



Outdoor Mathematics with MathCityMap

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Supporting curriculum through
integrated STEAM Education
practices



Viana do Castelo



School of Education

Outdoor Mathematics with MathCityMap

Part I **Let's try a math trail with MathCityMap**

Some ideas about:

Outdoor learning and math trails in mathematics education

MathCitymap – students' perspective

Part II **Design a trail with MathCityMap**

Some ideas about:

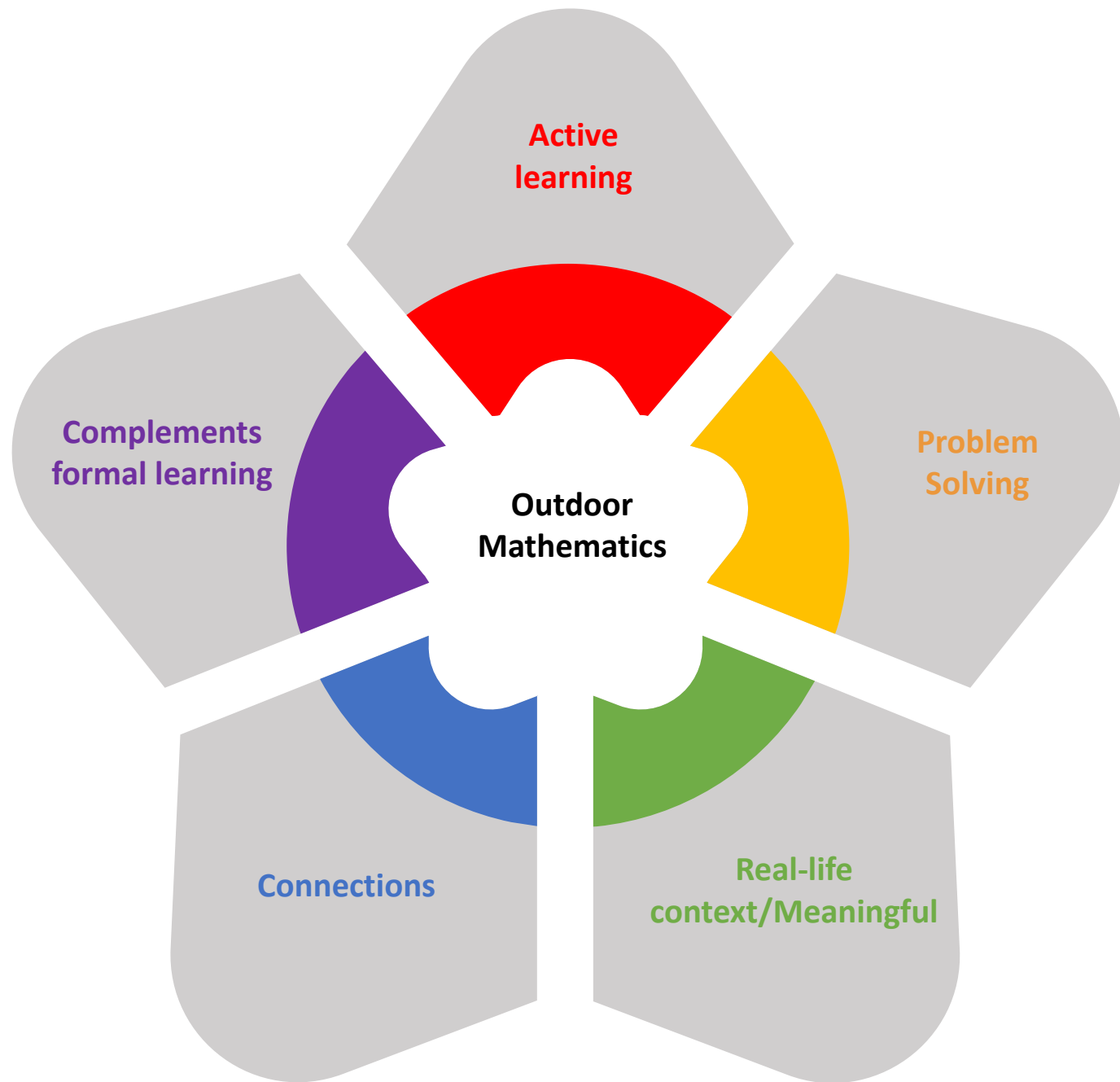
How to create a task and a trail with MCM – teachers' perspective

- ❖ Engagement of all students in individual and collaborative experiences.
- ❖ Development of the ability to think mathematically and to make sense of mathematical ideas.
- ❖ Promotion of a positive attitude of students towards mathematics.
- ❖ Establishing connections between ideas, between ideas and mathematical procedures, between curricular areas and between school mathematical contents and situations of the students' reality.

Learning is a process that takes place on a daily basis, in a more or less organized way and in different contexts, not being confined to the classroom or the time students spend there.

