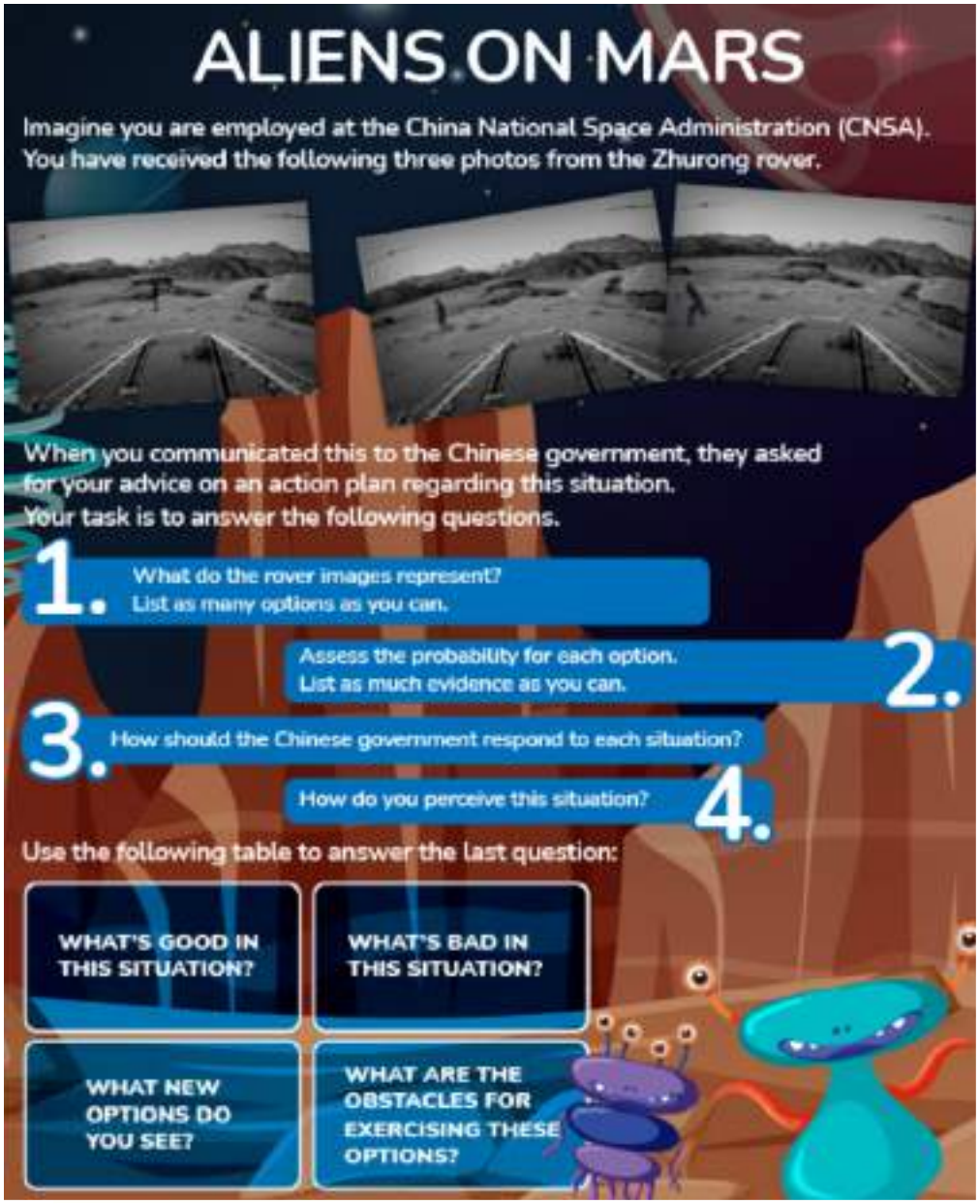
2.4 Open-ended Brainfinity detective problems

Unlike the problems of the previous type, the solution is not unique in these detective puzzles. This emphasizes the development of creative and critical thinking in solvers, particularly the skill of decision-making. It also opens up the possibility of organizing discussions about problem solutions, with a special focus on criteria that are not explicitly stated.

Like the previous type of problems, these problems are highly attractive to students. The following problems illustrate this type, with the first being a transitional variant between these two types. It presents a problem with a unique solution until the final step, where divergent thinking comes into play.

