VISIT MATH

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Pedagogical Guide

FERMAT SCIENCE
Une autre idée des maths

5th High School
Agrinio · Greece

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Contents

1. Introduction

Many teachers ask the question: how can we make mathematics more interesting to our pupils? Some teachers opt for a more practical approach of the subject, which feels difficult to grasp for many. (Emami Rizi, 2011) Some others adopt a gamified approach: people can have a good time learning, playing a game does not mean that one cannot learn anything from it. This project aims at gathering both methods into a single one, with the use of treasure hunts as a means to have pupils enjoy a class like no other!

Treasure hunts are **fun** ways to have people discover new things, and they can come in many shapes. Given how present mathematics is in our everyday life, treasure hunts allow us to go in the open and show pupils that what they study can take physical form. After all, **isn't mathematics a game**? This is at least the feeling we aim to provoke here! You will find math-based riddles, advice to ensure that you are not losing time on your sequences (perhaps those treasure hunts could even help you gain time!), and tips to make sure that treasure hunts can be fun for everyone to attend.

Creating a treasure hunt may sound daring at first, which is why they are not often used in class, or they take place in a closed environment. In this guide, you will discover how to plan your next school trip focused on mathematics and tips to make sure every student can attend. Finally, you will be provided with a short guide on how to create your own treasure hunt. With the following tools, you will be able to design a tour, create games if need be, and adapt the types of exercises to your own environment. Do not hesitate to mix mathematics with other subjects to make the treasure hunt even more interesting!

2. Mathematic trips and their benefits

2.1 Mathematics topics that can be studied through field trips

2.1.1 The different sorts of math topics used during field trips in a city

Many mathematical concepts can be studied during a field trip, so it is interesting to look at this in more detail.

Here, concept by concept, one or more examples of their use will be given.

Area and surface

The architecture of a town or village can be used to calculate the perimeter, area or surface of different geometric shapes such as circles, rectangles, triangles, etc.

Here are some examples to help you **visualise how to introduce mathematics** into the theme:

A village square

Suppose you have a square in the shape of a rectangle 5 meters long and 4 meters wide. What is the area of the square in square meters?

The Palace of Versailles and its gardens

The Palace of Versailles in France is famous for its beautiful gardens and elegant architecture. Given the dimensions of a room in the palace, can you calculate the area of the floor of the room using the formula Area = Length x Width?

A roof

Suppose a building is 5 metres wide and 5 metres deep.

Its roof is shaped like a pyramid with a square base and each side is an equilateral triangle.

How do you calculate the area of this roof?

A museum and its garden

An architect has to draw up plans for a museum of 1500 square meters with a rectangular shaped garden 250 meters long and 100 meters wide. What is the area of the museum as a percentage of the total area of the site, including the garden?

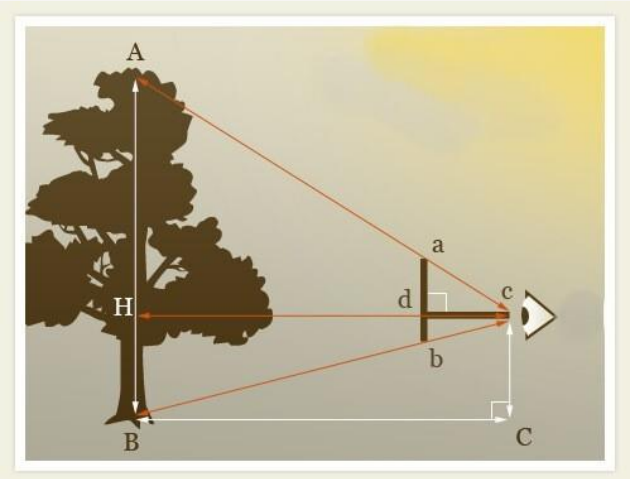
The fence around a field

In a rectangular-shaped park or field with sides that measure 24 meters by 45 meters, it is possible to find the length of the fence diagonally using the Pythagorean theorem.

Height

The height of a building

To determine the height of a tower, a water tank, a lighthouse, etc., it is possible to use the logger's cross method.



1 Schematic of The Woodcutter's Cross - (Association A.R.B.R.E.S)

By using Thales' theorem (twice) we can show that the height of the tree is equal to the distance between the tree and the observer: AB = BC

The height of a part of a building

An architect has to draw the plans for a building with 10 floors, each floor having a height of 3 meters. If the total distance from the ground to the top floor is 33 meters, how high is the crawl space under the building?

Volume

Calculation of the volume of different geometrical shapes, such as triangular prism, cubes, spheres, etc.

A building

If you know the length, with and height of a building, you can calculate the volume of the building. For example, if a building is 10 meters long, 8 meters wide and 5 meters high, what is its volume in cubic meters?

It is also possible to incorporate conversion concepts by changing the units: cm, m etc.

The volume of water needed

An architect has to draw the plans for a rectangular fountain 10 meters long and 5 meters wide. If the depth of the fountain is 0.30 meters, how much water is needed to fill the fountain completely?

A half-sphere dome

Find a small church or another building near you with an architectural structure such as a half-sphere dome or cupola and calculate its volume. Use mathematical formulas to calculate the volume of each element and add them together to get the total volume.

The Pantheon in Rome is a famous Roman monument with a massive dome. If the dome measures 43.3 meters in diameter, can you calculate the volume of the dome using the formula $V = 4/3\pi r^3$?

Calculate the volume of this dome.

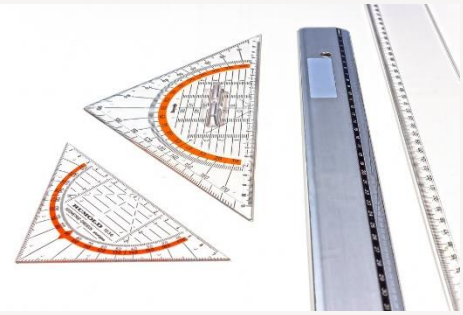
Data analysis

It is also possible to use information from a city to analyse mathematical data, such as numerical data sets, graphs, tables, etc.

Angles in geometry

A historic building

Choose a historic European building such as a cathedral, a castle or a famous monument and use measuring tools (e.g. a protractor) to calculate the angles of the different elements of the structure such as arches, vaults, buttresses and columns.



2 Architectural measuring instrument (PIXABAY)

Incline

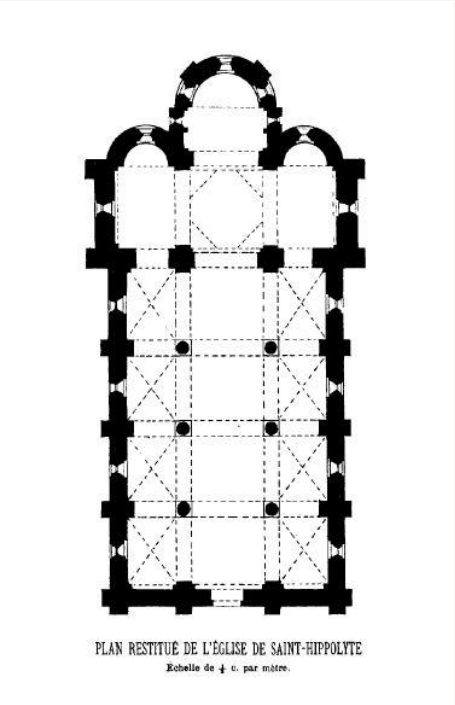
A roof

The Château de Chambord in France is famous for its elaborate roofs and monumental chimneys. Given the dimensions of a pitched roof, can you calculate the angle of inclination of the roof using trigonometry (formula: $\tan(\theta) = \text{height} / \text{length}$)?

Scale

A monument

Choose a European monument and draw a plan to a given scale. Use measuring tools to determine the exact dimensions of each room and element. You can also draw cross-sections and longitudinal sections to understand the internal layout of the building.



3 Restored plan of the church of Saint-Hippolyte - Scale of ½ cm per meter - (Wikipedia)

Proportions

You can calculate the proportions of a building by using measurement tools to determine the height, width and depth of the structure, and then calculate the proportions by dividing these measurements.

Equations

Equation concepts can be approached in simple problems using the student's environment during the field trip.

For example:

Two towers, 30m and 40m high, are 50m apart. A well is located between the two towers. Two birds fly at the same time from the top of each tower; they fly at the same speed and land on the well at the same time. Determine the position of this well between the two towers.

Or: The distance of the well from the tower of 30m is the triple of the distance of the well from the other tower. Determine the position of this well between the two towers.

Geometric patterns

Studying geometric patterns

Explore geometric patterns used in city architecture, such as mosaics, tiles and ceiling designs. Identify geometric shapes and visualise their characteristics, such as circles, squares and triangles, and use mathematical formulae to understand their arrangement and repetition.

4 Architecture - (Pxhere)

Visualising logical sequences

Pavements are quite common in cities; observe them to understand the logical sequence and reproduce it.

5 Paved floor - (Pxhere)

These mathematical exercises are designed to help you **explore the mathematical principles used in European architecture and to apply these principles to real-life problems**. They are suitable for **different levels of mathematical ability**, so feel free to adapt them to the level you want and the relevance of the learning to the curriculum. There are others, so do not hesitate to think of other exercises using mathematics related to your environment!

2.1.2 The advantages of a school trip to learn mathematical concepts

Field trips allow pupils to **see more concretely the usefulness of mathematics in real life and to have fun practising mathematics outside the classroom**. Let's look at the benefits of field trips to mathematics learning.

Reinforce learning in real contexts

- Allow pupils to see how mathematical concepts are applied in the real world and how they are used in buildings, bridge construction, streets, structures and historical monuments.