(Kenderov et al., 2009)

Outdoor Mathematics



(Barbosa & Vale, 2016; 2018; Barbosa et al., 2022; Vale et al., 2019; Vale & Barbosa, 2020)

Math Trails



Math trail

Sequence of tasks, along a previously planned route (with beginning and end), consisting of a set of stops at which students solve tasks in the surrounding environment. (Cross, 1997; Vale & Barbosa, 2016)



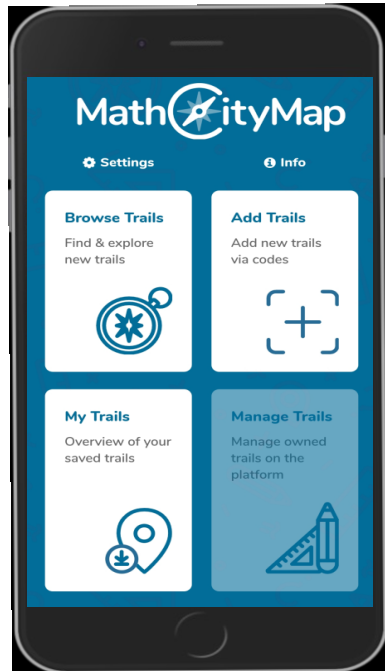
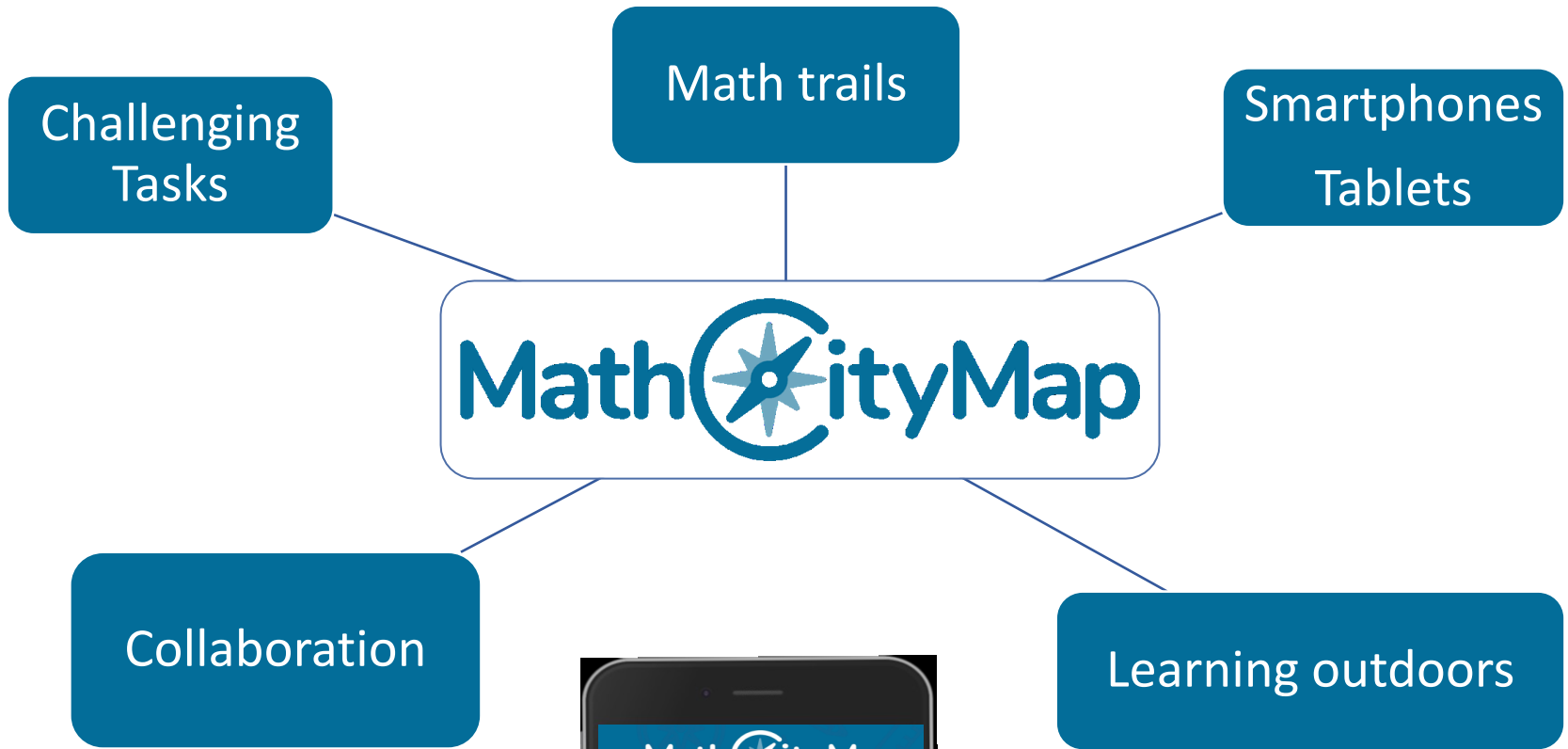
Math Trails