Problem 8: Leader

Problem 9: Aliens on Mars



Problem 10: FBI

Problem 11: Syracuse

2.5 Deciphering

Cryptanalysis is the study of analyzing and deciphering codes or ciphers in order to understand their content without having access to the key or algorithm used for encryption. It involves techniques such as frequency analysis, pattern recognition, and mathematical analysis to break the encryption and reveal the original message. Cryptanalysis is essential in the field of cryptography for testing the strength of encryption methods and developing stronger algorithms to protect sensitive information.

These problems are very interesting to students and mentally quite demanding. Additionally, solving them requires students to have a high level of quantitative skills, developed divergent thinking, and creativity. Cryptanalysis often involves mathematical concepts such as probability, algebra, and number theory. By engaging in cryptanalysis activities, students can improve their mathematical skills in a practical and engaging way.

Understanding how encryption works and how it can be broken helps kids become more aware of cybersecurity issues. They learn the importance of protecting their personal information and the consequences of weak encryption methods.

Cryptanalysis sometimes requires thinking outside the box and coming up with innovative approaches to break codes. Encouraging kids to engage in cryptanalysis fosters creativity and innovation.

Cryptanalysis is a valuable skill in various fields, including cybersecurity, intelligence, and law enforcement. Introducing kids to cryptanalysis at a young age can spark their interest in these fields and prepare them for future career opportunities.

Overall, solving problems from cryptanalysis not only equips students with valuable skills but also empowers them to become more informed and responsible digital citizens.

The following tasks illustrate cryptanalysis problems adapted for students. All of these problems contain basic concepts of cryptography within them.

Problem 12: Decode the message

Meomqe od ybe yvenyt-dakjy genyxkt, Ckeeyancj!

A ip vkayanc ybaj qeÿyek vayb ybe jmegadag anyenyaon od jbikanc jope mekjoniq yboxcbyj vayb yboje od tox vbo ike iqkeift dipaqaik vayb ewenyj vbagb yoor mqige hedoke inf fxkanc pt qadeyape, vbagb ike feyiaqef an ybe hoor. Qocag fagyiyej ybiy pt goppenyj vaqq he wakyxiqqt peinancqejj yo yboje vbo ike noy dipaqaik vayb ybe gakgxpjyingej.

Vbaqjy toxk ixybok, Fiwaej, bij fone i gkefahqe soh od feqawekanc tox lxaye jope gonjafekihqe anjacbyj anyo ybe jayxiyaonj vbagb jxkkoxnfef pe, iqonc vayb ybeak bajyokagiq gixjej inf higrckoxnfj, ybeke ike ybancj od vbagb be goxqf noy mojjahqt he ivike.

A biwe newek gonjafekef ptjeqd yo he i Ykinjtqwinain. A vij hokn ybeke, gekyianqt, hxy ay vij fxkanc ybe yape ybiy pt mikenyj qawef ybeke an i jeqd-apmojef euaqe. Ay noy onqt pife qade jidek dok pt poybek, hxy iqjo remy pt diybek iy ikp'j qencyb dkop voxqf-he ijjjjanj – be bif pxkfekef wikaoxj pephekj od ybe kawiq Boxje od Finejya inf ybe dipaqt vij oxy dok baj hqoof.

Iqq oxk gonwekjiyaon ihoxy 'bope' bancef on Viqqigbai, inf oxk ckeiyejy fkeip vij yo he ihqe yo keyxkn ybeke inf mkogeef vayb nokpiq qawej – iy qeijy, ij nokpiq ij tox goxqf eumegy dok i vikqokf inf baj dipaqt.

Qooranc higr iy ay, pt gbaqfboof vij newek vbiy tox pacby giqq eijt. tej, pt hkoybek inf A bif ckeiy dxn vben ve veke rafj, hxy pojy od ybiy vij fxe yo ybe gonjyiny iyyenyaon od oxk poybek, vbo faf bek hejy yo reem xj oggxmaef fxkanc ybe qonc mekaofj od pt diybekj ihjengej. Fejmaye pt poybekj hejy eddokyj. A danf ptjeqd xnihqe yo fejgkahe int miky od pt qade ij heanc intybanc oybek ybin bikf, ok faddagxqy. Heanc ybe jon od ybe vikqokf vijn'y ij eijt ij tox pacby ybanr.

Ij tox rnov, A vij onqt dawe vben A vij anfxgyef anyo ybe okfek inf cawen ybe ckely kejmonjahaqayt od fedenfanc oxk goxnykt icianjy ybe enept. veqq, ay jeepef qare dxn iy ybe yape, hxy ay keiqqt vij i qayyqe pxgb dok i dawe teik oqf.