Encourage observation and curiosity

- Help to stimulate pupils' curiosity about their environment. You can encourage them to observe their surroundings carefully and ask questions about the mathematical concepts they see around them.

Foster communication, collaboration and social interaction

- Provide opportunities for pupils to work together and communicate their ideas about mathematical concepts. Pupils can be encouraged to discuss what they have observed and to collaborate to solve mathematical problems, which can build their confidence and self-esteem. This method promotes interaction between children, which can increase their engagement and motivation to learn mathematical concepts.

Creating an interest in mathematics

- By showing them how mathematics is used in their environment, pupils can be inspired by the achievements they see around them. This can motivate them to pursue scientific careers.

Provide opportunities for experiential learning

- Field trips can provide opportunities for pupils to learn through experience. This can facilitate the understanding and learning of mathematical concepts, making them more tangible and accessible.
- Pupils can use measuring tools, maps and graphs to explore their environment and apply the mathematical concepts they have learned in class.
- This experience can help learners transfer their mathematical knowledge from theory to practice.

Multisensory learning

- These activities offer pupils a multi-sensory experience. They can touch, see, hear and even taste mathematics (**"Make them succeed in maths" - Armelle Géninet, Pedagogy Training, 2017)** in action. This experience can help students better understand mathematical concepts by using multiple senses.

Engagement and motivation

- Enhancing motivation, helping pupils by providing a hands-on, interactive experience. Pupils can be more engaged and enthusiastic when they are involved in activities outside the classroom to explore and discover new things. This motivation can help learners better understand and retain mathematical concepts.

Contextualisation

- Putting mathematical concepts into context, by showing how they are used in real life, in areas such as architecture, construction, finance, navigation, etc. This contextualisation can help pupils to better understand the usefulness and relevance of mathematical concepts.

Development of transferable skills

- Field trips can help pupils develop transferable skills, such as observation, measurement, problem-solving and communication. These skills are useful in many areas, including mathematics.

In sum, **field trips can help enrich mathematics learning by providing opportunities for students to see mathematics in action in the real world**, stimulate curiosity, foster communication and collaboration, create interest in mathematics, and provide experiential and interactive learning opportunities.

2.2 Cross-curricular teaching during field trips

Learning during the field trip is not limited to mathematics: pupils will also have the opportunity to develop other skills and knowledge. Here we will see which other areas can benefit from these mathematical field trips.

Social and emotional skills

As seen above, field trips can help develop pupils' social and emotional skills, such as communication, collaboration, tolerance, emotional management and decision-making. Pupils learn to work in teams and interact with people from different cultural and social backgrounds, which will develop their empathy and respect for others.

This can encourage them to work together to solve problems, share knowledge, negotiate and discuss their observations.

Language skills

These activities can enrich pupils' language skills by exposing them to real-life communication contexts. It is an opportunity for them to practice reading, writing and speaking in a variety of situations. Increase their level of vocabulary, grammar and pronunciation in a foreign language, if the visit is abroad, by interacting with local people and exploring cultural places.

Science skills

These activities also allow them to develop their learning in science. Pupils can observe and study the characteristics of plants and animals, the physical properties of matter, natural phenomena and the interactions between different elements in the environment.

Mathematical field trips can be combined with scientific activities, such as a visit to a science museum or an astronomical observatory.

Science and technology literacy

Field trips provide opportunities for learners to learn about science and technology in action. Pupils can be encouraged to observe scientific phenomena such as weather, traffic, pollution, etc. They can also be encouraged to observe how technology is used in the urban environment.

Mathematical field trips can help to understand the use of mathematics in modern technology. Pupils can visit research laboratories or technology companies to discover how mathematics is used in the design and programming of software and applications.

Artistic and cultural skills

These outings can also enable pupils to discover and appreciate art, culture and heritage. Pupils can visit museums, monuments, exhibitions and performances to discover different works of art and cultural events. Discover the use of mathematics in works of art, such as the use of perspective in painting.

In addition, it is possible to combine mathematics with art activities, such as visiting an art museum where pupils can explore patterns, shapes, colours and symmetries in works of art.

Environmental and cultural awareness

Field trips provide opportunities for pupils to learn about the environment and culture of the city. Encouraging them to learn more about history, architecture, geography, cuisine, music, traditions, etc. will motivate them to learn more.

It can also help them learn about local customs, traditions, historical events and important personalities.

Physical skills

Field trips can help pupils develop physical skills such as co-ordination, flexibility, strength and endurance by participating in outdoor activities, hikes or guided walking tours.

Observation and data collection skills

Pupils may be required to observe and record specific features of the environment and collect data on phenomena such as weather, pollution, population density, etc.

Navigation and orientation skills

This is also a way for pupils to develop navigation and orientation skills. During a field trip, students are encouraged to use maps, compasses, navigation and digital geolocation tools to move around the city and find their way.

Geography

Mathematical field trips can be linked to geography activities, such as a visit to a national park, where pupils can study topography, landforms, maps and distance measurements. They also represent an opportunity to introduce cartography and geolocation tools.

History

This is also a way to include history when visiting historical sites and combining mathematical concepts such as geometry, arithmetic, calendars and time measurement that have played an important role. Historical field trips can help understand how mathematics has evolved throughout history. Pupils can visit science museums to learn about the contributions of famous scientists and how their ideas have influenced modern science and mathematics.

In summary, mathematics-related field trips can benefit many other subjects in addition to mathematics, which can help pupils to understand how mathematics is used in the real world and to make connections with other subjects in a meaningful way. This can help them to develop skills and knowledge in different areas.

2.3 How to include these field trips in your sequences

In general, it is important to link the concepts seen in the curriculum to the field trip so that pupils can see their relevance in the real world. This can include concrete examples of situations where mathematical concepts are used, as well as practical activities to apply these concepts in a concrete context.

2.3.1 Before the mathematical concepts introduced in class

Approaching mathematical concepts in a non-formal way before they are introduced in class will allow pupils to have a less frontal approach than usual. This method of teaching helps to engage learners and keep them motivated.

Here are some examples:

Visit a science museum

- Many science museums have interactive and fun exhibits that allow pupils to experiment with different mathematical concepts. An exhibition on fractals, for example, could help pupils understand repeating patterns and symmetries in mathematics.

Organise a maths treasure hunt or use existing platforms such as MathCityMap

- In a park or in a city district, organise a treasure hunt based on mathematical puzzles. Pupils will have to solve maths, geometry or measurement problems to find the hidden clues.

Explore local architecture

- By visiting historic or modern buildings, pupils can learn how mathematics has been used to design the plans, shapes and dimensions of structures. This trip can also be an opportunity to learn about symmetry, proportionality and perspective.

Observe nature

- Nature offers many opportunities to observe mathematical phenomena, such as fractals, spirals and geometric patterns. An outdoor trip can be an opportunity to explore these concepts through the observation of plants, shells, insects or landscapes.

Go to a market

- A market is an ideal place to improve mathematical concepts such as fractions, percentages and ratios. Pupils could also learn how to calculate taxes and discounts.

Visit an observatory

- Astronomy is a discipline that uses a lot of mathematics. Pupils could understand how mathematics is used to calculate the positions of planets and stars.

Before the field trip, it is important to prepare pupils by giving them an overview of the concepts they will discover on site. Teachers can also provide worksheets or activities to be completed during the field trip to help pupils focus and take notes on the mathematical concepts that will be covered in more detail later in the lesson.

Organising a field trip around **these ideas helps learners to learn about important mathematical concepts in a practical and fun way**. They can then explore these concepts further in class through activities and exercises.

2.3.2 After a mathematics lesson

As mentioned previously, the mathematics field trip can be an excellent **opportunity to consolidate the mathematical knowledge acquired in class by applying it in real-life situations in a non-formal way**. It can be useful to help pupils understand why a concept is important, see how mathematics is used in the real world and how the concepts they have learned in class are relevant and useful in everyday life. **It is a way for pupils to feel more engaged and motivated to learn.**

Depending on the planned field trip, the teacher can focus on specific mathematical concepts related to the activity beforehand.

Mapping

- If the field trip involves moving around the city, it may be useful to introduce cartography and map reading with the pupils. This can include concepts such as scale, legend, direction, coordinates and cardinal points. The field trip will help to consolidate these concepts.
- Maps are an excellent tool to help pupils understand geometry, measurement, proportion and orientation. Prior to the field trip, pupils can be encouraged to use maps to familiarise themselves with the city environment and to use measurement skills to estimate distances between different points of interest.

Measurements

- For an outing in the city, it will be interesting to review measurement concepts with the pupils, e.g. measuring the height of a building or the length of a street. Review units of measurement, conversions, measuring tools, measuring volume and mass and calculating speed.

Statistics

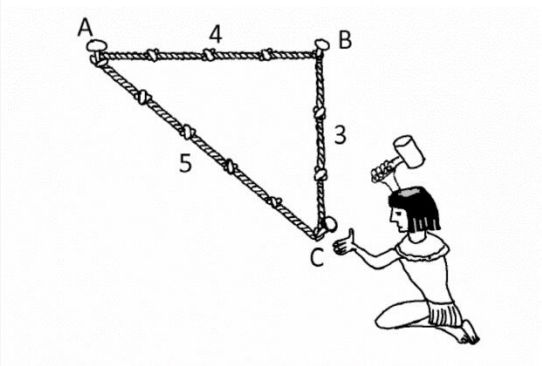
- When using statistics, for example on the number of people in an area or the types of shops on a street, it may be useful to review statistical concepts such as data collection, graphing and data analysis.
- For example, pupils may be required to conduct surveys or polls, collect and analyse the data, calculate frequencies, draw graphs and calculate probabilities.

