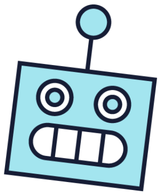
Pedagogical Guide

Empowering Learners Through Story-Driven and Playful Mathematics

Co-funded by the European Union

ENIGMATHICO

THE PROJECT



THE SITUATION IN THE EUROPEAN UNION

Mathematics often gets mixed reactions from pupils—some enjoy it, while others struggle or feel disconnected from it. Most intriguingly, this fracture between science and literacy has fed stereotypes splitting pupils in two categories: the scientists (logic, numbers, calculations), and the literate (good readers, proficient writers). This separation has contributed over decades to widen the gender and socioeconomic gaps between the pupils, which remains visible in PISA's results (2022) where girls outperform boys in reading, whereas boys scored higher in mathematics. The results also underlined the worrying impact of socio-economic status on overall academic performance. **Belgium, Greece, France and Romania** are particularly concerned with that issue. For instance, in Greece and France, a significant number of immigrant pupils face learning disadvantages, often due to language barriers, cultural differences, and limited access to educational support.

The PISA data (2022) also highlight a big drop of performance in both mathematics and literacy, noticeably in **Poland, Greece and France**. The 15 years old pupils scored as the 14 years old pupils in 2018. The OECD estimates that 30% of European pupils don't reach the minimum proficiency level in mathematics and 25% in literacy. In other words, students are below Level 2 proficiency, which is the baseline standard for PISA tests that all students should acquire by the end of secondary education. At this stage, students can use basic algorithms, simple scientific knowledge and interpret simple texts[1].

Those results demonstrate the need to tackle mathematics and literacy as a whole. Indeed, to solve a mathematical problem, pupils first need to read and make-meaning from the instructions, which helps them as well in everyday life challenges.

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[1] Schleicher, Andreas, Insights and Interpretations PISA 2022, OECD, 2023. https://www.oecd.org/content/dam/oecd/en/about/programmes/edu/pisa/publications/PISA%202022%20Insights%20and%20Interpretations.pdf.

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ENIGMATHICO’S PROPOSAL

Enigmathico’s goal is simple: **making mathematics fun and accessible to all learners**. To revive the teaching of STEM, our approach bridges literacy and mathematics. By resorting to storytelling and gamification tools, we aim to develop a methodology that is accessible, cross-curricular and easily adaptable to meet the needs of diverse learners. This stance is an answer to combat learning inequalities and school dropout.

The method places mathematics into real-world contexts and societal challenges (climate change, inclusion, social justice) as a means to foster engaging, critical and dynamic learning of mathematics. We are convinced that bringing mathematics to concrete and tangible situations can contribute to motivating the learners.

Therefore, the partnership develops a series of robust tools co-created by teachers and education and publishing professionals to strengthen the interdisciplinary approach of those resources:

- The current pedagogical guide that presents Enigmathico’s methodology and non-formal education.
- Six Enigmathico boxes adapted to two age groups (8-10 years and 10-12 years), each including: an interactive enigma novel, mathematical tools and games, and teaching sheets.
- 5 national webinars available online.
- An implementation guide to help future users to integrate the project's resources in diverse contexts.

TARGET GROUPS

Enigmathico’s boxes are designed for pupils aged 8 to 12, when the teaching of mathematics starts to be more abstract. Considering the strong inclusion stance of the methodology, we focus on pupils at risk of disengagement in mathematics (due to socio-educational background, learning difficulties, or lack of interest) to revive their motivation.

The project is designed to be implemented with teachers; therefore, several resources are addressed directly to professionals. The teachers are guides and implement the method, measure the pupils’ progress and mediate the teaching.

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CURRICULUM ALIGNMENT

By working with teachers in different European countries (Belgium, France, Greece, Romania and Poland), Enigmathico's approach ensures alignment with national and international curriculum standards. The partnership benefits from professionals in non-formal education who will be able to exchange and co-construct tools that will guarantee relevance for formal education in the different European contexts.

ENIGMATHICO

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PART 1: NON-FORMAL PEDAGOGY IN MATHEMATICS TEACHING

A/ NON-FORMAL PEDAGOGY IN MATH TEACHING

Math teaching does not have to be one-directional and boring. In this section, we will discuss several innovative approaches to mathematics, namely non-formal pedagogy, linking numeracy and literacy, and sensory and holistic approaches.

First of all, it's vital to understand where non-formal education fits within other established teaching methods. To date, there are three types of teaching methods:

- The most common is **formal education**, which takes place in a structured institutional setting such as a school or training centre. It is structured in a rigid and standardised way, with assessments and generally leads to certification or a diploma.