Inf ij in euyenjaon od ybiy, vbiy pt diybek faf yo pe inf Kifx an 1442 vij beikyhkeiranc inf joxq-fejykotanc. Ay vij xndokcaweihqe, fejmaye ybe oxygope. A fon'y rnov vbo deqy ay vokje, Kifx ok pe, hxy jopebov A ybanr ybiy Kifx gipe oxy od ay i qayyqe ibeif od pe. Be vij toxncek, noy ij jekaoxj inf poke dqeuahqe – sxjy qoor iy vbo baj nev hejy dkaenf dokewek yxknef oxy yo he!

Iy ybe yape vben A dakjy engoxnyekef oqf Diybek Cijyon. A vij ptjyadaef ht ybe kimmoky heyween bap inf pt poybek, inf ay kepianef i ptjyekt yo pe dok bxaye jope yape. Ewenyxiqqt, gxkaojayt coy ybe heyyek od pe, inf A immkoigbef pt poybek ihoxy ay. Pt jxjmagaon, ij tox kegjqq, yxknef oxy yo he vkonc. No jxkmkaje ybeke... bov vij i yo rnov?

Inf tej, A faf jee ybe cakq nipef Rkajya Sobnjon, hxy noy an toxk rnkejeny yape. Tox pxjy kepephek ybiy A vij feiqanc vayb bxaye in epekcengt iy ybiy popeny. inf A vijn'y ewen anlxajayawe ihoxy bek. Dok ybe Nev Vokafekj iponc tox inov rnovn ij ipekaginj), ay jeepj ybiy toxk coweknpenyj biwe diaqef yo afenyadt jope od ybe japmqejy noyaonj vbagb xnfekqae i nxphek od toxk gxkkeny mkchqepj. Ay aj faddagxqy dok pe yo jee bov ybet goxqf biwe pajjef jxgb ohwaoxj digyokj vben A moanyef ybep oxy, wekt gikedxqqt inf gqeikqt vit higr an 1456, iy ybe dakjy peeyanc A bif vayb ybe hotikj ly Gxkyei fe ikcej. Ybancj biwen'y gbincef.

Inf jmeiranc ihoxy ybiy peeyanc... Tej, od goxkje A anyenfef ybe mxn. Fo tox jekaoxjqt ybanr ybiy i pin vbo jmeirj dawe qincxicej inf jmeny fegifej jyxftanc qocag inf piybepiyagj voxqf pire i sore ht iggafeny?! Qey pe yeqq tox; yo pe, ay vijn'y ybe mqit on vokfj vbagb vij dxnnt. Ybe dxnnaejy miky vij ybe qoorj on ybeak digej inf ybe digy ybiy ybet veke yoo jgikef yo qixcb. Nov ybiy vij keiqqt baqikaoxj!

Ht ybe vit, A fon'y fo intybanc ht iggafeny.

Assignment no. 1: We would like to send them the following message: "We want to be friends with you." However, we want to make sure the code is correct. And that's your first task – code this message so that we can send it to the aliens.
Assignment no. 2: The second assignment is much more complex. Your task is to create an app that codes and decodes messages.

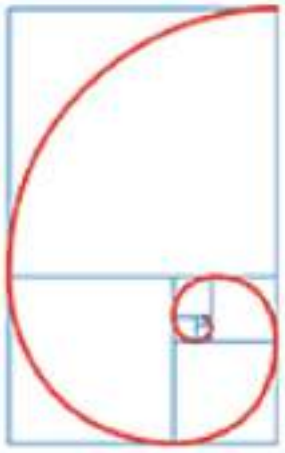
Problem 13: Fibonacci

"I watched the video you recommended for us to watch just before the Brainfinity Challenge in 2022 and it inspired me so much that I wanted to get into cryptography. I explored various forums to find the best way to learn cryptography and a mysterious figure who goes by the name of Mys Tery replied to me:

Look for this address:

267914296° 10946' 14930352" N
308061521170129° 5' 1346269" W

You will find all the answers there.



At first, I thought these were geographical coordinates, but they were too large. I tried in vain to figure out what these numbers meant and then I asked for help from the mysterious figure. However, he dismissed me by writing: Ask Fibonacci.

How can I ask Fibonacci?! He has long been dead!

Please help me solve this puzzle; it has intrigued me a lot."