Geometry

- When visiting architectural sites, such as historic buildings or bridges, it can be useful to review geometric concepts such as shapes, angles, lines and symmetries.
- Pupils can be encouraged to observe the geometric shapes used in architecture, identify angles, straight lines and curves, and measure the dimensions of buildings.

- Another idea is to use the 13-knot rope, an ancient geometry tool that is educational, easy to use and fun. It can be used alone to measure or draw geometric figures.

Connect the two ends of the rope, fix them together and then stretch two sides to form a triangle. And when the sides measure 3, 4 and 5 intervals respectively, the triangle is right-angled. This can then be checked with the Pythagorean theorem.



6 13-knot rope (IREM Montpellier)

Numeracy, budgeting

- A school trip often involves costs for entering a museum or buying food, travelling... it can be useful to review calculation concepts such as basic operations, money, percentages, transport costs, travel time...

Planning the trip

- Importantly, pupils will be happy to help plan the route using maps and city plans. This can help develop skills in geometry, map reading, orientation and distance calculation.

It appears, therefore, that addressing or including relevant mathematical concepts prior to a field trip can enhance pupils' understanding of these concepts. The concepts covered in the lesson can vary depending on the purpose and the mathematical skills that will be used during the field trip.

The field trip after a specific mathematical lesson then allows for a better appropriation of knowledge as well as a more lasting consolidation of skills.

3. Organising a field trip for all

3.1 Organising a field trip for all

3.1.1 A pedagogical guide to accessibility

"Teaching and learning experiences that take place outside the confines of the classroom walls have a range of benefits for both students and instructors" (Claiborne et al., 2020). When pupils put the **theory learned in class into practice in the real world**, it leads to a learning experience that enriches learning and contributes to their development. Moreover, learners participating in field trips show greater motivation, recall the course content more vividly, and perform better.

7 Source: Canva

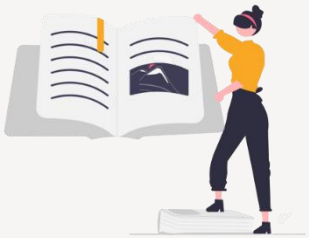
Therefore, **field trips are an excellent way to enhance learning experiences and allow pupils to explore and discover the world outside the classroom**. Indeed, as it is said, experience is the best teacher. That's precisely what the VisitMath project focuses on:

increasing engagement and motivation in STEM and particularly mathematics of pupils by linking mathematical subjects to European architecture.

However, when planning a field trip, it is important to **consider the accessibility** of the destination and activities so that it is adapted to every pupil's needs. In this guide, we will discuss some adaptations that can be made to ensure that your field trip is accessible to everyone.

Adaptations including reading, writing, maths, spoken language, motor and sensory difficulties are developed. Nevertheless, this list is non-exhaustive, and it is always preferable to directly ask your pupils what are their specific needs in order to adapt any material and the field trip in the best way possible.

Reading difficulties



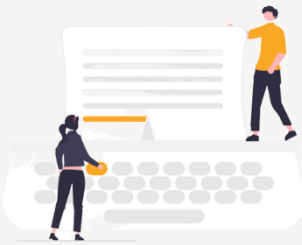
8 Source: unDraw illustrations

For learner with reading difficulties, it is important to adapt any written material so that it is inclusive and adapted to all pupils' needs. Here is a non-exhaustive list of how to adapt written material:

- Use a sans serif font like Arial, Open Sans, Century Gothic or OpenDys.
- Use a font size between 12 (text) and 14 (titles).
- Use an adapted line spacing of 1,5.
- Align the text to the left, do not justify it.
- Do not use italics, underlining and capitals.
- Put text in bold and/or colour to highlight it.
- Break down your text into small paragraphs and clear sentences.
- Structure your text with clearly distinguishable titles, subtitles, etc.
- Present the important items in bullet points.
- Use colours to separate information and be consistent in your colour codes.

- Use off-white or pastel background colour whenever possible.
- Make sure the contrast is good enough for the content to be readable.
- Be consistent with the use of language and writing style.
- Use visuals to supplement verbal instructions.

Writing difficulties



9 Source: unDraw illustrations

During a field trip, pupils might be led to write; keep in mind to make that task inclusive. A possible adaptation could be to not take into consideration any grammar or spelling mistakes in their answers. What's more, a multiple-choice questionnaire could be easier to fill in for some learners facing writing difficulties.

Written exercises can be done on paper but also using digital material. In this way, pupils can use dictation software, spellcheck, etc.

Another way to make an exercise accessible would be to allow extra time for written activities or to offer the possibility of answering the question orally or by drawing, for example.

Maths difficulties

As mathematics is often seen as an abstract subject, organising a maths-related field trip is an excellent way to offer non-formal teaching to pupils, where they can apply maths concepts in real life.

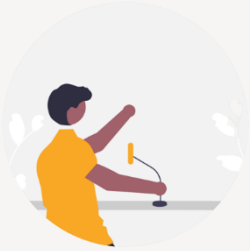
To make it inclusive, offer learners with specific needs the opportunity to use a calculator if needed.

10 Source: unDraw illustrations

In addition, reproducing the buildings (or any other architectural constructions) studied during the field trip in miniatures is another way to make the field trip

accessible. Indeed, by being able to grab an object and observe it closely, pupils might understand its characteristics better.

Oral language difficulties



11 Source: unDraw illustrations

Difficulties related to oral language can trigger pupils on a field trip, as it often involves oral answering and conversation or public speaking.

To make your trip inclusive, encourage learner to use communication aids they are comfortable with, such as speech-generating devices or communication boards. You could also allow them to support their message with visual aids such as pictures or gestures.

Providing a "safe space" where pupils don't feel pressured or judged by their peers is also a major adaptation for public speaking.

Motor difficulties

As a major focus of the VisitMath project is to learn mathematics thanks to architecture, considering motor difficulties that pupils might have is critical when planning your field trip. Indeed, discovering a city's architecture in "real life" involves a lot of movement!

12 Source: unDraw illustrations

For dyspraxic learners, you need to provide adapted physical material so they can use it without difficulty.

For pupils with reduced mobility, for example, using a wheelchair or crutches, make sure that the venue is accessible with ramps, lifts, and wide doorways. If needed, modify activities to accommodate physical limitations.

Sensory difficulties

The most frequent sensory difficulties are visual and hearing impairment.

In order to fill the needs of people having sensory difficulties, here are some criteria to take into account:

13 Source: unDraw illustrations

To answer the needs of pupils having hearing impairment;

- Consider hiring a sign language interpreter.
- If the field trip includes audio material, have a written transcription ready.
- Make sure speakers articulate and position themselves properly to allow lip-reading.
- Use visual clues to get the pupil's attention, like raising your arm.

To answer the needs of pupils having visual impairment;

- Provide written materials in alternative formats such as audio or braille.
- Include an audio description of the activities and give oral instructions.
- Describe the environment, buildings, architecture, etc., orally.
- Offer the opportunity to learners with visual impairment to use other senses, such as touch or smell, to understand their surroundings fully.

Other adaptations

14 Source: unDraw illustrations

The adaptations mentioned hereinabove are some among so many others. Here are some miscellaneous actions that could be undertaken to make your field trip inclusive and adapted to all pupils' needs.

First, when organising any activity, always consider any other disabilities or special needs that your

learners may have and make adaptations accordingly. To do so, consult with the pupils and their families to determine their needs and preferences.

Besides, make sure the staff is trained on disability awareness and how to provide appropriate support. This way, they can be prepared to answer any pupils' needs.

In addition, when answering a question or working on a specific task, create small groups. Balance the group regarding skills, so pupils can work as a team and help one another. Moreover, always separate instructions for a task and make it intelligible, clear and simple.

Dys-learners have difficulties going from one plane to another. Consequently, some tasks requiring eye movement can be a real challenge for them. For example, if they have to observe a building and then answer questions about it on a piece of paper, include a picture of the same building (maybe with a zoom on a specific part) on their paper so that they don't have to move from one plane to another when answering.