Photo credit by pexels-photo

- A completely different approach in this panel is **informal teaching**, which accompanies learners spontaneously and naturally. It is not structured in the same way as the previous approach, and it is based on personal experience and social interaction. It is spontaneous learning with no predefined objectives and is influenced by the social and cultural environment in which the learner lives. Examples of informal learning include learning a language by travelling, watching documentaries or learning to cook by watching a parent.

Photo credit by pexels-photo

- So, where does non-formal education fit into all this? Well, entirely simply somewhere in between! Located outside the traditional education system, i.e. 'the formal', it is nonetheless **organised and planned**. It is **more flexible** and **tailored to the needs of each learner**, while **targeting specific learning objectives**, unlike informal learning. Learning is based on experience, and learners are actively involved in workshops, projects, etc[2].

[2] (Enseignement Non-formel, 2024) (Education Formelle/Non-formelle/Informelle, 2015)

Photo credit by Flickr

In this guide, we will focus mainly on non-formal learning. This approach to learning, as we have pointed out, is more flexible, allowing learners to participate actively while still having a pre-established learning goal. Non-formal learning typically does not result in a diploma or any other form of certification. Nevertheless, it can contribute to **personal and professional development**, as well as the acquisition of essential skills.

It can therefore easily be seen as **complementary** to the more traditional formal approach.

Its principles are based on:

1. Flexibility: Its flexibility in terms of learning methods, content, and locations means that it can be adapted to the needs and pace of learners, while taking account of the social and cultural context.
2. Active participation: essential to encourage exchange, collaboration and learning from experience.
3. Lifelong learning: This approach promotes lifelong learning by demonstrating that education is not limited to the school setting.

It offers several advantages, including:

- Improved accessibility for learners outside the formal education system, enabling the offer of alternatives tailored to their specific needs.
- Improving learner engagement and motivation through an active participative approach.
- The development of practical skills to enhance your abilities in areas that benefit both your personal and professional life, such as collaboration, communication, and problem-solving.

In a series of interviews with individuals involved in various fields of education, we posed an open-ended question to gather their perspectives on how non-formal approaches can address the challenges of learning mathematics. Here are a few extracts:

According to **Pierre CRESPIN, scientific mediator at the EurëK'Alès Association[3] ,**

> **"The non-formal approach offers an undeniable advantage thanks to the context in which it takes place..." "The absence of obligation and control... makes it possible to explore a multitude of concepts outside the traditional school framework."**

Moreover, as **Houria Lafrance, mathematics teacher and President of the Association Les Maths en Scène,** points out,

> **"Above all, non-formal approaches must be accessible and engaging. They must stimulate learners' motivation, pleasure and curiosity. A key element is the development of self-confidence: it is essential to create an environment where mistakes are seen as a regular part of learning. Interdisciplinarity also plays a fundamental role."**

Additionally, in this approach to learning, **Gautier DIETRICH, a teacher in a preparatory class specialising in mathematics and computing at a lycée (15 – 18 years old),** notes that

> **"non-formal approaches, such as storytelling and games, can help pupils develop their ability to project themselves into a virtual setting and accept the rules." "The history of mathematics and its use in other disciplines can make the subject more concrete and accessible. The use of sensory objects can make mathematical definitions more comprehensible."**

In line with these perspectives, **Giorgos ALVANOPOULOS, an expert in special education**, explains,

> **"Non-formal educational approaches are particularly valuable for students with special educational needs. The standard curriculum in formal education can be too rigid for these students, and non-formal methods often offer more effective support for their learning."**

[3] https://www.eurekales.fr/

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Finally, for **Emilie DAYDÉ, departmental educational adviser for modern foreign and regional languages**,

> **"Non-formal approaches can make learning more fun and motivating, and enable pupils to progress at their own pace."**

B/ CONNECTING LITERACY AND NUMERACY

Literacy and numeracy are two key competencies that play an essential role in learning. By combining them with a non-formal teaching approach, they can offer interesting opportunities for interdisciplinary learning.

According to an official information note, the OECD[4] defines literacy and numeracy as follows:

- Literacy is the ability to understand and use written information in everyday life, at home, at work and at school to achieve personal goals and extend one's knowledge and abilities.
- Numeracy is a person's ability to appropriate, validate, perform and reason mathematically in order to solve problems in a variety of real-world contexts.

Literacy and numeracy skills are closely interconnected. As Melina STAMPOULI, a pedagogical consultant in primary schools, points out, 'Good literacy comprehension is fundamental for solving mathematical problems. Pupils who can understand instructions, analyse texts, and communicate their thoughts are more successful in mathematical reasoning.' This highlights the importance of integrating both skills to improve problem-solving abilities in mathematics.

To illustrate how these skills can be integrated into non-formal learning, here is another example from the recreaMATHS[5] project.

This project, designed for children aged 4 to 7, focuses on the language of mathematics by contextualising it through stories. Mathematical concepts are integrated into narrative e-books that feature real-life situations, such as characters exploring a museum or discovering the four seasons. This approach encourages children to become immersed and engaged in learning.