Problem 14: Scientist's message

PART 3 TEACHER TRAINING

Our aim is to train you in this section to create Brainfinity problems on your own so that you can improve your teaching practice and successfully organize a Brainfinity competition in your community. As you have seen in the previous chapter, solving Brainfinity problems requires a range of skills important in today's world, and creating problems requires even more. Especially in creating Brainfinity problems, it's important to think outside the box, to let your imagination run wild, and to let your creativity flow.

It's crucial to harness the synergy of the team because it expands your mental horizons and boosts your creativity. So, everything you do within this training is in collaboration with the team, and you strive to listen to each other, respect others' opinions and arguments, and help team members give their intellectual best in this challenging task.

We've divided this training into five phases, which are not evenly distributed in terms of duration or the level of demand.

3.1 Building Brainfinity skills

To successfully create a Brainfinity problem, you must first become familiar with this type of problem directly. You will best do this by solving problems. In this phase, you will work on solving the 14 problems listed in Chapter 2, exactly in that order. In problems 2 and 3, you can use the tool at the link. Please follow the important stages in problem-solving.

3.1.1 Stage 1: Brainstorming

Brainstorming is a creative problem-solving technique used to generate a large number of ideas or solutions to a specific problem or challenge.

Create a comfortable and relaxed environment conducive to free thinking. Start by clearly defining the problem. This sets the focus for the brainstorming session.

Encourage you and your teammates to suspend judgment and criticism during the brainstorming process. Generate as many ideas as possible, regardless of feasibility or quality. Quantity is key at this stage. Ideas should be brief and to the point.

Think creatively and explore different perspectives. Build your ideas on ideas of your team mates. One idea may spark another, leading to even more creative solutions.

Record all ideas without judgment or evaluation. This can be done on a whiteboard, flip chart, or digital document where everyone can see the proposed ideas.

Brainstorming is a versatile technique that can be used in various settings, from business meetings to classroom activities, to generate creative solutions to problems and stimulate innovation.

3.1.2 Stage 2: Evaluation and selection of ideas

After the brainstorming session, review the list of ideas and identify those that stand out or have the most potential. Refine and consolidate similar ideas. Evaluate the ideas based on criteria such as feasibility, effectiveness, and alignment with goals. Select the most promising ideas to pursue further.

3.1.3 Stage 3: Action Planning

Develop an action plan for implementing the selected ideas. Assign responsibilities and establish a plan for monitoring progress. If necessary, divide the problem into several parts and assign roles, specifying who will do what in the team.

3.1.4 Stage 4: Investigation

In accordance with the action plan, conduct all necessary research and record the conclusions you have reached. This phase can be conducted collaboratively, or each team member can conduct it individually, according to the assigned roles.

3.1.5 Stage 5: Formulating the solution

This is the phase where all the pieces need to come together into one solution. In this phase, it's important to formulate the solution in a way that is understandable and convincing to everyone. Here, you should use some classic techniques of critical thinking.

Imagine first that your team is presenting this solution to a client whom you need to persuade of the accuracy and effectiveness of your solution.

Also, imagine if someone else presented this solution to you as a client; would you be satisfied?

Finally, consider your solution as if it were from a competing team and try to critique it. After passing through these three tests, formulate the final solution. Upload your solution as a Google document.

3.1.6 Stage 6: Group-level evaluation

In this phase, all solutions should be visible to all groups. Teams then work on evaluating the solutions of other teams using the provided tables, which should be open in a Google document visible to all teams. (Expand the table according to the number of teams.)

Solution of Team 1			
	Do you think the solution meets the problem requirements? If not, please explain why.	Is the solution clear and easy to read? Enter improvements if needed.	What would you specifically commend about this solution?
Team 1			
Team 2			

For some problems, these tables will be quite sparse, while for others, you will spend a long time working on the texts. It all depends on the nature of the problem and the quality of the solutions. After this, you should conduct a final rounding of the solutions, which we don't have to consider as a separate phase.

3.2 Identifying cognitive processes

This part of the training is crucial for empowering you to develop the skills of creating appropriate detective problems. It is important that the problems stimulate the development of higher-order thinking.

In this regard, for this training segment, it is essential to consider Bloom's taxonomy of learning outcomes. The problems themselves are closely connected to reality, so a large number of outcomes will fall within the domain of application. From this perspective, you should be encouraged to identify outcomes in the domains of analysis, synthesis, and evaluation.

Metacognition is crucial for identifying outcomes. Metacognition is the ability to think about one's own thinking process. It involves being aware of and understanding how you solve problems, make decisions, and regulate your cognitive processes. Metacognition allows individuals to monitor and control their cognitive activities, such as planning, monitoring progress, evaluating strategies, and making adjustments as needed. It plays a crucial role in learning and problem-solving by helping individuals become more effective learners and thinkers.