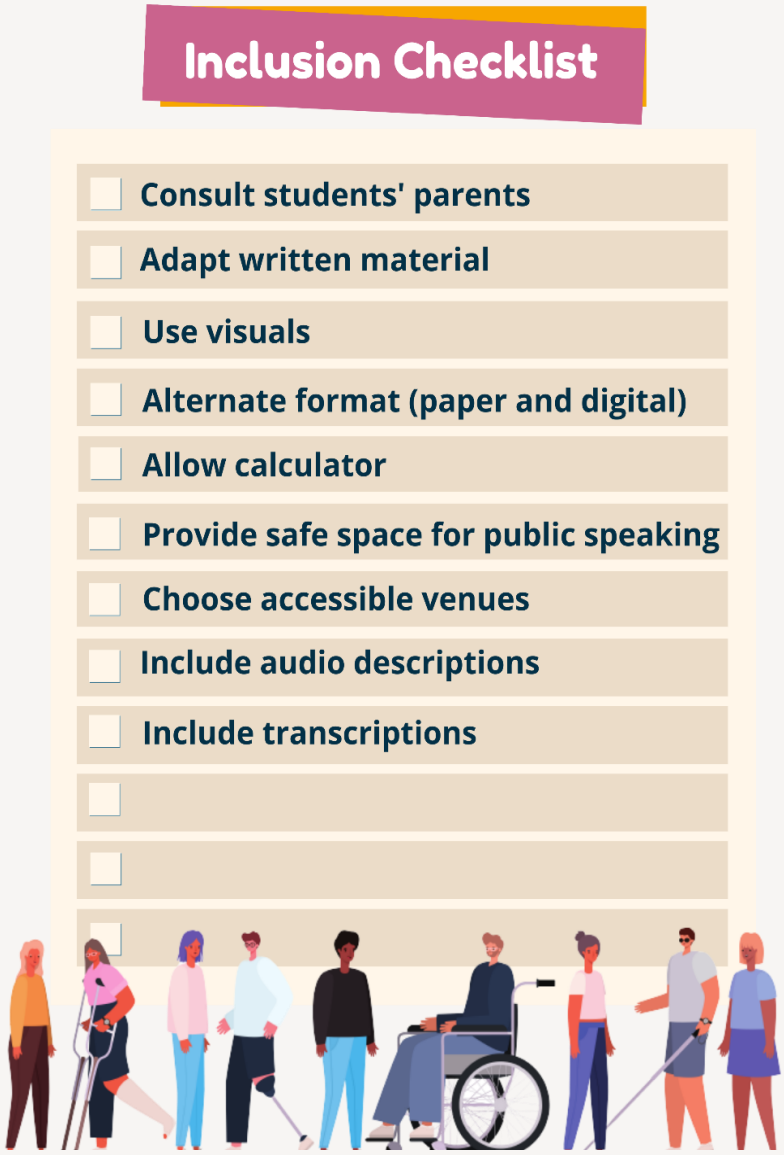
15 Source: Canva

In a nutshell, with an inclusive field trip, teachers can ensure that **all learners have the opportunity to explore and discover the world outside the classroom**.

3.1.2 Inclusion Checklist

Based on pupils' difficulties, preparing a checklist before a field trip is recommended. It will ensure the field trip is organised in the most inclusive way possible for learners. The checklist will vary from one trip to another and from one class to another to answer the learners' specific needs.

Here is an example of a general checklist to use to ensure the excursion is accessible to all pupils:



Now that you hold all the cards, it is time to properly organise an inclusive and accessible field trip!

3.2 Logistics, preparation and debriefing

Education is not just limited to the confines of the classroom. School field trips can provide pupils with **valuable learning experiences** that are difficult to replicate in the traditional classroom setting. A maths and architecture field trip is an excellent opportunity for learners to explore how mathematical principles are applied in real-world settings. By exploring the relationship between maths and architecture, pupils can gain a deeper understanding of mathematical concepts and how they are used in practical applications.

However, organising a successful field trip requires **careful planning and execution**. The logistics of preparing and executing a field trip can be overwhelming, but with the proper organisation, it can be an enriching experience for both teachers and pupils.

This part of the guide will focus on the logistics, preparation, and debriefing of a school field trip aimed at teaching mathematics through architecture. Each section will cover essential considerations and strategies for ensuring an inclusive and fruitful experience for all learners. By following this guide, teachers can plan and execute a memorable and educational field trip that will inspire pupils to learn and explore the world around them.

One must note that those are guidelines that can be followed, but that are adaptable and interchangeable to each context.

3.2.1 Before the field trip

The preparation phase is crucial to ensure the success of a field trip. Being able to understand the venue layout, asking parents about their children's needs, and being well prepared, generally speaking, are key factors in overseeing the smooth running of a field trip.

When organising it, consider the following steps:

Identify the Objectives

To begin with, the first step in organising a field trip is to **determine its goal in terms of learning objectives**.

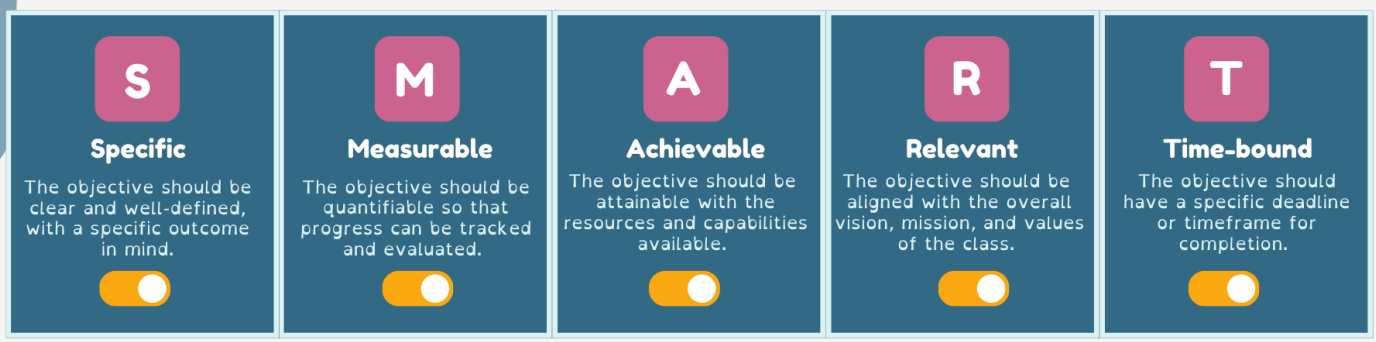
What do you want to achieve with this field trip? How will it be related to your class? In the case of VisitMath, field trips are related to mathematics. Therefore, you could wonder how to expose pupils to real-world applications of mathematics. Which specific area of maths, such as geometry or calculus, do you want to study?

Answering these questions will help you narrow down your options for the kind of field trip you want to carry out. Remember to create a clear link between the content taught in class and the field trip so that pupils also understand the learning objectives.

In practice, the learning objectives for a maths and architecture field trip could be to:

- Identify and describe the different shapes, angles, and lines used in architectural design.
- Understand how architects use geometry to create buildings.
- Apply mathematical concepts to solve problems related to building design and construction.
- And so much more!

Furthermore, to determine the general objectives of your field trip organisation, you can use the **"SMART" framework**. This framework will help you identify goals that are Specific, Measurable, Achievable, Relevant, and Time-bound.



Using SMART objectives to plan a field trip can help ensure that the trip is well-organised, effective, and meets its intended goals. Here are some reasons why using SMART objectives can be helpful:

- **Specific**: Setting specific objectives can help ensure that everyone involved in the field trip understands what is expected of them. If the objective is to learn mathematics thanks to architecture, then the specific activities to achieve this objective can be planned accordingly.
- **Measurable**: By setting measurable objectives, it becomes easier to evaluate the success of the field trip. For instance, if the objective is to increase learner's engagement, then the measurable outcome could be a debriefing after the field trip to assess the pupils' level of engagement during the trip.
- **Achievable**: Objectives should be achievable with available resources, including time, money, and personnel. If the objective is to visit a landmark related to maths, then hiring a guide may be necessary.
- **Relevant**: Objectives should be relevant to the goals of the field trip and the overall learning objectives of the course. For example, if you aim to learn about architecture, visiting a city may be more relevant than going to the countryside.
- **Time-bound**: Setting a deadline for achieving the objectives helps ensure the trip is well-planned and executed within the allotted time frame.

SMART objectives help educators ensure that the field trip is effective and meets its intended goals, which provides pupils with a meaningful and engaging learning experience

Choose the Location

Choosing a location for a field trip can be a fun and exciting task. The location should be **relevant to the learning objectives and accessible to all pupils**.

To begin with, **research potential locations**. Once you have a goal, you can start researching specific places. Look for places that align with your previously determined goals and offer opportunities for learning and exploration. For example, you might

consider a nearby city or a historical landmark that can be studied from a mathematical point of view. Make sure that the location provides opportunities for hands-on learning!

Then, you must **consider accessibility**. When organising a field trip, it is crucial to make it accessible to all learners, regardless of any disabilities or limitations they may have. To do so, have a look at the previous section called "A pedagogical guide to accessibility". You will find all the necessary information about organising an inclusive field trip.

Plan your Itinerary

Once you have chosen a location, plan your itinerary. Determine what you want to see and do at the location and how much time you need for each activity. Be sure to include time for breaks, meals, and any necessary travel time.

Arrange Transportation

The transportation should be arranged based on the number of learners and the location of the field trip. It is essential to consider the pupils' needs, such as wheelchair access or other special requirements. The mode of transportation should be safe, reliable, cost-effective, and as sustainable as possible.

Obtain Necessary Permissions

Permission slips should be sent to parents or guardians to obtain permission for their child to participate in the field trip. It is essential to ensure that all necessary insurance coverage is in place. The permission slip should include information on the field trip's date, time, location, and purpose. It should also provide emergency contact information and any special instructions or requirements.

Provide Information to Pupils

Pupils should be informed about the field trip and provided with the necessary information, such as the location, dress code, and schedule. Teachers should also provide learners with any relevant materials to prepare them for the field trip.

It is also important to explain to the pupils that the field trip is linked to what they are learning in the classroom. Being able to use their previously acquired knowledge in a "real life" context is the best way to anchor knowledge.

To ensure pupils are prepared and engaged before the field trip, teachers can provide **pre-trip activities** that introduce the concepts and ideas that will be explored during the trip. These activities could include readings, videos, or interactive assignments that get learners excited about the field trip and prepare them to make the most of the experience. Teachers could also encourage pupils to research the location or site they will be visiting and create presentations to share with the class.

To conclude, the **success of a field trip largely depends on adequate preparation**. Before organising a field trip, educators must identify the learning objectives, choose a relevant and accessible location, plan the itinerary, arrange transportation, obtain necessary permissions and provide learners with information and materials. By following those simple steps, educators can ensure the success of the field trip and create an inclusive learning experience for pupils.