[4] file:///C:/Users/utilisateur11/Downloads/ni-23-31-156437-1.pdf

[5] https://recreamaths.eu/fr/

Play and manipulation are also integral to this project, featuring 3D guides that enable children to explore mathematical concepts interactively, utilising manipulative techniques to foster a deeper and more lasting understanding.

The diversity of resources in the recreaMATHS project allows a choice of tools that can be adapted more easily to the needs and interests of learners. The inclusive approach of the teaching resources ensures that all learner profiles will have the opportunity to develop numeracy and literacy skills.

Another example of non-formal learning that links numeracy and literacy is the MathandMove[6] project.

This project combines mathematics with body movement and storytelling for children aged 6 to 9 years old. It includes activity sheets for children on specific mathematical concepts. Children are invited to practise movements on their own or in groups and learn about mathematical concepts in a fun way, for example, by turning a magic wheel to learn about division and multiplication, or by measuring objects using parts of their body.

There are also interactive narrative e-books to introduce mathematical activities. The stories serve as a context that immerses the child, encouraging motivation and making the concepts covered more accessible.

Educators have access to a wide range of resources, including lessons, activity sheets, videos, and e-books, to adapt to different types of learners, particularly those with learning difficulties, as well as suggestions for adapting to varying age groups.

In this project, the emphasis is on fun and games to engage learners in a dynamic and inclusive way.

C/ SENSORY AND HOLISTIC APPROACHES

Experiencing learning as a whole through the **senses** (sight, touch, hearing, etc.) and **connecting it with the real world** is beneficial in making science subjects, and particularly mathematics, more accessible to everyone. The sensory approach, based on the idea that learning happens through the senses, and the holistic approach, which considers the child's development as a whole, although distinct, can complement each other to create a rich and meaningful learning environment.

[6] https://mathandmove.eu/fr/home-2/

Experimenting with objects, using colours and so on are all components that create the desire and pleasure of learning in children from a very early age and that last a lifetime. It adapts to different learning styles and learner profiles, helping to anchor knowledge in a more lasting way.

Here is an example of a good practice from the interview of **Cathy Vandenbroeck, a psychologist and primary school teacher**:

> **"I really enjoy using body percussion with pupils who are starting to learn the multiplication tables. For example, for the table of 2, the pupil walks on the spot, counts in their head, and only says the number out loud when they put their right foot down. (...) For the table of 4, they walk on the spot (left 1, right 2), tap their thighs (left three, then right), say "four" out loud, and start again. Using rhythm helps to incorporate and understand what a table is in very concrete terms."**

And, as **Cécile Dewolf, Speech therapist**, says:

> **"We really need to incorporate more hands-on, concrete learning. Mathematics teaching is too abstract and disconnected from reality. It's very important for children to realise that maths is all around them all the time. Whether it's house numbers or anything else, numbers are part of our everyday lives."**

Relating concepts to real-life situations and seeing how they interact with other disciplines is relevant for giving meaning to learning. However, it is also important to consider the learner as a whole, i.e., by taking into account their different characteristics, such as intelligence, emotional aspects, social context, and not just the intellect in the strict sense of the term.

Combining these two approaches to learning mathematics can be genuinely stimulating and appropriate for all learner profiles. (O'Malley, 2023)

The project, My Box of STEAM, aims to make mathematics accessible to all learners by incorporating sensory experiences and hands-on activities. It offers practical, interdisciplinary activity kits. These kits, designed for pupils aged 6 to 12, provide an opportunity to develop skills in STEAM (Science, Technology, Engineering, Arts, and Mathematics) and explore these areas through projects such as creating games and conducting scientific experiments. This approach fosters collaboration and knowledge sharing.

The MathandMove project mentioned above also builds on these approaches. It focuses on integrating physical movement into mathematics learning to demonstrate how reading, writing, and arithmetic can be linked using stimulating, non-traditional methods. On the one hand, on a sensory level, through movement with activities such as learning geometric lines by moving in space or understanding fractions by dancing. In a holistic way, by approaching mathematics in various contexts, using games, challenges, storytelling, and themes from everyday life.

In conclusion, non-formal pedagogy, which combines literacy and numeracy with sensory and holistic approaches, can be used to make learning mathematics more engaging, enriching, and enjoyable. The following chapter provides concrete examples of how this can be put into practice.

PART 2: PRACTICAL APPLICATIONS

The Enigmathico project reimagines mathematics education by integrating storytelling and literature with numerical concepts. As mathematics is often perceived as rigid or disconnected from daily life, Enigmathico demonstrates that it can be dynamic and accessible when explored through narrative. Pupils engage in mathematical adventures where problems are woven into familiar storylines, making abstract concepts more tangible and easier to grasp.