For this reason, training in this domain begins by brainstorming in teams on listing cognitive processes you identify through problem solving activities of the previous stage of training. First, as a team, identify the cognitive processes for each problem individually, and then enter into the table below those outcomes that no team has entered yet. For each specific cognitive process, find the appropriate category in Bloom's taxonomy.

	Remembering: Recalling facts, information, or concepts from memory.	Understanding: Comprehending and interpreting information, including explaining ideas or concepts in one's own words.	Applying: Using knowledge or concepts in new or practical situations.	Applying: Using knowledge or concepts in new or practical situations. Analyzing: Breaking down information into its component parts and examining the relationships between them.	Evaluating: Making judgments or assessments based on criteria and standards.	Creating: Generating new ideas, products, or solutions based on existing knowledge or concepts.
Problem1						
Problem2						
Problem3						
Problem4						
...						

3.3 Creating logic-puzzle problems

We have reached the first phase of the training where you are expected to create problems. This is not a completely free phase; rather, you work in a semi-structured environment. Namely, your task is to download one problem of your team's choice from the link and restructure its narrative to be engaging and understandable for students. Be mindful that even very small changes can disrupt the logical structure of the problem. Creativity is expected from you, but within the logical rules imposed by the problem you have chosen. If your team feels ready to independently create problems of this type, you can attempt to do so.

In this section, it's important to follow the steps that will gradually lead you to a satisfactory logical puzzle of the Einstein type. The following text describes these steps.

3.3.1 Brainstorming

Use the brainstorming technique to choose the problem you will revise, as well as to generate ideas about changing the narrative of the problem.

3.3.2 Solving

Solve the puzzle using the methodology consistent with the section where you solved problems (the second and third problem). Record each step while solving. When you reach the final solution, review your steps and try to minimize the number of steps and simplify them to make them as clear as possible to the reader.

3.3.3 Creating

In this part, your task is to collaboratively devise a text that serves as an introduction to the logic puzzle (up to 1000 characters). This text (stimulus) should motivate students to engage in problem-solving. Afterward, adapt all clues to fit this text and further animate them to be as engaging as possible for students.

3.3.4 Verification

Go through the puzzle again, as if you don't know the solution, and check if the logical structure of the puzzle has been compromised.

3.3.5 Adapting the solution

Now, return to the solution of the original puzzle and reformulate it to fit your creation.

3.3.6 Group-level evaluation

In this phase, all problems with solutions should be visible to all groups. Teams then work on solving and evaluating the puzzles and solutions of other teams using the provided tables, which should be open in a Google document visible to all teams. Don't read the solution before solving the problem yourself to verify if the puzzle is logically consistent and to determine its difficulty. (Expand the table according to the number of teams.)

Logical puzzle of Team 1				
	Is the puzzle text understandable? Write suggestions for improvement.	Is there a solution that satisfies all the clues, and is it unique?	Is the solution clear and easy to read? Enter improvements if needed.	Estimate the difficulty of the problem.
1				
2				

3.3.7 Finishing the puzzle

When you've read all the comments for your puzzle, make the appropriate changes, and enter your puzzle and solution into the table below.

FRAME FOR THE LOGIC PUZZLES

Team	
Title of the logic puzzle	
Intro story - up to 1000 characters	
Clues leading to solution (5 to 10 clues, depending on the level of difficulty of the puzzle)	
Solution	

3.4 Creating Brainfinity detective problem

We've reached the most important phase of your training. We believe that by going through the previous stages, you are prepared both intellectually and emotionally to create your own Brainfinity detective problem. You'll need to engage all your intellectual and creative capacities to successfully complete this task. Team collaboration is crucial, as well as following the steps we outline for you.

3.4.1 Choice of problem type

At the outset, you need to decide which type of Brainfinity problem you want to create. You can choose one of three types: Brainfinity detective problem with unique solution, Open ended Brainfinity detective problem or Deciphering.

3.4.2 Brainstorming

Like other activities so far, we start this one with brainstorming. This time, you must be much more patient and listen to each other much more. Generate as many ideas as possible about what the context of your problem could be. With the context, you should also come up with basic ideas to develop the context into a detective problem. After exhausting all ideas, carefully analyze each one and choose what will be the context of your problem, as well as the basic ideas for creating the problem. In this phase, use everything that will stimulate divergent thinking and creativity, primarily internet search engines and artificial intelligence.