3.2.2 During the field trip

Keeping pupils engaged during a field trip is crucial to make it a meaningful and enjoyable learning experience. Here are some steps that you can follow during the field trip to keep your learners engaged and connected to the learning goals:

Provide Clear Instructions

Preparation work will already have been completed before the field trip. Nevertheless, during the field trip, it is essential to provide clear instructions to pupils so that they

know what they are expected to do. Instructions should be provided in an inclusive way so that everyone can understand, as seen in the pedagogical guide on accessibility.

You could divide pupils into smaller balanced groups so that each of them feels confident. This way, they can help each other, and you can ensure that everyone gets the attention and guidance they need throughout the trip.

Engage Pupils

Provide hands-on, interactive activities for learners to participate in throughout the trip. This will help to keep them engaged and focused on the learning objectives.

You should also encourage active participation; by encouraging pupils to strongly take part in the field trip activities by asking questions, sharing ideas, and engaging in discussions with their peers. This will help to deepen their understanding and foster a sense of curiosity.

Monitor Pupils

Educators should monitor learners to ensure that they are safe and engaged in their activities. It is essential to ensure that nobody is left out of any activities and that all pupils are given an opportunity to participate. If necessary, teachers should be trained to assist people with disabilities.

In conclusion, a well-organised and engaging field trip can be a powerful tool to enhance pupils learning and understanding. By providing clear instructions, engaging learners with interactive activities, and monitoring them throughout the trip, educators can help to keep pupils engaged and connected to the learning objectives. It is crucial to ensure that all learners are included and given the support they need to participate fully in the experience, including those with disabilities. With these strategies in place, field trips can become a valuable part of the educational process, providing pupils with hands-on learning opportunities that they will remember for many years.

3.2.3 After the field trip

Debriefing, feedback, evaluation, and follow-up activities are all critical steps that educators should take after a field trip to reinforce learning objectives, provide feedback to pupils, and improve future field trips. These steps help ensure learners have a valuable and enriching educational experience.

Debriefing

Immediately after the field trip, a debriefing should take place with the pupils to address any questions or concerns they may have and encourage them to reflect on their experiences and share what they learned with others.

This debriefing could be an informal talk with the pupils on the way back to school. The important point is to gather their opinion right after the field trip to have their immediate reaction.

Feedback and Evaluation

After the field trip, it is important to assess the trip's effectiveness in achieving its intended learning outcomes. Feedback and evaluation can help teachers determine what worked well, what did not, and how the experience can be improved in the future.

You may use a survey or questionnaire to gather learners' feedback about their opinions and experiences. These surveys can be designed to get feedback on specific aspects of the field trip, such as the location, transportation, activities, and learning outcomes. Feedback can be collected through written responses or online surveys, depending on the preference of the teacher and pupils.

Evaluation and assessment are crucial components of any educational experience, including field trips. By assessing the effectiveness of the field trip and pupils learning outcomes, teachers can improve future field trips and ensure that learners take part in a meaningful experience.

Follow-up activities

Debriefing, feedback and evaluation should be done to measure the effectiveness of the field trip in achieving the learning objectives. After those steps, follow-up activities can be used to assess the effectiveness of the field trip and pupils learning outcomes.

Teachers can reinforce learning objectives by asking pupils to reflect on what they learned during the trip through group discussions, written reflections, class presentations, assessments and quizzes, among others, where learners can demonstrate their understanding of the material.

A successful field trip does not end when the pupils leave the location. The debriefing, feedback, evaluation, and follow-up activities that take place after the field trip are crucial to reinforce learning objectives, provide feedback to pupils, and improve future field trips. Teachers must take the time to assess the trip's effectiveness, gather learners' feedback, and reinforce the learning objectives through follow-up activities. By **facilitating reflection and encouraging further exploration**, teachers can help pupils **internalise what they learned** and **make connections to their everyday lives**.

In conclusion, a mathematical and architectural field trip can be an excellent way for **pupils to learn about the practical applications of mathematical principles**. By exploring how maths is used in architecture, learners can better understand mathematical concepts and their real-world relevance.

However, organising a field trip requires careful planning and preparation. By following the steps outlined in this paper, educators can ensure that all pupils can participate fully in the activities and achieve the learning objectives. Field trips are an excellent way to **supplement classroom learning** and **provide learners with hands-on experiences**. With meticulous organisation, teachers can create a **memorable and educational experience** that will inspire pupils to learn and explore the world around them.

16 Source: Canva

School field trips are like windows that open up the classroom walls and allow pupils to discover the wonders around them. They provide a pathway to new horizons and inspire curiosity, imagination, and lifelong learning.

4. Game mechanics, how to create a treasure or scavenger hunt, storytelling

4.1 What are treasure and scavenger hunts, and how do we create one?

4.1.1 Starting from a known territory: orienteering

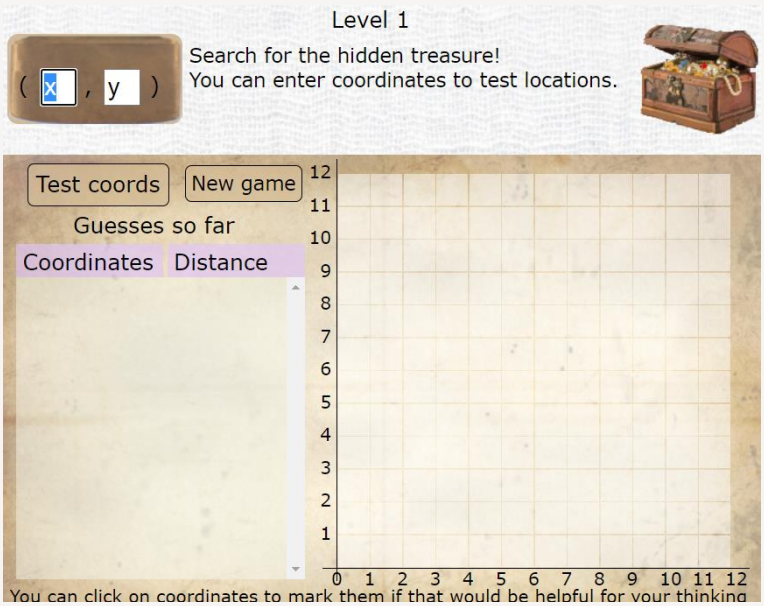
If treasure hunts are not often used as a pedagogical tool at school, orienteering is a common practice in Physical Education, and both subjects are based on the same ground rules: being the fastest to find clues that have been hidden by the game master or the teacher. Orienteering, as it is usually played at school, only asks pupils to find the next clue whatever it is: a code written on a piece of paper for example, or a beacon hidden under a pile of leaves in a forest.

Since the goal is to find the clues as quickly as possible, teachers give a map to their pupils with the exact position of each of the objectives written on it. The challenging aspect of this first part is, for the learners, to avoid getting lost while searching for their objective. However, such activity can also be made slightly more challenging by asking pupils to write a code on a piece of paper to prove that they have found the objective while not removing it entirely for the others to find it. For example, pupils may have to answer a mathematic question when they find the clue, and write down their answer on a sheet of paper (Te4chActive, 2020). The teachers can then make sure that all learners found the clue by checking that all answers are correct.

4.1.2 What exactly is a treasure hunt?

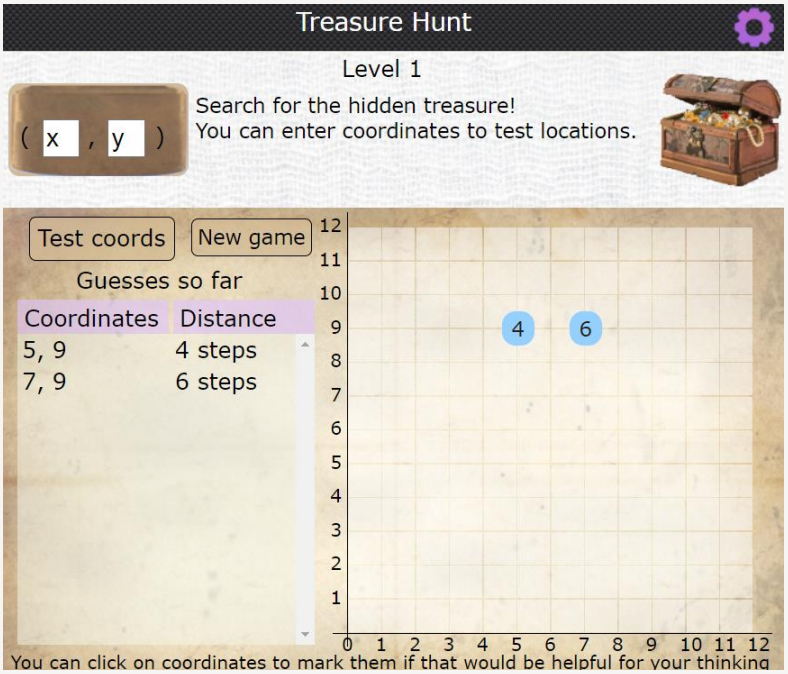
A treasure hunt is a game that usually takes place in the open, and in which a game master hides a “treasure” from the players. The goal is for the players to find the treasure as quickly as possible by solving riddles given by the game master as they advance. Treasure hunts are designed with a goal in mind, which is to have the players discover something about the place they are in: its **history**, its **geography**, the **life of a famous character**... In order to reach the treasure, the players will have to solve riddles left by the game master and which will help them know more about the topic of the game: for example, if a treasure hunt focuses on the life of a writer, the riddles could follow the lifespan of the person in chronological order, from their birth to their death and paying attention to some of their most famous publications. The **journey** that leads to the treasure is usually **more important than the prize** itself, since the players can simply stroll to reach each of the objectives. Scavenger hunts only differ by the fact that each step brings a small prize, but the principle remains the same.