This chapter explores practical classroom applications of Enigmathico's methodology, presenting adaptable activities, usage scenarios, and digital tools to enhance engagement across diverse educational settings.

A/ SAMPLE ACTIVITIES

The following section presents sample activities that demonstrate how stories can be effectively used to teach mathematics to pupils aged 7–12.

The Mystery of the Missing Number

Pupils become detectives solving a mysterious case in which numbers are vanishing from historical documents. Each clue they uncover leads them to an arithmetic problem that needs to be solved to proceed.

- **Mathematical focus:** Addition, subtraction, logical reasoning.
- **Implementation:** The teacher distributes numbered clues, each containing a riddle or arithmetic challenge. Pupils solve them collaboratively to advance in the story.
- **Outcome:** Reinforces problem-solving skills and numerical fluency while encouraging teamwork.

The Time-Traveling Mathematician

A young mathematician accidentally activates a time machine and travels to different historical periods. To return to the present, pupils must solve mathematical puzzles from each era.

- **Mathematical focus:** Geometry, historical number systems, algebraic reasoning.
- **Implementation:** Each historical period presents a new challenge.
- Outcome: Connects math with history, encouraging contextual learning

The Architect's Dilemma

Pupils take on the role of architects designing a new city, ensuring that all buildings and roads follow mathematical rules.

- **Mathematical focus:** Geometry, proportions, symmetry, measurement.
- Implementation: Using graph paper or digital tools like Tinkercad, pupils design blueprints and calculate dimensions.
- **Outcome:** Demonstrates real-world applications of mathematics.

The Enchanted Forest

Pupils explore a magical forest where trees grow in specific patterns, and they must decode the sequences to unlock pathways.

- **Mathematical focus:** Number patterns, sequences, Fibonacci series.
- **Implementation:** Pupils analyse tree growth patterns and predict the next elements in the sequence.
- **Outcome:** Enhances understanding of mathematical sequences and their presence in nature.

B/ USAGE SCENARIOS

The following section outlines suggestions demonstrating how the Enigmathico approach can be applied in different classroom settings for pupils aged 7–12. Each scenario includes a description, practical example, and key benefits, illustrating the flexibility and inclusiveness of storytelling-based mathematics instruction.

Whole-Class Setting

The entire class engages in a shared mathematical adventure, working together to solve problems and progress through the story.

- **Example:** "The Mystery of the Missing Number" serves as a detective-themed lesson where pupils collaboratively uncover missing digits in historical documents.
- **Implementation:** The teacher narrates the story while pupils solve problems in real-time, fostering engagement and collaborative problem-solving.
- **Benefits:** Promotes active participation, teamwork, and critical thinking, while developing key problem-solving skills.

Small Group Collaboration

Pupils are divided into small groups, each tackling different aspects of the story and later sharing their findings with the class.

- **Example:** "The Architect's Dilemma" challenges groups to design geometrically sound structures based on provided mathematical constraints.
- **Benefits:** Encourages communication, peer learning, and cooperation, while enabling personalised support from the teacher.

Cross-Disciplinary Workshops

This scenario integrates mathematics with other subjects, offering a comprehensive, interdisciplinary learning experience.

- **Example:** Pupils explore mathematical patterns in natural phenomena or cultural artifacts—for instance, the Fibonacci sequence in sunflower growth or geometric shapes in historical architecture. They solve related problems to understand how mathematics helps explain the world around them.
- **Benefits:** Reinforces the idea that mathematics is a universal language. Encourages holistic learning, curiosity, and connections between disciplines such as science, history, and art.

After-School Enrichment Programs

These sessions extend learning beyond regular hours, offering informal, project-based opportunities for pupils to blend storytelling and mathematical exploration.

- **Example:** Pupils might create a storybook or digital game such as "The Pirate's Treasure Map", using coordinates and vectors to design challenges.
- **Benefits:** Fosters creativity, independent thinking, and deeper engagement with math in a relaxed, hands-on environment tailored to pupils' interests.

Individualised Learning Paths

Tailors learning to individual pupils' needs and pace, enabling exploration of mathematical ideas through personalised storytelling activities.

- **Example:** Using digital tools like GeoGebra or Scratch, pupils solve math puzzles embedded in customised narratives. One might tackle simple arithmetic, while another works through algebraic challenges, all within the same story framework.

- **Benefits:** Supports mixed-ability classrooms by addressing diverse learning needs. Builds confidence, accommodates different styles, and ensures meaningful engagement for every pupil.

C/ DIGITAL TOOLS IN PRACTICE

The following section presents digital tools and resources that educators can use to effectively implement storytelling-based mathematics education in an engaging way for pupils aged 7–12.

Tinkercad

Tinkercad is a user-friendly, online 3D design and modelling tool ideal for creating geometric shapes and structures. It helps visualise complex concepts and fosters spatial reasoning.