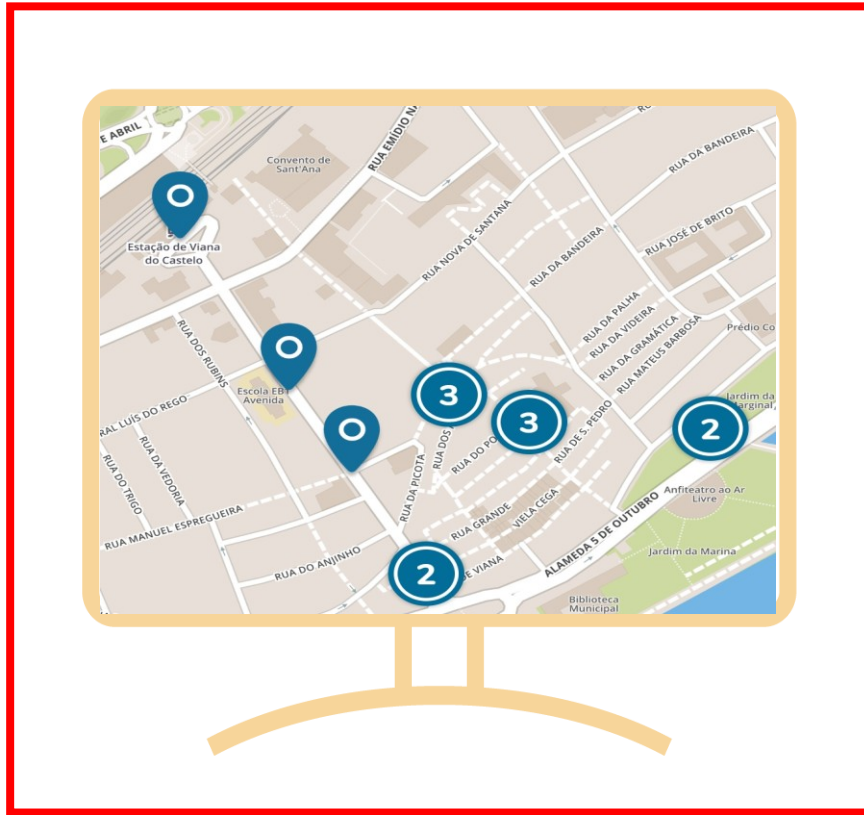
Through a **Math trail** students:

- solve problems in real context;
- understand connections between mathematics and daily life;
- show positive attitudes towards mathematics;
- develop abilities like problems solving, communication, reasoning, critical thinking, collaboration.

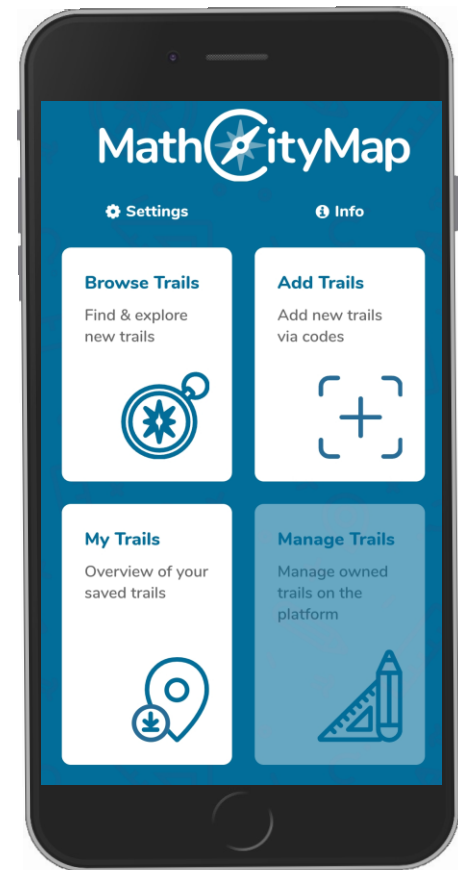




Webportal



App



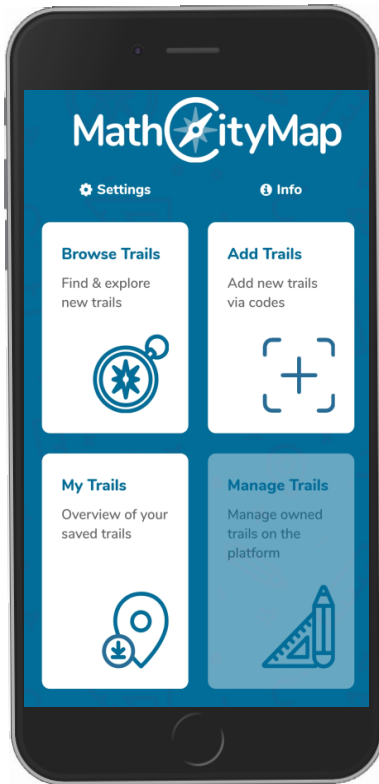
Tasks are marked through a pin in a map.