3.4.3 Exploring

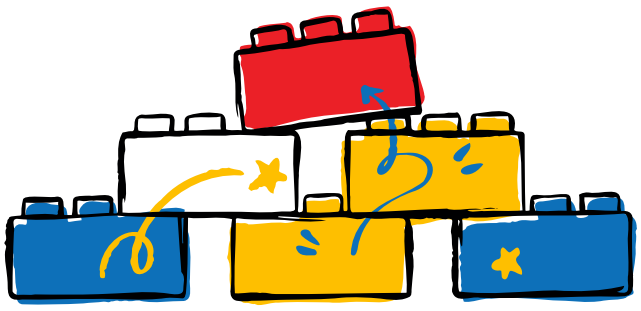
Now that you have the basic context of the problem and the main ideas around which the problem will be formed, you move on to the research phase. While researching the context of the problem, share with the team and write down any ideas you come across that could be useful for creating the problem. Once you've exhausted your research capacity, review all the ideas, reformulate them if necessary, and sort them to prepare for the next phase - creating the problem.

3.4.4 Creating

Now we're at the peak of your training. This is the moment when you need to be most creative. Based on the ideas and data you've listed, you need to create a story. Be sure to include an introductory story (no more than 1000 characters) before formulating the problem itself. The introductory story must intrigue students and motivate them to engage in solving the problem. Therefore, the narrative of the entire problem should be tailored to students. The problem statement should not exceed 2000 characters and should be as unambiguous as possible.

3.4.5 Solution

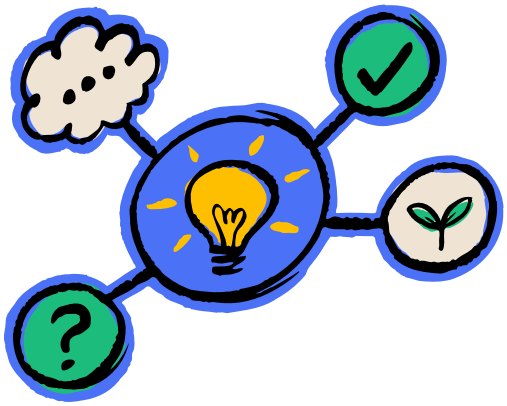
Once you have formulated the problem, write down the solution step by step. If during the writing of the solution you realize that some step is too difficult or, conversely, some conclusions are reached too easily, you can return to the problem formulation and add or remove some assistance. After that, share the problem formulation, without the solution, as a Google document with the other teams.



3.4.6 Group-level evaluation of Brainfinity detective problems

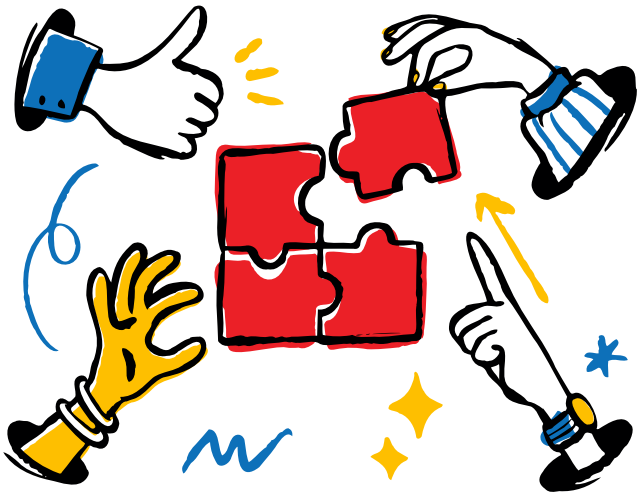
This is probably the most interesting part of the training, where you solve problems for each other. Be sure that while solving, you also analyze the problem and record all the steps in solving, both those leading you to the solution and those leading you astray. This is important so that you can assess the difficulty and consistency of the problem. After that, fill in the table below for the problem you solved.

Brainfinity detective problem of Team 1			
	Is the problem formulation clear and suitable for students? Enter suggestions for improvement.	Estimate the difficulty of the problem. Which steps in solving presented a particular challenge, and why?	What would you highlight as good practice in formulation of the problem?
1			
2			



3.4.7 Instructions for evaluating the problem solution

Imagine now that you're on the jury of a Brainfinity competition and you need to evaluate a team's solution. To do this successfully, you need to anticipate what students are capable of doing on this problem and how you will assess it. The way other teams have solved your problem can also help you with this. So, describe in as much detail as possible how you will evaluate each likely step in solving your problem. In real practice, there is a high probability that a solution will appear that you did not anticipate with your evaluation instructions. The jury specifically deals with such solutions and evaluates their quality compared to the quality of the official and other solutions.