Such riddles can look like the following:



17 NRICH online treasure hunt, n.d.

In this example, the learner has to guess the position of the treasure hidden in the grid. They would try different locations which will indicate how close they are to the chest.



18 NRICH online treasure hunt, n.d.

When the learner gets to the treasure, they win! A paper version could require students to calculate the coordinates of a point on the map where they could find their treasure – or their next step to it. Note that treasure hunts allow for mistakes: if the players misses their objective, they can try again. This means that every learner will be incentivised to make attempts, even those who usually fear maths!

Contrary to orienteering (although both are connected), treasure hunts rely on **storytelling**, an aspect that is usually left aside when running for specific objectives. Treasure hunts want the players to be involved in what they are looking for, and not only to find the treasure. So, although the goal is still to be the fastest at finding the last objective, everyone can be a winner by enjoying the story they experienced.

Famous treasure hunts include the **Trail of the Golden Owl** in France and the **Secret** in the USA. Both of them are books that lead the players through French and American landscapes using local history and geographic clues. Players from all around the world gather to decipher the mysteries hiding within the pages. Why are they doing so? Mostly because the stories compel them to collaborate to find the right clues! However, although those books have been written dozens of years ago, these examples have never been solved... But with a little patience, maybe you (or one of your students) will!

4.1.3 What are the main elements of a treasure hunt?

The main elements of a treasure hunt are, with no surprise, the clues and the treasure at the end of the game!

Jokes aside, the route must be planned carefully (see next section). It must represent a journey through which the learners progress. In a way, there is no treasure hunt if there is no **sense of progression** to reach the final objective. In order to advance, diverse clues will give the players indications on where to go, and these clues often offer riddles to solve.

The **places** explored by the players represent a big part of the treasure hunt too: they must be **meaningful** and represent some form of progression through the game. Don't just put a clue at the bottom of a wall, unless this wall is important in some way (is it part of the house of a famous person? The last remain of a castle in ruins?). A treasure hunt must be appealing to the players: immerse them into your world. Once the players have reached the end, they must have learned something: knowledge about a specific topic or soft skills such as teamwork, communication or problem- solving. If you are ambitious, you could even have your players learn hard skills as they build items that will help them solve their next riddle.

Let's take the Trail of the Golden Owl for example. The riddles have been written by author Max Valentin, and each of the riddles indicates a clue to find the Golden Owl's location. After crossing all the pieces of evidence together, the treasure should be at hand… Note that you may also add red herrings (fake hints) to your treasure hunt, although it will drastically increase the length of the hunt.

4.1.4 How do teachers plan a treasure hunt?

When creating a treasure hunt, good planning skills are required.

Step 1: Choose a **good hiding spot** for your "treasure". You will plan your clues accordingly. Of course, the treasure and the clues must be easy to access: everyone must able to find them, so they must not be too small or hidden in a place that is hard

to access for some people, but they must also be put in places that pupils are allowed to go in the first place. Avoid hiding your treasure in a private property, or to put it in places that could be damaged. Cemeteries, public flowerbeds or a room in a museum could suffer from the impact of an army of teenagers frantically searching for an object. Also, do not put your clues in places that could harm your pupils. Avoid cliffs, river banks or parking lots for their safety. Once your treasure is hidden, plan where the clues will be hidden: they must not be too obvious, but not too hard to find either. Basically, the same ground rules apply to your treasure as to your clues.

Step 2: The clues must be located in important places and be **planned in a logical order**. As mentioned before, a treasure hunt is created around a theme: all clues must be related to that theme. The locations must not be too far from one another either, or the players may believe that they went the wrong way if they cannot find them.

Step 3: Your treasure hunt should be useful in the context of a sequence. They must answer the **pedagogical requirements** of the lessons that teenagers are studying. Perhaps some of the riddles we offer here will not correspond to what you want to do. Feel free to use and adapt our material to suit your needs!

4.1.5 Storytelling

If you want to fully commit your pupils to the treasure hunt, do not forget to create a **universe** for them to explore! There are several ways for you to achieve that, and the more the better (as long as it does not slow you down too much of course). For example, you can:

- Think about the kind of world you want to explore. Immerse your pupils in a **historical setting**, such as the Antiquity, the Middle Ages or the Renaissance. You may also aim for **made-up worlds** which are either adapted from or entirely different from history (steampunk, sci-fi universe, etc.)
- Think about who your pupils are, what their **role** is in the world you created. They can be scientists, explorers, researchers... Think about the future: putting

girls in the shoes of a renowned scientist could help them choose their job later.

- Think about a **mission** or a **general objective** that goes a bit further than "find the treasure". Are your pupils trying to save the world from collapse by unravelling an ancient relic? Are they racing against time to stop a bomb? Are they chasing a mythical beast? You may find inspiration in the popular series, movies or books for your learners' age group.

Still, providing them with a setting may not be enough. Indeed, creating an engaging treasure hunt will require you to put your pupils in the right mood. You may either write them a summary of what they are about to face, or tell them as they progress through the story.

What are the most compelling ways to create a great storytelling experience?

On the one hand, if you want to create the perfect **immersive experience**, you may start by giving your players a good introduction speech / a well-written paragraph. It has to look – or sound – authentic (Shapiro, n.d.). How can you achieve that? Well, if you want to involve your players, you have to be involved in your own storytelling yourself. Do not make your pupils feel awkward about the situation they are about to encounter.

And how can you create such experience? Building a world is no easy task, but you do not necessarily have to go that far, unless you want to obviously. First of all, for clarity purposes, you may very well **abide to the classical unities**: one place, one time, one main action. This should help you focus on your world building. You are allowed to get inspired from existing time periods and existing characters, possibly link them to people and places your players know of.

On the other hand, you may play with suspense, and this is possible in a treasure hunt too! Having your pupils on the edge of their seat – or on the tip of their toes – requires a bit of practice, and this is what this part is about. In addition to creating an interesting world, you also have to make sure that your players live in it (Shapiro, n.d.). In a treasure hunt, this can be done by using various techniques: for example, you can give away crucial **pieces of information** from the beginning **with missing items**. Your

pupils will need to find more clues to unfold the mystery they try to uncover. Or, you can also create a cooperative experience by **giving roles to each player**. Information then only starts to make sense when the whole team gathers to explain what they discovered, and gathering the evidence will give them the answer to what they were looking for.

Ensure that your riddles are neither too hard or too easy, especially when your setting revolves around a universe that your audience likes. They would be disappointed if they cannot finish the hunt in time or if they get stuck at some point, but they would also not appreciate not facing a real challenge if things become too easy (McDowell, Nicholson, 2022). A part of your storytelling comes from a good estimation of what your players can or cannot do!

4.1.6 What kind of riddles can one use to create a treasure hunt?

In order to make the treasure hunt interesting, the riddles need to be compelling. First, make sure to create them bearing the local landscape in mind. The architecture of the church, of buildings on the main road or in the old town, of a bridge… all of those items can be used to create challenges for players to solve.

Riddles can take many forms, but the general rule is that it consists in some form of a question or scheme to complete that will then give indications on where to find the next clue. We would tend to advise teachers not to create treasure hunts that contain clues that are too far-fetched: the goal is for everyone to find the treasure in the given time! Plus, since there is an additional pedagogical aim, it may take time for pupils to solve the riddles if they are not comfortable with their subject.

Riddles can be presented as **text**, and there are many ways to use text.

- Secret code
- Paragraph alluding to something
- Play on words

Riddles can be presented as **pictures** or **graphs.**

- An image
- A graph to give directions, represent something…

Of course, the core idea of a riddle is that it must be deciphered: the goal is to "lose" your players for a short time: what should they do with their clue? What is the message hidden behind the data? This drawing from the Secret book contains all the necessary clues to find a crate located somewhere in the US. By carefully analysing all the shapes, the meaning of the symbols hidden on the picture (what kind of bird is it? What does it stand for?) and perhaps even the colours, the players should be able to precisely locate a small box buried in an American city. Doesn't it sound amazing?

19 The Secret book cover, Byron Preiss (1982)

Of course, the goal here is not to create something that complex, since pupils must be able to finalise their hunt in a few hours at most. Using adapted content, you may still create an engaging and challenging treasure hunt.

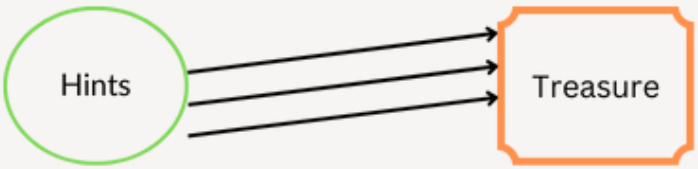
4.1.7 Riddle structure

As seen in the examples above, treasure hunts can be developed in three ways (Nicholson, 2016). The "open", "sequential" and "path-based" puzzles are the most common ones, and although Scott Nicholson developed what they stood for in an escape room context, those can also be applied to treasure hunts. After all, the major difference between both is the fact that treasure hunts take place in the open while escape rooms are closed places the player has to get out of.

First of all, the "**open**" riddle structure is the one that is being used in our two previous examples of the Trail to the Golden Owl and the Secret. Players are given all the

riddles at once from the start, but they have to decipher them to find the treasure. Finding where the hints are, in the text or in the picture, is the first part of this puzzle. Then, players need to make sense out of them!