The MathCityMap App

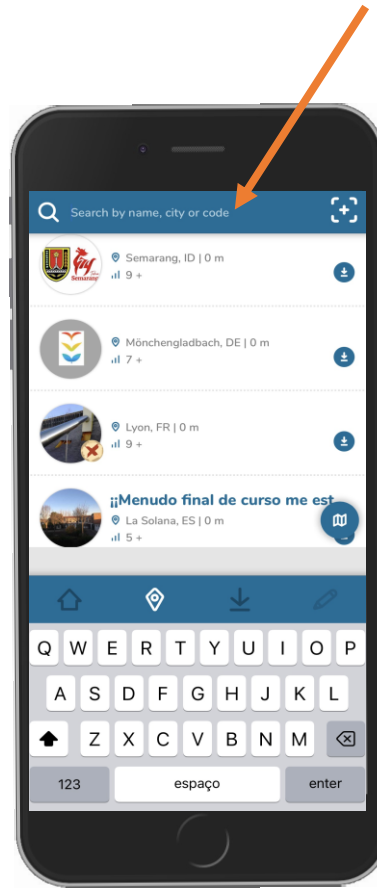
- The trails are **downloaded** to a smartphone or tablet.
- The MathCityMap app is **free**, ad-free and in compliance with the General Data Protection Regulation (GDPR).
- The app is **available** for Android and iOS.



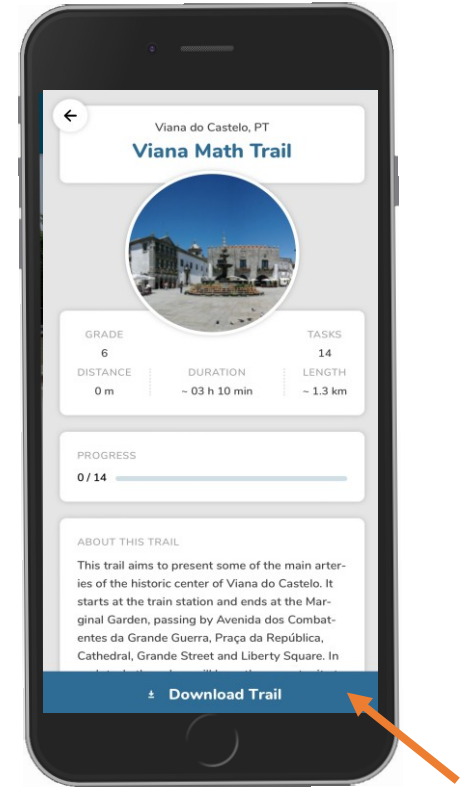
The MathCityMap App



1. Open the app MathCityMap and select *Browse trails*

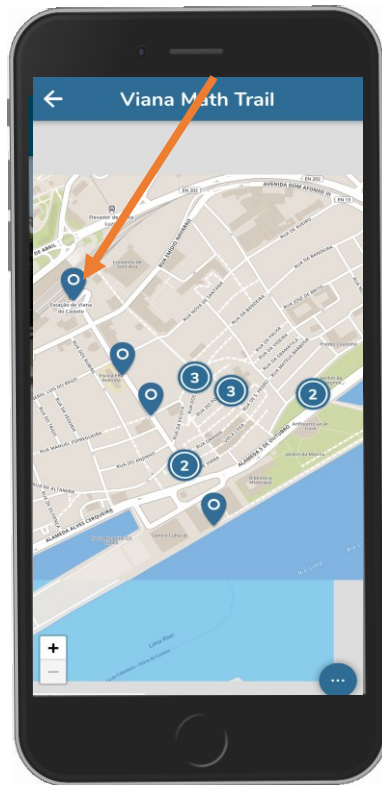


2. Insert the name, city or code of the trail to find it

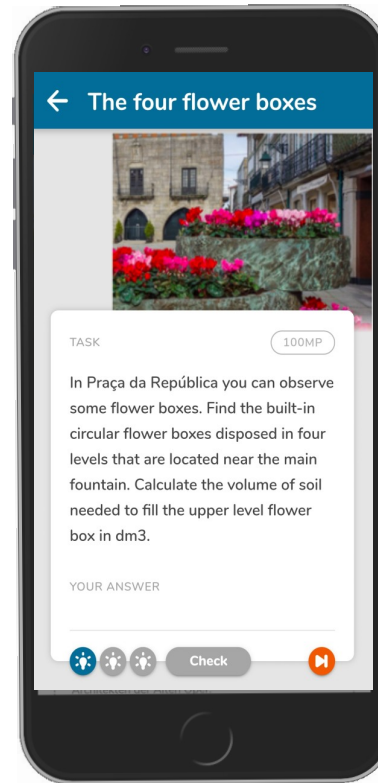


3. Download the trail to the mobile device and select *Start trail*.

The MathCityMap App



4. Select each task by picking one of the blue pins in the trail.



5. Each pin corresponds to a task in the trail that the user has to solve, introducing the answer in the correspondent field.