Mathematical skills: Spatial reasoning, symmetry, proportions, volume, surface area.
Example: In *The Architect's Dilemma*, pupils design buildings or cities, applying geometry to create proportional, symmetrical models.
Benefits: Makes geometry hands-on and visual; promotes creativity and practical problem-solving.
Suitable for ages: Yes, ideal for ages 7–12 (with adult guidance for younger pupils).
Free: Yes, free with account registration.

- **https://www.tinkercad.com/**

Scratch

Scratch is a block-based programming platform where pupils create interactive stories, games, and animations.

Mathematical skills: Sequences, logic, problem-solving, programming, algorithmic thinking.
Example: Pupils create *The Time-Traveling Mathematician,* where solving puzzles in different historical periods reveals key events.
Benefits: Encourages computational and mathematical thinking through creative storytelling.
Suitable for ages: Yes, especially suited for ages 8–12 (ScratchJr available for younger pupils).
Free: Yes.

- **https://scratch.mit.edu/**

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Desmos

Desmos is a powerful graphing calculator that allows exploration of functions and equations through interactive visualisation.

Mathematical skills: Graphing, algebra, coordinate geometry, functions.
Example: In *The Enchanted Forest,* pupils graph tree growth patterns (e.g., Fibonacci sequences) or model data using equations.
Benefits: Enhances understanding of algebra through real-time graph manipulation.
Suitable for ages: Yes, especially effective for ages 10–12; younger pupils may need support.
Free: Yes.

- Link to download the app

GeoGebra

GeoGebra is an interactive mathematics software combining geometry, algebra, and calculus for visual and analytical learning.

Mathematical skills: Geometry, algebra, measurement, visualisation.
Example: In *The Architect's Dilemma*, pupils construct 3D models, test designs, and explore mathematical relationships.
Benefits: Supports inquiry-based learning and interactive modelling; helps visualise abstract ideas.
Suitable for ages: Yes, with scaffolding, appropriate from age 9+.
Free: Yes.

- **https://www.geogebra.org/**

Book Creator

A platform for creating multimedia storybooks using text, images, videos, and audio.

Mathematical skills: Storytelling, sequencing, problem-solving, layout planning.
Example: Pupils retell *The Time-Traveling Mathematician*, integrating math puzzles, diagrams, and illustrations in a digital book.
Benefits: Promotes creativity and personalised learning; supports multimodal literacy.
Free: Free version with limited features; full access requires subscription.
Suitable for ages: Yes, excellent for ages 7–12.

- **https://bookcreator.com/**

Kahoot!

Kahoot! is a quiz-based game platform ideal for assessing mathematical knowledge in an engaging, competitive format.

Mathematical skills: Logical reasoning, number sense, recall.
Example: After *The Pirate's Treasure Map*, a quiz tests pupils on coordinates, directions, or angles learned during the lesson.
Benefits: Encourages participation and immediate feedback in a fun, game-like environment.
Suitable for ages: Yes, great for all levels within 7–12 age range.
Free: Yes, basic version is free; premium options available.

- **https://kahoot.com/**

By implementing these activities, methods, and tools, the Enigmathico project offers a dynamic, engaging, and interdisciplinary approach to teaching mathematics through literature and storytelling. This method not only enhances numeracy but also fosters creativity, critical thinking, and collaboration among pupils of all learning styles. Moreover, it promotes inclusivity by addressing diverse learning needs, ensuring that mathematics is accessible to all learners regardless of background or ability. Through this fusion of narrative and numeracy, Enigmathico transforms traditional math instruction into an immersive and enriching educational experience.

PART 3: DEVELOPING KEY COMPETENCIES

A/ PSYCHOSOCIAL SKILLS

Why are psychosocial skills important?

Psychosocial skills, such as **critical thinking, collaboration, and resilience**, are essential for children's learning and personal growth. These skills not only help pupils succeed academically but also navigate challenges in real life[7]. Mathematics offers an ideal environment for developing these skills through creativity and research activities[8]. According to Vygotsky's constructivist theory[9], learning becomes more effective when **learners interact, discuss, and exchange ideas** with one another. By integrating psychosocial skills into mathematics, pupils foster logical thinking, teamwork, and perseverance in facing challenges.

Critical thinking in mathematics

Critical thinking is the ability to examine, evaluate, and apply knowledge in a way that allows pupils to solve problems effectively[10]. In mathematics, it enables them to approach problems in an organised way, adapt their thinking and support their reasoning with arguments.

How does mathematics enhance critical thinking?

- Open-ended problems provide pupils with the opportunity to explore multiple solutions and develop different problem-solving strategies, therefore enhancing their creative and analytical thinking[11].
- Exploratory questions, such as "What is the cause of this phenomenon?" and "In what ways can we prove it?", encourage pupils to deepen their thinking, challenge assumptions, and develop logical reasoning[12].

