

## CHALLENGE YOUR BRAIN

An artifact from the CRECIM-Universitat Autònoma de Barcelona for the STEAM4U program



### HOW TO USE THIS ARTIFACT

This game consists on 3 cards with 3 challenges of ascending complexity, meaning that the 1<sup>st</sup> challenge implies lower cognitive demands and the 3<sup>rd</sup> implies higher cognitive demands compared to the previous 2 ones.

### GENERAL AND CONCRETE AIMS

These three challenges are aimed at reinforcing and structuring the learnings regarding the relationship between 2D and 3D representations that students have previously built during the lessons or workshops. The way this artifact is designed (including some gamified elements, an accessible challenge, establishing references to students' real world...) aims that students have a successful experience in the field of mathematics that will help them improve their perception of self-efficacy.

Specifically, when using this artifact, students are expected to:

- Be able to solve each challenge using what they have learnt previously during the Unix-workshop session.
- Be able to explain the mental and physic processes or strategies that have allowed them to build a particular answer to the challenge.

In parallel, when using these challenge cards, teachers/educators are expected to:

- Identify the knowledge that the students are capable of putting into play to solve a particular challenge (especially the mathematical knowledge) and, therefore, identify the contents in which the students can be considered competent.
- To be aware of the strategies students use to solve the challenge in order to regulate them.

### TARGET GROUP

Young people from the 1<sup>st</sup> and 2<sup>nd</sup> years of high school (between 12 and 15 years of age) with a low level of self-perception of mathematical competence.



## INSTRUCTIONS OF USE

After a lesson or workshop session each student/ participant will be given a challenge card. Students will be asked to provide an answer to the challenge at their homes, applying the knowledge they have learned and constructed in the previous sessions. That is, challenges will be used at home within lessons/workshops. It is important to follow the order of the challenges, as they are designed in increasing order of difficulty.

For the construction of the challenge's solution, students can and should put into play all the strategies that they are able to manage. In this sense, for example, students will be able to use family, friends and/or colleagues' help. If this strategy is actually used, help from other people should be focused on both helping the student to understand the phenomenon and helping the student to identify the strategy used to build the solution.

Each challenge has a back side with some hints to help students to build the solution. Students can use them in case of need, though they need to report it. As well, other hint-cards can be built to assist those students facing more difficulties (see the last section of this document).

In the following work session of the posed challenge, students' answers will be discussed. In class, the discussion will focus on identifying the strategies that students had used to solve the challenge, with special emphasis on making students aware of the limitations and potential of each of the identified strategies. Thus, "correct" answers to each challenge will take a secondary place in the group the discussion.

## TEACHING MATERIALS

The three challenges are the following ones:

Challenge 1 – front side:

## CHALLENGE #1: Can you solve the Sudoku locating all the buildings on the board with their heights?

Each number on the side shows  
you how many buildings are seen  
from this perspective.

If you need a hint, you can have a  
look at some examples at the  
back of this card

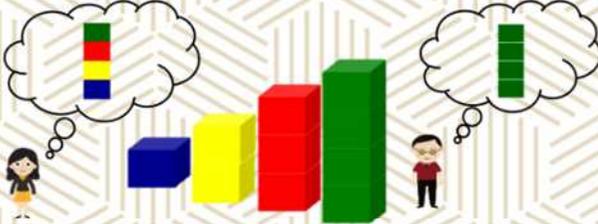
	3	1	2	2	
2					2
2					2
4					1
1					4
	1	2	3	2	

Challenge 1, back side (with hints):

**Hint 1:** There are 4 buildings: one of 1 floor (10 cm), one of 2 floors (20 cm), one of 3 (30 cm) and one of 4 (40 cm).

**Hint 2:** Another solved Sudoku can act as a good model

If Katja looks at them from her side, she sees 4 buildings (10 cm, 20 cm, 30 cm and 40 cm). If Peter looks at them from his side, he only sees the Green one (40 cm).



	4	2	2	1	
4	10	20	30	40	1
2	20	10	40	30	2
2	30	40	20	10	3
1	40	30	10	20	3
	1	2	3	3	

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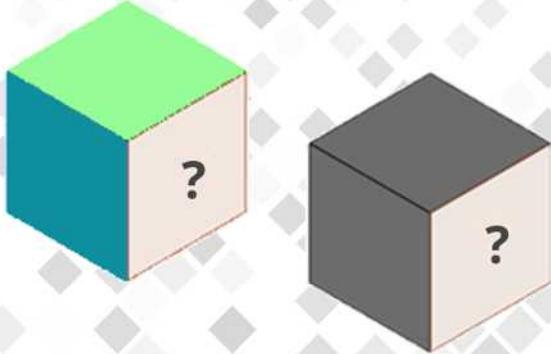
Challenge 2 – front side:

## CHALLENGE #2: Folding and unfolding cubes

Pau is preparing a cube with the following template:



Can you guess the colour of the face marked with “?” once the cube is built?