The MathCityMap App

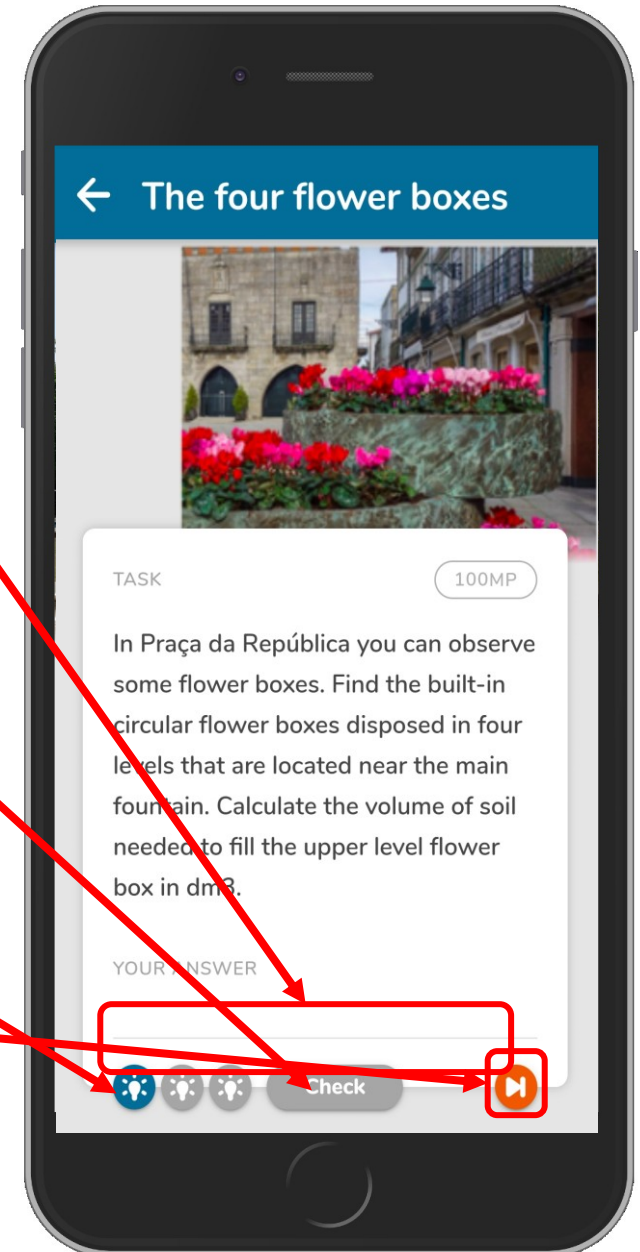
Select to introduce the answer

Verify the answer:

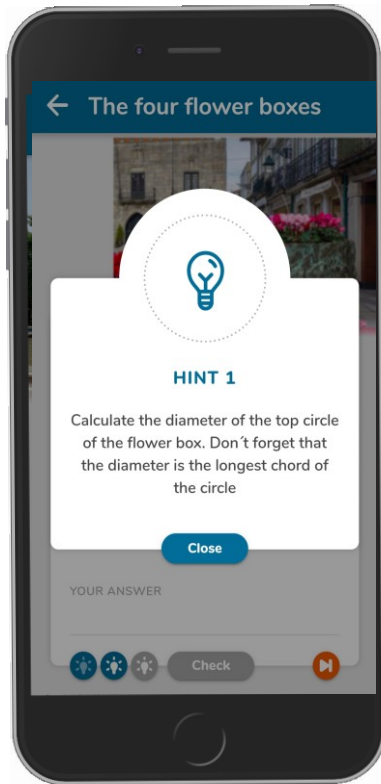
- Excellent solution
- Good solution
- Wrong solution

Hints
(text, image, video)

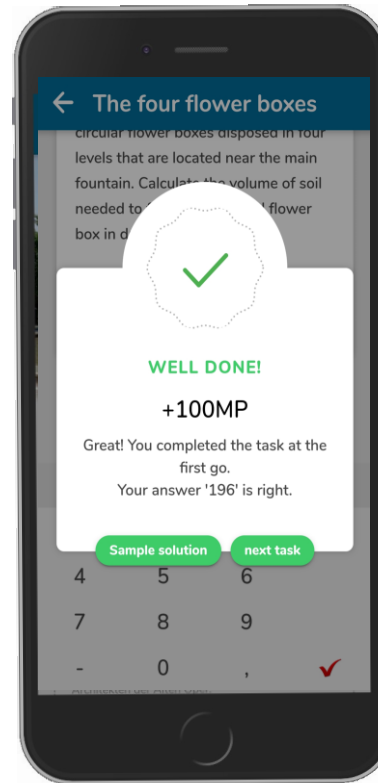
Skip the task



The MathCityMap App



6. Hints on demand. Up to three hints per task.



7. The solution is confirmed by the app

Prepare for a trail with MathCityMap

- Form groups of three elements.
- There are 3 roles:
 - **Navigation** -operates the app, helps find the tasks
 - **Data collection** -responsible for the tools and measurements
 - **Written records** -makes a record of the data/measurements and solutions
- Give a math trail kit to each group:
calculator, measuring tool, writing material, ...
- Each group needs a smartphone/tablet with the app MCM.