3.4.8 Group-level evaluation of solutions and of Brainfinity detective problems

Now you need to share the solution to your problem and the evaluation instructions with all the teams. Then, you will evaluate the solutions and evaluation instructions for the problems of other teams by completing the table below.

Solution of the Brainfinity detective problem of Team 1		
	Is each step in the solution clear? Suggest improvements.	Would you change anything in the evaluation instructions? Explain why and how.
1		
2		

3.4.9 Finished product

Now carefully read all the feedback on your problem, both on the formulation and solution and evaluation instructions. Make changes that will improve your problem and enter the finished product into the table below.

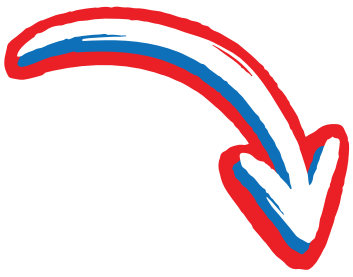
FRAME FOR DETECTIVE'S PROBLEMS

Team	
Title of detectives task	
Type of Brainfinity problem	
Materials needed (?)	
Intro story - up to 1000 characters	
Formulation of the task - up to 2000 characters	
Suggestions for visual identity and problem design	
Instructions for evaluating solutions	
Additional comment - if any, up to 1000 characters	
Links to additional materials	

PART 4 CONCLUSION

Developing key 21st-century skills in students requires their teachers to make a fundamental change in their approach to teaching. It is necessary to reformulate teaching to resemble reality and daily situations. Those situations are complex, and multidisciplinary and require the connection of knowledge from different fields. They require analytical and critical thinking, cooperation, and creativity.

Brainfinity methodology and training provide teachers with detailed guidance and tools to design assignments to encourage students to collaborate, reflect, discuss, analyze, and be creative. The method is very demanding, because it requires teachers to release and use their creativity and work together with their colleagues to prepare tasks for students. Unlike the standard way of working and approach to teaching, it requires thinking outside the box and relying on the use of online tools in the work - which also contributes to the teachers' digital literacy.



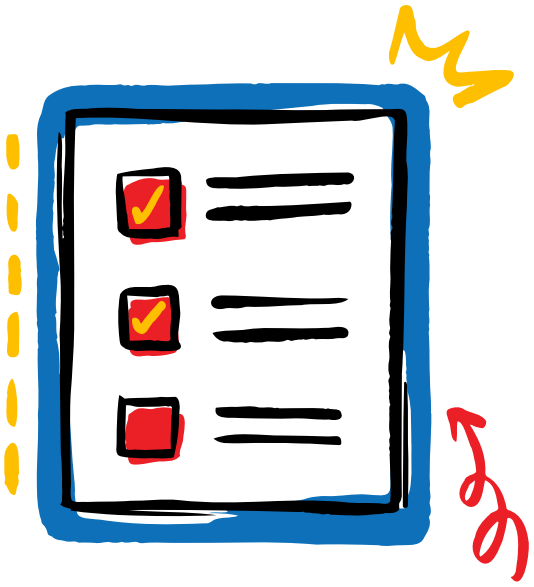
There will be a reward for the effort of creating Braininifty tasks. Already in the class itself, the atmosphere of cooperation, the excitement and enthusiasm of the students will be a sign that the effort invested is fully justified. Is there any greater satisfaction for a dedicated teacher than when the students do not want to leave the classroom after the lesson is over? Or when students ask: can we have another assignment? And the experience we have with the application of this method says that the result will be exactly that. Let's not even talk about the satisfaction that a teacher has when he sees off a student who he has prepared for the life and work situations that await him in the future.

Therefore, release your repressed creativity and dive into the world of logical problems and detective tasks that we introduced you to through this training. We're sure you'll enjoy working together and turn your students into real little Brainfinity detectives!