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[7] OECD. (2018). *The Future of Education and Skills: Education 2030*. OECD Publishing.
[8] Boaler, J. (2016). *Mathematical Mindsets: Unleashing Students' Potential through Creative Math, Inspiring Messages and Innovative Teaching*. Jossey-Bass.
[9] Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.
[10] Facione, P. A. (1990). *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction*. The Delphi Report. California Academic Press.
[11] Schoenfeld, A. H. (1992). *Learning to Think Mathematically: Problem Solving, Metacognition, and Sense Making in Mathematics*. Lawrence Erlbaum Associates.
[12] Lipman, M. (2003). *Thinking in Education*. Cambridge University Press.

- Connecting mathematics to real-life situations, such as managing financial data or analysing environmental issues, helps pupils understand the usefulness of mathematics and apply critical thinking to practical scenarios[13].

Research showed that learners who participated in **inquiry-based learning activities developed stronger reasoning skills** and greater confidence in tackling complex and unfamiliar problems[14].

Collaboration in mathematics

Collaborative learning happens when two or more people learn together or try to understand a subject jointly[15]. It is also described as a process where participants work together with the common goal of solving a problem[16]. In education, **collaboration** is considered one of the most important skills of the 21st century, and it is crucial to develop it from an early age. Collaborative learning environments are based on communication, interaction, and shared goals. Research shows that collaboration can enhance the learning process, even for pupils with lower academic performance[17].

How does mathematics enhance collaboration?

- Group problem-solving activities promote dialogue and the exchange of mathematical reasoning[18].
- Peer teaching and collaborative learning contribute to deeper understanding[19].
- Interdisciplinary STEM projects require teamwork and the application of mathematical concepts to real-world challenges[20].

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13 Boaler, J. (2016). *Mathematical Mindsets: Unleashing Students' Potential through Creative Math, Inspiring Messages and Innovative Teaching*. Jossey-Bass.

14 Bressoud, D. M., Rasmussen, C., & Bottenberg, E. (2015). Inquiry-Based Learning: A New Approach to Learning Mathematics. *Educational Studies in Mathematics, 88*(3), 287-300.

15 Dillenbourg, P. (1999). *Collaborative Learning: Cognitive and Computational Approaches*. Elsevier.

16 Roschelle, J., & Teasley, S. D. (1995). The Construction of Shared Knowledge in Collaborative Problem-Solving. In *Computer-Supported Collaborative Learning* (pp. 69-97). Springer.

17 Lai, K. W. (2011). *The Impact of Collaborative Learning on Academic Performance: A Meta-analysis of Studies*. Educational Research Review, 6(1), 15-29.

18 Slavin, R. E. (2014). Cooperative Learning and Academic Achievement: Why Does Groupwork Work? Educational Psychology Review, 26(3), 1-7.

19 Webb, N. M. (2009). The Influence of Peers on Achievement in Collaborative Learning Groups. In The Cambridge Handbook of the Learning Sciences (pp. 477-493). Cambridge University Press.

20 English, L. D. (2016). STEM Education: A Review of the Literature. International Journal of STEM Education, 3(1), 11-21.

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A study showed that students working in collaborative math teams developed stronger communication skills and achieved better results in problem-solving compared to those working individually[21].

Resilience in mathematics

Resilience is the ability to keep going despite challenges, to learn from mistakes, and to adjust strategies when necessary[16]. For pupils, this means not getting discouraged in math, even when faced with difficulties, and continuing to put in effort to overcome obstacles.

How does mathematics build resilience?

- Teaching pupils to have a growth mindset, which means that instead of feeling discouraged by mistakes, they see them as opportunities to learn and improve their math skills[22].
- Using productive failure, where pupils explore wrong solutions before finding the right one[23].
- Using scaffolding techniques by providing pupils with support initially and gradually increasing the difficulty of problems as they become more confident, helping them build skills step by step[24].

According to research, students who worked on challenging math tasks with teacher support developed greater persistence and flexibility in problem-solving[25].

B/ DIGITAL COMPETENCIES

The importance of digital competencies

Digital skills are important in the 21st century, playing a key role in both education and everyday life. The OECD highlights that developing these skills improves the learning process and prepares students for a constantly changing technological world[26]. Moreover, studies indicate

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[21] Webb, N. M., & Farivar, S. (1994). *The Effects of Grouping Practices on the Achievement and Communication of Students*. Journal of Educational Psychology, 86(2), 348-358.
[22] Dweck, C. S. (2006). *Mindset: The New Psychology of Success*. Random House.
[23] Kapur, M. (2016). Productive Failure. Learning and Instruction, 41, 1-6. https://doi.org/10.1016/j.learninstruc.2015.10.001
[24] Hattie, J., & Timperley, H. (2007). The Power of Feedback. Review of Educational Research, 77(1), 81-112. https://doi.org/10.3102/003465430298487
[25] Boaler, J. (2013). The Importance of Struggle in Learning Mathematics. Stanford University.
[26] OECD. (2021). The OECD Digital Education Outlook 2021: Pushing the Frontiers with Artificial Intelligence, Big Data, and Robotics. OECD Publishing.

that using technology in education can enhance creativity, critical thinking, and collaboration, which are essential skills for contemporary society[27].