Let's try out a math trail with MCM

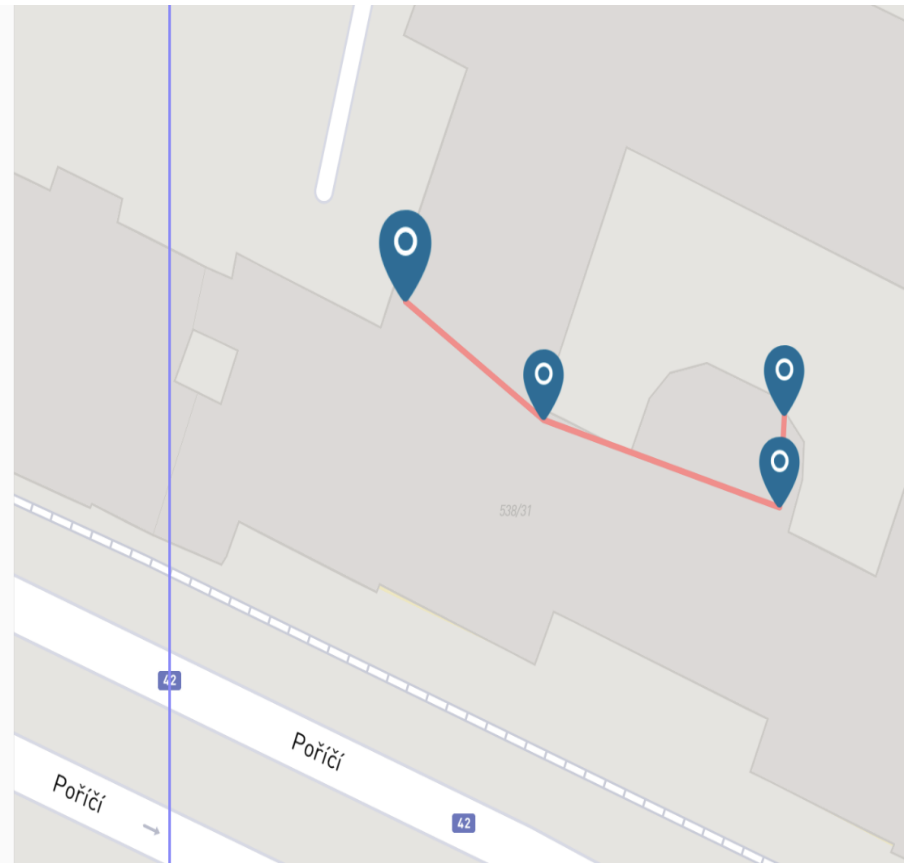
MASARYK UNIVERSITY



BIP STEAM Education

Try out this short trail to get acquainted with MathCityMap. Have fun!

i CODE: 2422862



Part 2

Design a trail in MathCityMap

Design a trail in MathCityMap

<https://mathcitymap.eu>

MathCityMap

GET IT ON Google Play | Download on the App Store

Start

Portal

Tutorials

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Forgotten Password? Register

MathCityMap in winter? Of course!

MathCityMap in winter? Of course! [Read the article]

PORTAL

TUTORIALS

PUBLICATIONS

NEWS

Trail of the Month

Date: 15. May 2023 | By: Philipp Larmann | Category: General | 1 Comment

Trail of the month: XV OLIMPIADAS MATEMÁTICAS

For the Trail of the Month for May, we head to the city of Ávila in Spain,

The Project

MathCityMap is a project of the working group MATIS I (IDMI, Goethe-Universität Frankfurt a.M.).



In Cooperation with



stiftung rechnen

EU-Projects



Co-funded by the Erasmus+ Programme of the European Union



Design a trail in MathCityMap

Create tasks

The screenshot displays the MathCityMap web portal interface. At the top, there is a dark blue header with the logo 'MCM Web portal' on the left and search, notification, language (English), user profile, and share icons on the right. Below the header, the user profile for 'Ana Barbosa' is shown, including her role as 'reviewer' and 'Level: 30'. A grid of navigation cards is visible: 'Trails' (Create and manage), 'Tasks' (Create and manage), 'Groups' (Create and manage), 'Profile' (Personal data, statistics), and 'Reviews' (We ask for your opinion, with a notification badge of 79). An orange arrow points to the 'Tasks' card. On the right side, a map of Africa and the Middle East is displayed, with a search bar containing the word 'Procurar'. The map shows various countries and cities, with the 'North Atlantic Ocean' and 'South Atlantic Ocean' labeled.

Design a trail in MathCityMap

Create tasks

The screenshot displays the MathCityMap web portal interface. At the top, there is a dark blue header with the logo 'MCM Web portal' on the left and search, user, and language (English) icons on the right. Below the header, a navigation bar shows 'Tasks' with search, list, and add (+) icons. An orange arrow points to the '+' icon. The main content area is divided into 'PUBLIC TASKS' and 'MY TASKS' (which is selected). Under 'MY TASKS', there are tabs for 'FOR ME' and 'FAVOURITES'. An 'Order by' dropdown is set to 'Latest', with up, down, and refresh icons. Two task cards are visible:

- Torre romântica**: Distribuição de probabilidade. Includes icons for EV, globe, graduation cap, 10, location pin, 5437.4 km, share, 2748080, and a 'SHOW ON MAP' button.
- Passeio de carro**: Diagrama de extremos e quartis. Includes icons for MC, globe, graduation cap, 10, location pin, 5437.3 km, share, 0148079, and a 'SHOW ON MAP' button.