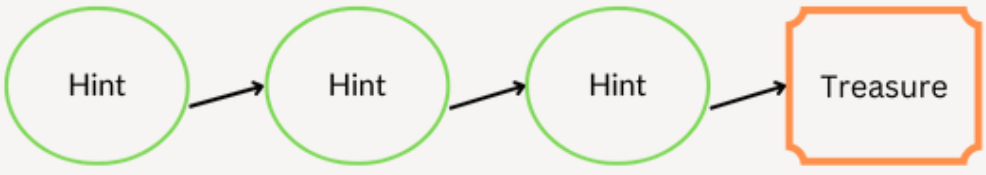
The structure of this kind of puzzle would be as follows:



Still, you have to take into account the fact that without all the clues, players may be misled and their chances of finding the treasure would dramatically decrease. In class, this kind of treasure hunt could be planned with the whole group so that the teacher can check if their pupils have all the tools they need to succeed.

Next, the "**sequential**" structure leaves less room for mistakes since the players are confronted with the riddles one at a time. Each riddle indicates where the next one is, up until the players find the treasure. This way, the game masters can have a bit more control over what the players are going to do next and how they can help them if needed.

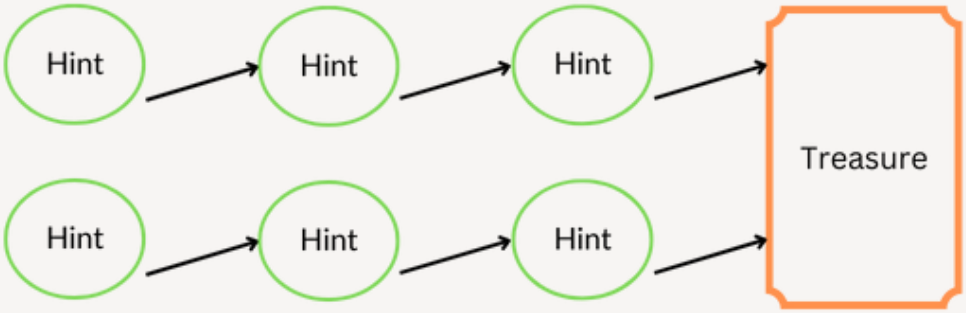
The structure of this kind of puzzle would be as follows:



As you can see, the progression is linear and neither the players nor the game master should be lost at any point. This is the kind of puzzle arrangement that treasure hunts for kids tend to use, because they can focus on one task at a time.

Finally, "path-based" puzzles are a mix of the two previous methods. Players are given several hints at once, which each leads to a sequence of riddles that unlocks part of the final one. The players then have to complete each puzzle sequence to unlock all the information needed to find the treasure.

The structure of this kind of puzzle would be as follows:



This structure can allow the game master to vary the difficulty of the riddles, and even to block certain paths since they would require players to have completed another series of riddles. The fact that the players are presented with several path options at first means that they can easily go back to where they started while not losing their progression on the other paths.

4.2 How to create a treasure hunt focused on teaching maths

First, you need to determine how you want to create your treasure hunt. There are two ways to create an engaging game – and an engaging treasure hunt – which are the top-down or bottom-up designs (see chapter "The importance of games in our everyday life" in our other guide for more details). To summarise, what matters is what you intend to have pupils practice: do you want them to discover all the places

in the city that use maths first (and thus focus on the usefulness of the subject) or do you want them to practice **specific topics** (and thus focus on upcoming exams)? If you ask yourself the right questions from the start, you will be able to create the right treasure hunt for your pupils.

4.2.1 Places to look for

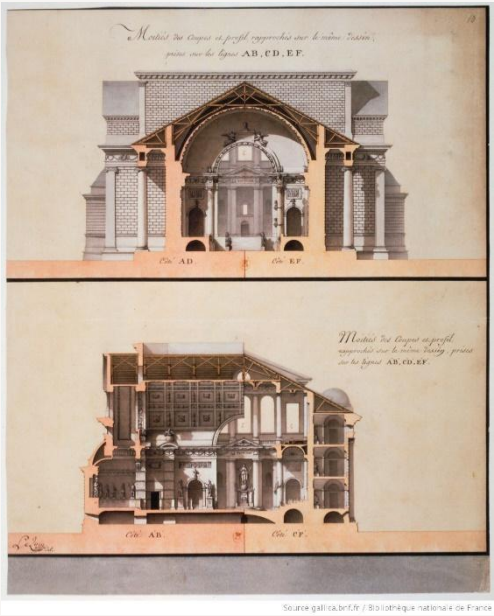
Treasure hunt game mechanics can be applied to almost anything, including maths training. In our case, the riddles have to focus on mathematical concepts that apply to architecture and to give useful clues to the pupils. Let's have an overview of the various places you could come across and what you could do with them.

Keep in mind that these are examples of the most common kinds of buildings you may encounter. The following content can be adapted to any building that could use the same concepts. This list is presented as a top-down design (in order to have a look at the various places that use maths in the city), if you are interested in specific topics you can refer to the previous chapters of this guide and check how they apply in the following examples!

The church

Why is it interesting?

What is the common point of all towns and villages in Europe? They all have a church! Back in the Middle Ages, villages were actually built around churches, which explains why there are so many everywhere, no matter which country you live in. With that being said, churches allow for quite a wide range of mathematic exercises. Let's have a look at the church plan here:



20 Study for La Madeleine, Lequeu (1806)

The first thing we can notice is how geometric the building looks. There are columns, square or rectangular rooms and a certain sense of proportions. This can help us play with numbers as well as geometry.

What can we do with it?

Now that you have found a nice church to study with your class, let's get to work! Pupils will have to answer your treasure hunt riddles with observation and mathematic skills: when you want them to study that kind of building, make sure to provide them either with a plan or with approximate dimensions if they need to care about them. Then the hints pretty much write themselves! Do you need to use the church as a signpost? Create a riddle that will ask them to use the bell tower so that they can see it from afar. You can also have them practice geometry or trigonometry to guide them to a street around the building. Are there gargoyles? With the use of numbers (fractions for example) they can also go towards a specific point by using these elements of the façade.

However, remember that churches are religious places: respect the peace of those who work or pray there. Whenever possible, keep your pupils outside the building, there are many sculptures to look at!

Other topics to study

The main subject that can be used when looking at a church might just be history. Studying the evolution of architecture (Roman or Gothic churches) or the influence of the various kinds of Christianism in Europe can help anchor the topic as more than just another math exercise. For more advanced learners, the very architecture of the building can be used as a start to study forces in physics and determine why those buildings were designed this way.

Road agency

Why is it interesting?

Roads in villages or cities are designed with a simple goal in mind: having drivers and pedestrians link point A to point B in the quickest way possible. So instead of having the traditional exercise of guessing where two trains will meet on a railway, pupils may have to calculate durations and lengths in a real setting.

What can we do with it?

21 Map of Naples with tourist attractions (2018)

Sending your pupils on the hunt of an escaped character, you may ask them to determine the shortest way between two places and follow it up with distance calculations, fractions or equations to have them stop at a specific point in the streets. Do not hesitate to add variables: imagine that some streets are more crowded than others so they would take more time moving forward in some places. Force them to take a detour. If you want to create a red herring to have an “obvious” choice, do not hesitate to do so!

Other topics to study

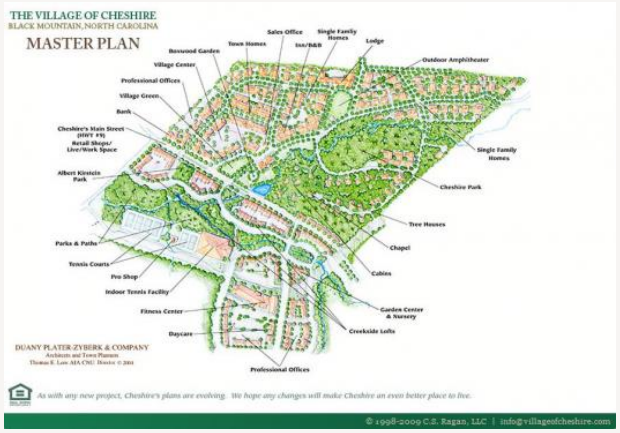
Depending on the universe you want your pupils to explore, there are many ways for you to link the exploration of the city to a school subject. For example, you can link it

to history or literature if remarkable events or famous people have lived there. You may also make good use of geography to study the various neighbourhoods of the city (if it is big enough) or the main shops and where they are located in a smaller environment.

The main road

Why is it interesting?

Each town or each neighbourhood has a "main road" that traverses the place in a straight line. In mathematics, straight lines are great to study! You can use it to create geometry, find angles and, if the main road has a perpendicular intersection, it may even serve as abscissa and ordinate for a graph.



22 Small town map with a main road, Toth (2012)

What can we do with it?

First of all, as we just mentioned, the straight line of the main street can be used for various purposes, even to create triangles using the Pythagorean theorem. Second, since the students will know which street to focus on from the start (contrary to the city plan where they have to find the right one), we can use the house numbers as a means to ask for a specific number, perhaps to create equations for example. You may also use statistics and probabilities: estimate the number of passer-byes, cars…

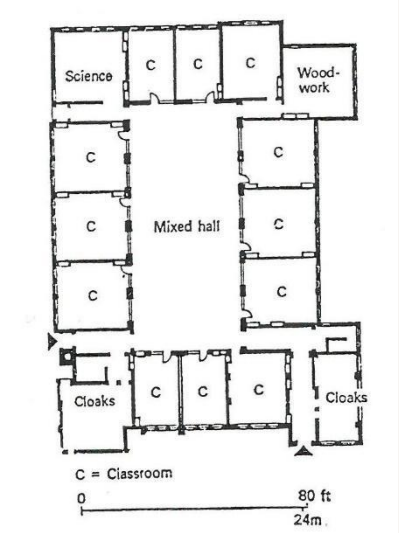
Other topics to study

Studying the main street of a village or a city can become a journey into the past of the place! What did the surroundings use to look like? What are the main shops? Those can be useful to study basic vocabulary in foreign language classes too!