Digital competencies and mathematics education

Technology can act as a bridge between theory and practice in math, helping pupils understand abstract concepts through interaction. In mathematics education, digital tools provide interactive ways to explore mathematical concepts, making learning more engaging and accessible. Using technology allows pupils to experiment with mathematical relationships, test hypotheses, and visualise abstract ideas interactively, rather than relying only on static representations[28].

Research shows that using interactive tools, such as simulations and dynamic learning environments, helps learners achieve a deeper understanding of mathematical concepts[29]. Additionally, technology can support differentiated learning, allowing pupils to progress in a way that suits them and receive individualised feedback. Taking part in digital problem-solving activities with guidance adapted to their needs helps pupils think more logically and gain confidence in tackling math challenges[30].

Interactive learning environments that provide immediate feedback support pupils in improving their problem-solving skills and encouraging them to keep trying despite difficulties[31]. Furthermore, **integrating real-life data into digital learning enhances pupils' engagement and understanding**, making learning more relevant while helping them develop a deeper understanding of math and actively participate in the process[32]. Such activities encourage active engagement and demonstrate the relevance of mathematics beyond the classroom.

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The role of educators

Teachers play a key role in effectively integrating technology into learning, and this requires continuous professional development in digital technologies[33]. The TPACK model (Technological Pedagogical Content Knowledge) emphasises how crucial it is for educators to have a strong understanding of both the technology they use and the content they teach, in order to achieve the best learning outcomes for their pupils[34].

When digital tools are used creatively and interactively, they foster a sense of autonomy, competence, and curiosity among pupils, which in turn boosts motivation and enhances learning outcomes[35]. Moreover, how educators integrate these digital tools into their teaching influences not only pupils' comprehension but also their enthusiasm for learning. Research has shown that when technology is applied in an interactive and pupils-centred way, it improves classroom dynamics and increases engagement[36].

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Additionally, digital teaching methods promote collaboration among pupils, encouraging teamwork and active participation in the learning process[37]. Through thoughtful and intentional integration of technology, teachers can ensure it becomes a powerful tool for deeper learning rather than merely a passive delivery method for content[38].

C/ STEM SKILLS

The importance of STEM Skills in enhancing mathematical thinking

Science, technology, engineering, and mathematics (STEM) are essential tools for understanding the world around us and addressing contemporary challenges, such as climate change and sustainable development[39]. Mathematics, as a key component of STEM, provides methods for data analysis, modelling, and making evidence-based decisions[40]. According to the National Research Council, STEM education helps develop critical thinking and strengthens the connection between theory and practical application[41].

STEM learning is not just about studying separate subjects—it encourages pupils to integrate knowledge from different fields to solve real-world problems[42]. Through hands-on activities, pupils learn to use mathematics as a tool to analyse data, test solutions, and make logical predictions[43]. By working on STEM projects, pupils develop problem-solving skills, creativity, and the ability to apply mathematical reasoning in diverse contexts, from engineering to scientific research.

The Enigmathico project builds on this concept by integrating STEM-based mathematical tasks that encourage pupils to think critically and apply their mathematical knowledge in meaningful ways. By engaging with real-world problems related to sustainability and innovation, pupils gain confidence in using mathematics as a tool for understanding and solving challenges.

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Mathematical thinking and the role of STEM education in addressing contemporary challenges

Mathematical thinking is essential for analysing and understanding modern social and environmental challenges. It enables individuals to process data, recognise patterns, and build models that explain real-world phenomena, such as climate change and resource management[44]. Mathematics is not just about numbers— it is a **structured way of thinking** that helps in evaluating solutions and making well-founded decisions[45].

In today's world, where data is everywhere, mathematical reasoning is essential for **understanding and interpreting large amounts of information**. It plays a key role in important decisions in science, economics, and sustainability[46]. Mathematics is crucial for addressing global challenges such as climate change, energy efficiency, and sustainable development. Statistical analysis, data modelling, and probability theory help scientists predict climate trends, assess risks, and design strategies for reducing environmental impact[47]. Using mathematical models, we can measure carbon footprints, analyse the effects of deforestation, and evaluate the efficiency of renewable energy sources[48].

The Enigmathico project involves this approach by integrating mathematical problem-solving with real-world environmental challenges. By engaging pupils in hands-on, inquiry-based activities, it helps them see how mathematics is not just a subject in the classroom but a powerful tool for understanding and improving the world.