On the right side, a map of Africa and the Atlantic Ocean is shown. A search bar at the top of the map contains the text 'Procurar'. A yellow circle with the number '184' is visible on the map near Lisbon. The map includes various navigation controls on the right edge.

Design a trail in MathCityMap

Create tasks

← Create task
✎

Web portal > Tasks > Create

Title image

Insert image
Insert image
Insert image

Insert image
Bild einfügen

Insert image
Insert image
Insert image

Please upload a representative image for your task.

SELECT IMAGE

Basic data

Title *

Title is required

Definition of task *

0 / 800

Ω

Position & AR

Position [click on the map]*

Lat: * Lon: *

Augmented Reality Scene ▼

Answer format and solution

Task type

[Choose]

Interval

Exact value

Multiple Choice

Fill in the Blanks

Task type and solution*

Sample solution

TEXT PICTURE

Sample solution

0 / 1000

Ω

Stepped Hints

Hint 1 ^

[Choose]

Type of hint ▼

Text

Hint text

0 / 1000

Ω

ADD FURTHER HINT

Task meta data

About this object:

0 / 600

From grade:* [Choose] ▼

Tools: [Choose] ▼

Tags (confirm with Enter)

Enter tags

Author

Author

Ana Barbosa

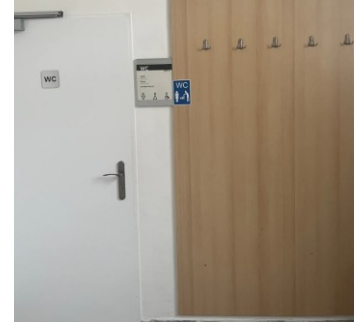
E-Mail

anabarbosa@ese.ipv.c.pt

CREATE

Design a trail in MathCityMap

Create tasks – some answer formats



Exact value

- When to use:
 - Combinatorics questions with an exact answer
 - Counting tasks in which the number can be determined exactly
- Example:

How many windows can you count on the south facade of the building?

Answer: 40
- **Author** defines a **number** in the web portal
- **User** introduces a **number** in the app

Design a trail in MathCityMap

Create tasks – some answer formats



Multiple choice

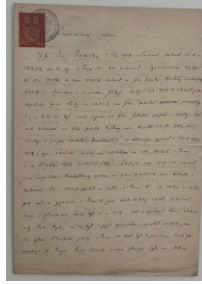
- When to use:
 - Tasks with multiple answers
 - Tasks that demand words or expressions as answer
 - Tasks with equivalent answers (ex. 3×2 ; 6)
- Example:

What solids and geometric figures do you identify in the Tower of Pisa?

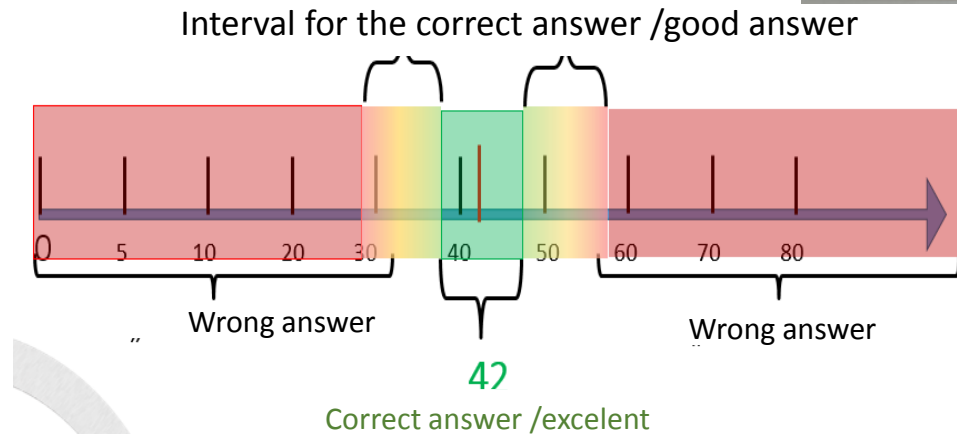
Answer: cylinder; squares; triangles; circles
- **Author** defines **at least 2 possible answers** in the web portal, identifying the correct ones
- **User** chooses the **correct answers from the list** in the app

Design a trail in MathCityMap

Create tasks – some answer formats



Interval

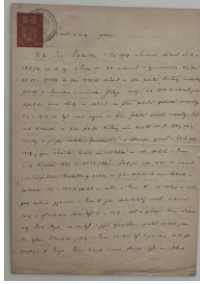


- When to use:
 - All the tasks that require measurements.
- Example:

Calculate the area of the school yard in m²
 Answer: Approximately 5000 m²
- **Author** defines 4 numbers in the web portal, extremes of the green and orange intervals
- **User** introduces a number in the app

Design a trail in MathCityMap

Create tasks – some answer formats



Interval

- The deviation is defined for each measured value that is to be accepted.
(e.g. **3%-green interval** and **7%-orange interval**):

Acceptable measuring error	Measurement	Acceptable measuring error
$a_1 = 97\text{m}$	$a = 100\text{m}$	$a_2 = 103\text{m}$
$b_1 = 48,5\text{m}$	$b = 50\text{m}$	$b_2 = 51,5\text{m}$
$A = a_2 b_2 = 4704,5\text{m}^2$	$A = ab = 5000\text{m}^2$	$A = a_2 b_2 = 5304,5\text{m}^2$

- We proceed in the same way for the orange interval.