The school

Why is it interesting?

The school is where your pupils go almost every day, so this is a familiar environment for them. You may gain some time on exploration, but this does not make the treasure hunt less interesting! On the contrary, schools contain all the necessary elements of a great mathematics treasure hunt. When it comes to algebra, take a look at the number of pupils, teachers or classrooms. The buildings traditionally have a rectangular shape which can be used for geometry. If your school contains several buildings, you may use those to create geographical coordinates to guide your players towards the next clue.



23 Layout of a Victorian school, Costanzo (2017)

What can we do with it?

You can create pretty much any kind of exercise with a school plan. The main advantage of this place is that your pupils know its boundaries and the general setting of the rooms. You may also use the playground during your treasure hunt to create trigonometry- based riddles. If the rooms of your school are numbered, you can refer to them in your riddles, either in the question or the answer. However, it would be best if you do not stay inside the school for the whole hunt: the goal is to have your pupils discover the city around them, so they should have a look at other kinds of infrastructure.

Other topics to study

Are there rooms or aisles that belong to specific school subjects? You can intertwine those with your math questions. Do not hesitate to ask for help from other colleagues who might join in the fun too!

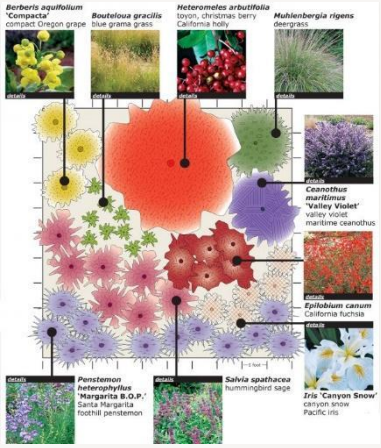
Public gardens

Why is it interesting?

Public gardens must look nice. Today, in order to create a nice-looking garden, people tend to recreate geometrical shapes. Although you may not have a “jardin à la française” near you, you may still find some pretty interesting shapes in your local floral arrangements.

What can we do with it?

Public gardens are composed of several kinds of flowers, arranged in a specific order. Depending on what your local decoration looks like, you may use the shapes to create exercises about geometry or symmetry. You can also study the growth of flowers to create exercises that are related to other topics.



24 Garden arrangement, UC Davis Arboretum and Public Garden

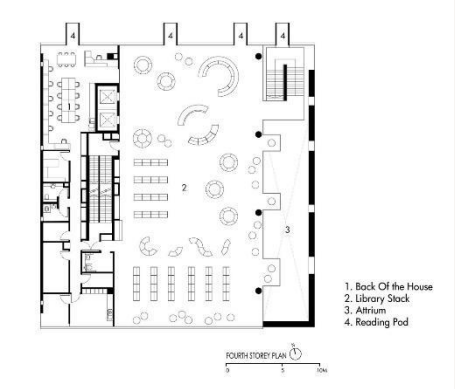
Other topics to study

Do not hesitate to use this example with biology: you can create probability exercises with pollen for example, and have the pupils guess which plant would take over the rest if left unchecked during a certain amount of time. Such exercise could use pollen emission rate and travel distances to create probabilities of which flowers would be most or least likely to overcome the rest of the plantation. You may also play with colour and colour theory in physics to indicate which kind of flowers is the clue pupils should be looking for.

The public library

Why is it interesting?

Just like the school, the public library is a place of knowledge where everything can be used for math-related riddles. Of course, the very nature of the building means that your pupils would need to be particularly quiet – which is why we will not include museums in this guide – but looking for clues about a treasure in bookshelves adds flavour to the treasure hunt.



25 Bishan Public Library

What can we do with it?

Although you may not find the plan of your local public library online with the bookshelves located at the right place, you may go there beforehand a draw a map of the place yourself. Bookshelves can act as lines – straight lines or curves – and the fact that the books are usually numbered can send your pupils on a treasure hunt within the treasure hunt. Many libraries have adopted treasure hunts as a means to have people discover what they have to offer, so you can work in collaboration with the librarians to set up the hunt before your pupils come. The outside building can be used in the same way as a school's, but we would advise, if possible, to have your learners look at the books for clues. If you look at the plan above, you may use seats as a starting point for trigonometry exercises too.

Other topics to study

You may obviously use this approach to pair up mathematics with literature. Ask your pupils' literature teacher for clues of which books to look at! Otherwise, you may also find scientific literature that discuss every school subject. You decide what to focus on!

4.2.2 Creating the setting

Now that you have found the places you need for your treasure hunt, let's see how we can tie them up together to create an immersive experience. The main goal of the activity is to allow pupils to walk through a town and observe the mathematical concepts that shaped the landscape around them. Therefore, the treasure hunt should follow a route that will allow pupils to explore their surroundings with a new eye. As mentioned in the "How do teachers plan a treasure hunt?" chapter, this can be partially achieved by immersing learners in a specific universe. Since this treasure hunt should mostly focus on maths, here are a few ideas of settings that you could use:

The first mathematicians of Antiquity

This setting can be used for younger pupils since it would mostly revolve around some of today's basic mathematical concepts. You can use geometry theorems such as Pythagoras' or Thales', study volumes with Archimedes and discover many more topics with other famous Greek mathematicians!

Enlightenment

The mathematicians from this era sought to know more about the discoveries of the Antiquity. This theme would lead pupils to discover the works of René Descartes, Blaise Pascal and John Napier and dive into calculus and applied geometry.

Crack the code of a 20th century secret message

Follow the path of Alan Turing to decipher a secret code! It seems that your enemy has used nearby buildings as a hint to meet their target. Find out who this person is and what they are trying to do! This kind of activity can be adapted to all levels.

26 Steelrising and Rise of P screenshots, GameRant, 2022

If you want to go even further, you can also give your pupils time to create their own character that would fit in the chosen universe, or even dress-up to mimic the fashion of the time!

4.2.3 Adding a digital experience

Treasure hunts usually require players to gather all their clues and sort them out as they progress. This means there is a lot of writing and erasing, and sometimes the whole experience becomes a mess.

In larger treasure hunts such as the Trail of the Golden Owl, players take years to attempt to solve the riddles and use a lot of space and paper. Pupils will not have all of that – in the first place, they will not need years to complete the challenge, but they will not need to carry too much paper either. What if they used eBooks in their search?

If you are not familiar with eBooks, we suggest you read the chapter on "Gamification and eBooks to learn maths" in the other guide. They offer a digital solution to several issues that can appear when trying to solve a math-based treasure hunt.

First of all, eBooks are **easier to read** than paper sheets, at least for dyslexic people (Nosowitz, 2021). The fact that you can modify how you see the text makes it a prime choice for inclusivity. You may also adapt the **brightness** of the screen when necessary, so you can easily read the document when in a dark place for example.

Additionally, learners can write (digital) notes on eBooks: they will not fold the paper or compromise it after erasing too many times. The plans, for example, will remain readable no matter what, which is a huge asset when making that kind of activity. In general, we command the interactive aspect of eBooks since it allows players to **display the pieces of information** they need when they need them, but it also helps to reduce the quantity of materials they need. They can click on the screen to enlarge or reduce a window, to move on to the next step or room of a building, or even to access external resources recommended by the teacher.

5. Conclusion

Math-related field trips allow pupils to better grasp the mathematical concepts that they study in class. This method aims at making them more motivated to study maths and to score better results during the school year and before they reach university. Studying **architecture has many benefits**, from simply admiring the way some buildings were created to practicing a wide variety of subjects, whether they are related to maths or not. Indeed, one of the benefits of architecture is that everyone can find something that will make them enjoy the lesson. Learners who are fond of history, literature, physics or any other subject will discover fascinating facts throughout the field trip. It is even better if the related teachers are here to help!

Field trips contribute to developing the participants' soft skills too. Their use can be varied depending on what the teachers want to practice specifically, but they can be used as an introduction or a conclusion to a pedagogical sequence, or help the class come together to work on a more difficult topic.

In order to create a successful field trip, many aspects have to be taken into account. First, it needs to be accessible to all: you would not want a pupil to find themselves left aside, so make sure that everyone finds their place in the project. Worksheets need to be adapted to everyone, or to be digitalised to allow everyone to advance at their own rhythm. Any difficulties encountered in the classroom will not vanish simply because the field trip takes place outside. Therefore, in addition to preparing the topic of the field trip before going, make sure the experience will be positive for everyone!

Once your field trip has been carefully planned, you need to find activities for your pupils to make, which are... you guessed it (especially if you have read the guide before), treasure hunts! Treasure hunts can work with any topic, this project aims to have learners practice their mathematic skills and others via architecture. The variety of constructions allows for a wide range of topics and games and, depending on how ambitious you feel, you can find inspiration in existing treasure hunts. The key element of creating a treasure hunt is to **focus on storytelling** so that your pupils will

not feel like they are answering another batch of mathematic exercises. If you apply our advice on creating an inclusive field trip and get inspired with our selection of topics and places to use for a practical approach of math training, you should be able to create an experience that your pupils will never forget. After the hunt is over, make sure to provide feedback to your learners – and ask if they have any. They might have ideas to improve your next one!

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