PART 5 LITERATURE

- Davidson, N., & Major, C. H. (2024). Boundary crossings: Cooperative learning, collaborative learning, and problem-based learning.
- González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of Education 4.0 in 21st century skills frameworks: systematic review. Sustainability, 14(3), 1493.
- Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn?. Educational psychology review, 16, 235-266.
- Lee, S., Mott, B., Ottenbreit-Leftwich, A., Scribner, A., Taylor, S., Park, K., ... & Lester, J. (2021, May). AI-infused collaborative inquiry in upper elementary school: A game-based learning approach. In Proceedings of the AAAI conference on artificial intelligence (Vol. 35, No. 17, pp. 15591-15599).
- Tan, O. S. (2021). Problem-based learning innovation: Using problems to power learning in the 21st century. Gale Cengage Learning.
- Weng, T. S. (2022). Enhancing Problem-Solving Ability through a Puzzle-Type Logical Thinking Game. Scientific Programming, 2022(1), 7481798.
- Wood, D. F. (2003). Problem based learning. Bmj, 326(7384), 328-330.

TRAINING IMPLEMENTATION SET



Introduction

The primary goal of this Training Implementation Set is to supply school teachers with extra resources and guidance for the effective delivery of our Brainfinity training program to children aged 11-14. The Set includes the collection of 50 logical puzzles and detectives' tasks created by the project team, that can be used by teachers in their classrooms; it also includes tools for teacher observation and self-reflection, forms to track the development of skills and changes in attitudes, advice on providing constructive feedback to students, and a survey to evaluate the program's pilot testing. All these components are thoughtfully designed with a singular objective: to support and enable teachers in their efforts to foster improved problem-solving skills in their students.

Brainfinity Educational Content

The theoretical background for our training program is the Brainfinity Educational content. This is the LINK to the version of the booklet in English

Booklet with 50 Brainfininty tasks

The tasks in this collection are put in order from easier to those more demanding. It is important to introduce to students first the easier tasks, and to support them in finding solutions. This way they will get encouragement to continue to more demanding tasks. You may be surprised how easy it may be once the students are “infected” with the Brainfininty virus! LINK

Observation Forms on Gained Skills and Change in Attitudes

These forms serve as a means for teachers to monitor and record the progression of students' skills and shifts in attitude throughout the Brainfinity program. They facilitate tracking the individual and collective growth of students in areas such as logical and analytical thinking, teamwork, and data mining. By observing changes in students before and after various segments of the program, teachers can measure the impact of their instruction. This insight allows them to adjust their teaching techniques to achieve optimal outcomes.

Link: 3. Brainfinity Assessment tool on Gained Skills and Change in Students' Attitudes

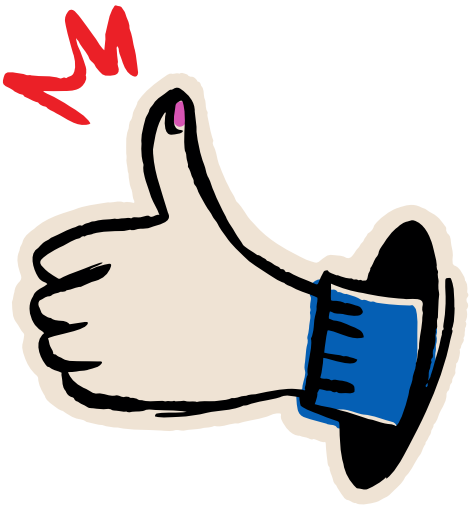
Tips for providing feedback to students

It is crucial that throughout the problem-solving process, both in the preparatory and competitive phases, students receive constructive feedback that will facilitate their rapid progress. That's why we've developed checklists that will help teachers more easily identify areas where a student can progress. This makes it easier for teachers to provide feedback. Based on the checklist, the teacher gives feedback to the student that should meet the following criteria:

- it must be communicated in language that is close to the student,
- it must be informative, in the sense that the student can infer what they need to do to progress in the right direction,
- it must be affirmative, not just listing the shortcomings the teacher has noticed,

it should be motivational, encouraging the student to explore and solve problems further.

Link: 4. Brainfinity - Providing feedback to Students



Checklist for teachers: Preparing your students for national Brainfinity competition

We are sure this training will motivate you to share your new skills in your classroom. The Brainfininty approach to teaching will be well accepted by students, we are sure they will enjoy the learning process as much as you have enjoyed the Brainfinity training. Hoewer, getting ready for the national competition needs continuous work, so we are providing you with some useful tips in the form of a checklist.

Link: 5. Brainfinity checklist for teachers: preparing students for national Brainfininty competition

Survey for Evaluation of the Teachers' training/Pilot Testing

This form is designed to collect feedback on the pilot testing of our training program, aiming to understand its effectiveness and gather suggestions for improvement.

Link: Evaluation survey

Partners

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Co-funded by the European Union