4325

4704

5305

5725

Design a trail in MathCityMap

Create tasks – some answer formats

- **Fraction**

Tasks that require a fraction as answer.

- **Vector (exact value)**

More than one question in the same task with the answer being an exact value.

(ex: Calculate the minimum and maximum values in a set of data; two or more questions of exact value about the same object)

- **Vector (interval)**

More than one question in the same task with the answer being an approximate value.

(ex: Calculate the area and the perimeter of the flower bed; two or more questions of exact value about the same object)

- **Fill in the blanks**

Sentence with spaces to complete (words or numbers).

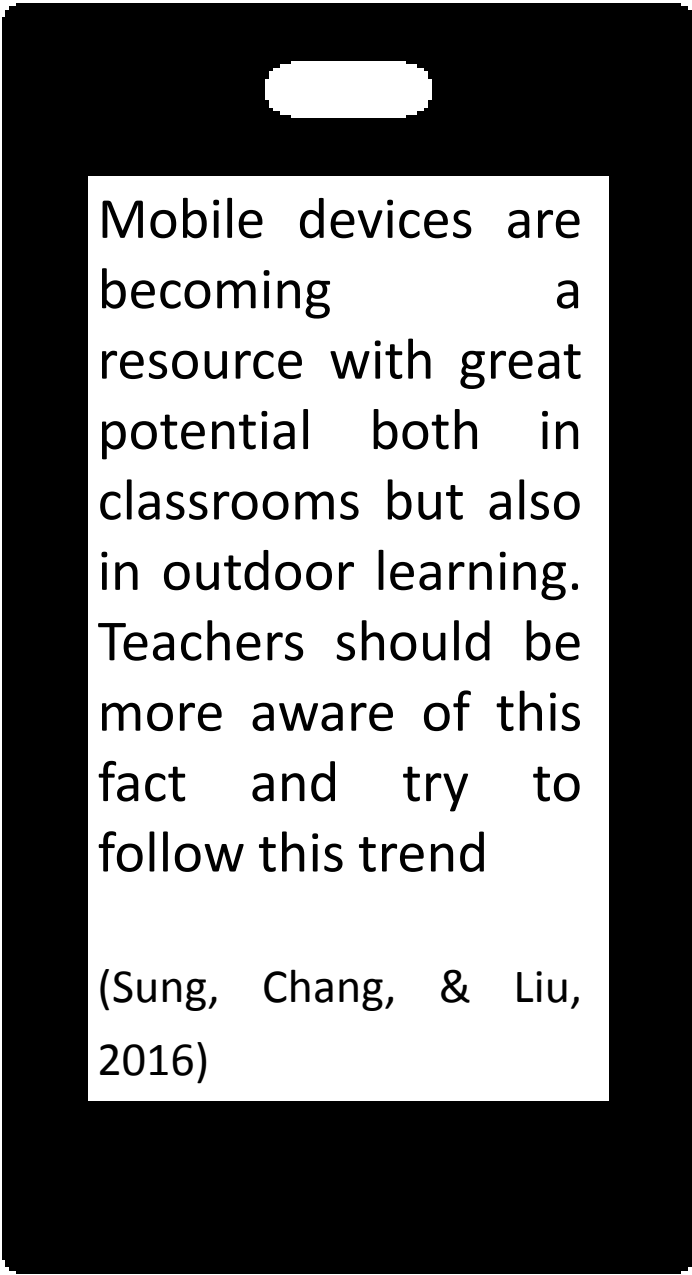


Other formats

Design a trail in MathCityMap

Create a trail

- In groups, you will go outside and choose **three** objects that inspire you to create MCM tasks: one of each type (choose 3 of the 4 types - **exact value**, **interval**, **multiple choice**, **vector**).
- Take a **picture** of each object.
- **Collect** all the needed data (counting, measurements).
- Complete the **task creation template** for each task before submitting it to MCM.



Mobile devices are becoming a resource with great potential both in classrooms but also in outdoor learning. Teachers should be more aware of this fact and try to follow this trend

(Sung, Chang, & Liu, 2016)

STEAM education can become more interesting, significant and enjoyable for students, enhancing the possibilities for their engagement in this type of subjects, inside but also outside the classroom.

(e.g. Sung et al., 2016)

The extension of the classroom to the outdoors is facilitated by the portability and wireless functionality of the mobile devices, which presents students with a more authentic and appropriate context, making it easier to explore the surrounding environment.

(Cahyono & Ludwig, 2019)