Challenge 2 – back side:

**Hint 1:** Try to imagine how would you build the cube from the unfolded pattern

**Hint 2:** Try to build the cube and check if you were right



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Challenge 3 – front side:

## CHALLENGE #3: From which spot was the picture taken?

Can you guess it  
just by looking at  
the map of the  
city?

Can you suggest a  
similar challenge  
to your friends?



Challenge 3 – back side:

Hint 1: Try to guess from which spot (1-6) this picture was taken so the buildings are arranged as displayed in the picture.



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## TREATING DIVERSITY AND PROMOTING EQUITY

To make more inclusive this artifact and facilitate the successful participation of all students in the resolution of the challenge, some aids are taken into account:

### HINT-CARDS

- 1 Previously to the delivery of the first challenge and during the students' work within the lesson, it is essential to observe all the students and identify difficulties in each case.
- 2 Once these particular needs of each student have been detected and assessed, these students will be given a hint adjusted to their needs (hint-card). It is important that not all students have a hint and that the hints are different.
- 3 These aids will be distributed in a sealed envelope (hint-cards), so that the selected students can have the experience of facing the challenge under the same conditions as their colleagues and choosing whether they want to open the envelope or not and when. This measure is aimed at raising the self-knowledge and self-regulation of the students.

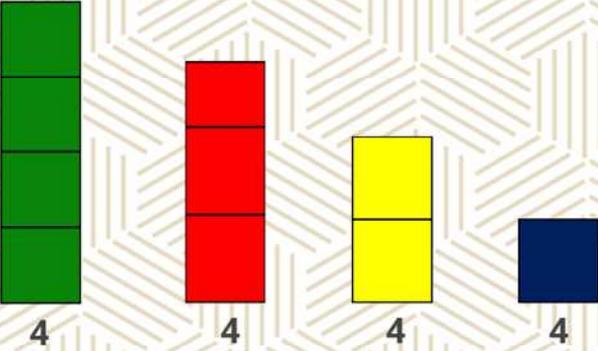
In the following table below, we identify some of the difficulties that young people can face trying to provide a solution to each challenge and we propose an aid for each of the cases. As special hint card is provided as example. Blank cards for special hints are also provided to be used for teachers.

CHALLENGE	POSSIBLE DIFFICULTIES	HINTS
Challenge 1: Skyscraper sudoku	Understanding the dynamics of the game and its rules	It can help you to know that there are 4 buildings of each type: 4 buildings of 40 cm, 4 buildings of 30 cm, 4 buildings of 20 cm and 4 buildings of 10 cm.
	Spatial distribution of bodies	It can help you to draw or use manipulative material to represent the 4 types of buildings with colors and then think about their spacial distribution.
	Choosing strategies for problem solving	Try to place the tallest buildings on the sudoku board first.
Challenge 2: Folding and Unfolding	Relating a figure in 3D with its 2D unfolding (small difficulty)	It may help you to try to paint the faces of a cube with the colors that appear in the figure displayed, bearing in mind that the two situations of the cube in 3D that appear on the card must be met.
	Relating a figure in 3D with its 2D unfolding (big difficulty)	It can help you to reproduce the cube deployed with each one of the painted faces as it appears in the figure of the card.
Challenge 3: Where the photo was taken from?	Making the 2D-3D relationship on a large scale	It can help you to propose a challenge to the other groups using everyday objects for you that you put in a specific position.
	Choosing strategies for problem solving	It can help you to use some programs such as Google maps or maps of your interactive city to find a solution to this challenge.

Example one hint-card for students (Challenge 1):

**CHALLENGE #1: Special hint card**

To solve this challenge, it can help you know that in each row and column there are 4 buildings of each type: 40 cm, 30 cm, 20 cm and 10 cm.



4 4 4 4

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Blank card for hint-cards of challenge 1:



Blank card for hint-cards of challenge 2:



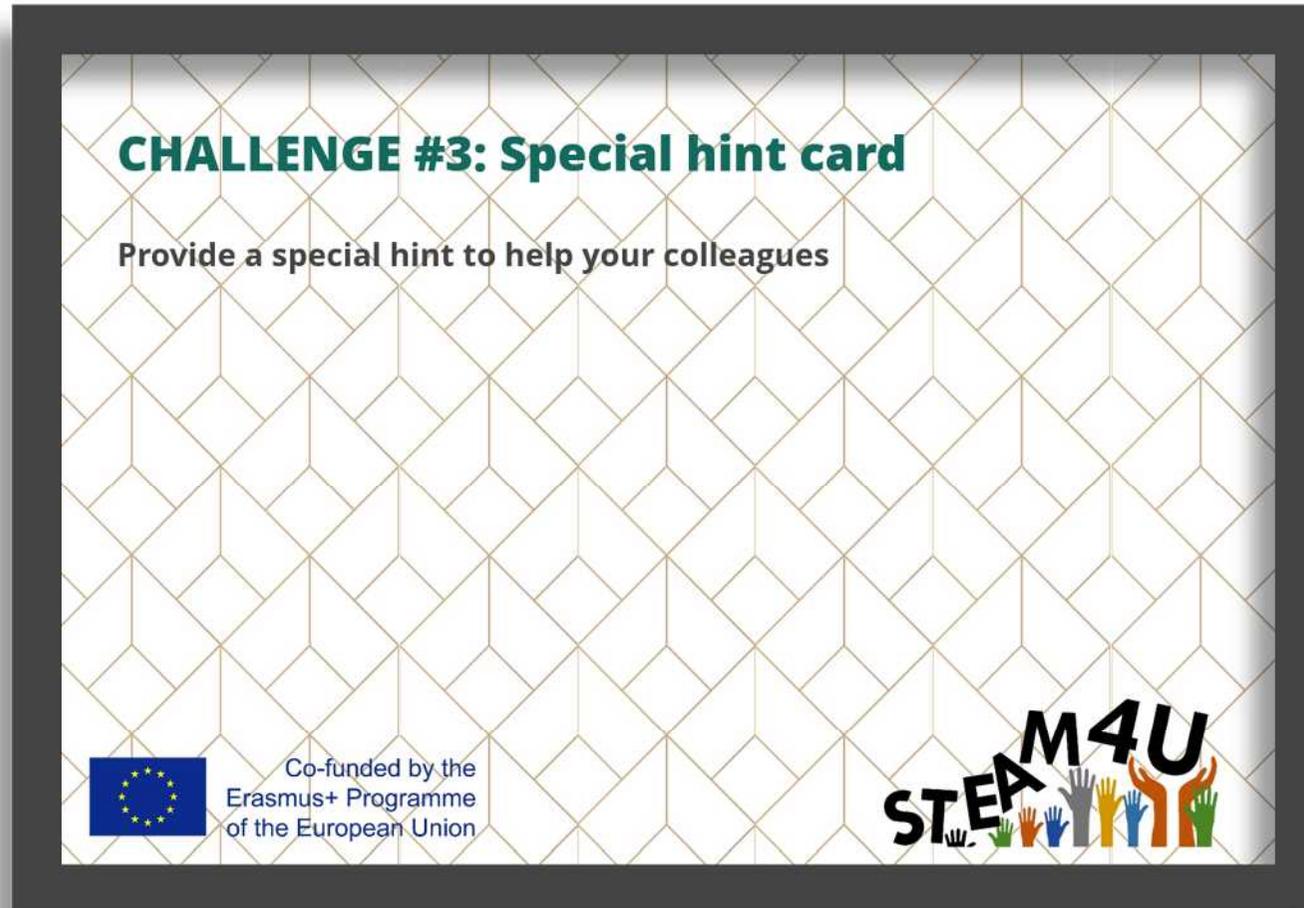
**CHALLENGE #2: Special hint card**

Provide a special hint to help your colleagues

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Blank card for hint-cards of challenge 3:



## INTERACTING WITH STUDENTS

Apart from the hint-cards, some considerations should be taken into account regarding the role of the teacher when promoting the group discussion:

- 1 In the group discussion, students should feel that nothing happens if they say something wrong. In this sense, the teacher should foster the participation of all students (especially those ones that are less participative) and decriminalise the mistake by giving a formative meaning (that is, using them as a ways to learn). In order to make all students participate, the teacher can project the answers of all students in the board and comment them.
- 2 As said previously, the teacher/educator should focus the group discussion on the different strategies of problem solving. This approach pretends that students are more aware of the ways a challenge can be solved, enhancing their self-regulation. The teacher can compare different strategies of different profile of students (especially those ones under-represented in the STEM field), emphasizing their advantages, etc. and the way all the strategies can be used to solve any new challenges (strategy transference).
- 3 It is important also that the teacher help students to read appropriately their own successes when trying to build a solution. For example, it is possible that a student has not been able to build a correct solution, but has used an original strategy than their colleagues. This action would make students more aware of their own successes.
- 4 The teacher should praise students about their work, but emphasizing skill development, effort, perseverance and persistence rather than simply for the achievement of a solution. It is necessary to foster the belief that competence in STEM (and in general) is a changeable, controllable aspect of development, not an innate character trait. It is also necessary to encourage effort, perseverance, and persistence as ways to overcome obstacles. However, providing praise when it is undeserved, however, is dishonest, manipulative, and potentially dangerous.