Beyond climate change, mathematical thinking also **enhances decision-making in various fields**. For example, pupils can use mathematical models to analyse patterns in climate data, explore the efficiency of renewable energy sources, or calculate the impact of human activities on ecosystems. These applications make mathematical learning more meaningful and relevant to real-world sustainability issues.

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By incorporating real-world problem-solving into mathematics education, pupils learn how to interpret data, think logically, and apply quantitative reasoning to contemporary challenges. This interdisciplinary approach, supported by STEM education, prepares them for a future where mathematical literacy is essential for making informed decisions and driving innovation[49].

"The main challenge in teaching mathematics is giving meaning to learning by connecting it to real-life situations, like calculating school trip costs or tallying points in sports activities."

Elodie DESABIE, primary school teacher, France

The Enigmathico project integrates critical life skills into mathematics education, focusing on critical thinking, collaboration, resilience, and digital competencies. By blending storytelling, problem-solving, and interdisciplinary connections, it fosters an engaging environment where pupils can explore mathematical concepts deeply, collaborate effectively, and persist in overcoming challenges. This approach encourages creativity, adaptability, and logical reasoning, making mathematics more accessible and relevant to real-world issues.

Mathematical ability is not just about finding the right answer, but about learning to think, reflect, and keep trying. Enigmathico promotes this mindset through strategies that connect mathematics with real-world challenges, such as sustainability and innovation. These methods also foster digital and STEM competencies, enabling pupils to interpret data, solve complex problems, and make informed decisions in a rapidly changing world. In this way, Enigmathico helps pupils develop both their mathematical skills and their ability to apply them to real-life situations.

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PART 4: INCLUSION AND DIVERSITY

In this chapter, we will discuss the benefits of adapting pedagogical practices for diverse groups of pupils, of using non-formal methodologies to make mathematics accessible to pupils from disadvantaged backgrounds, and of creating educational content reflecting Europe's cultural and social diversity.

A/ ADAPTING PEDAGOGICAL PRACTICES

This first section addresses the difficulties that diverse pupils may encounter with traditional math approaches and explores possible adaptations of pedagogical practices. Difficulties can be caused by various factors, such as learning disorders, a home language that is not the language of instruction, or disabilities. Different groups of pupils have varying needs, but it is still possible to implement changes that have been proven beneficial for most or all of them.

Numbers	**Diverse groups**
6 to 8% of children in France[50]	Students with a learning disorder
11,5 % of students in the EU [51]	Students with a different home language than the language of instruction
about 5% of EU families[52]	Children with disabilities
0.5 to 5 in every 1,000 children [53]	Children born deaf or who develop hearing loss in childhood
6/10000 children in developed countries[54]	Children with blindness

There are no official statistics about the number of **pupils with specific learning disorders** (Dys), but from different estimates, about two pupils would be concerned per class of twenty. These pupils can have difficulties specifically with mathematics (dyscalculia) or difficulties in other domains that can affect their overall learning (dyslexia, dysphasia, dyspraxia...).

- **Dyscalculia** causes persistent difficulties with number sense, calculation, and mathematical reasoning. Pupils often fail to progress from basic to advanced skills and may also struggle with memory, organisation, and problem-solving[55]. Effective strategies include concrete manipulation, visual supports, scaffolded guidance, and tasks rooted in real-life contexts. Emphasising understanding over memorisation and allowing alternative problem-solving approaches fosters inclusion and motivation[56].

[50] Fédération Française des DYS, 2025.
[51] European Commission, 2024.
[52] European Disability Forum, 2020.
[53] World Health Organisation, 2021.
[54] Yekta et al., 2022.
[55] Hasselbring, Lott & Zydney, 2006.
[56] Bašić et al., 2021.

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- **Dyslexia** primarily affects reading and language processing,but also impacts mathematics. Pupils may confuse symbols, struggle to read instructions or to follow multi-step operations (FFDYS, 2025). Working memory and sequencing issues are also common. To help these pupils, teachers should limit written text, use clear fonts and spacing, and present instructions orally and visually. Multisensory and contextual methods[57] (e.g. storytelling, movement) support understanding and reduce anxiety.

As **children with disabilities** are a heterogeneous group, it is difficult to make generalisations. However, most disabilities seem to cause difficulties with mathematics in one way or another. Here are two examples:

- **Children born deaf or who develop hearing loss in childhood** consistently have difficulties with mathematics, especially if their language access is limited due to insufficient exposure to sign language from a young age[58]. Qualified interpreters, visual materials, assistive technologies, and inclusive pedagogical methods are necessary to address these challenges.
- **Children with blindness** also face significant challenges in learning mathematics due to the abstract way it is often taught[59]. Methods to improve their math capacities aim to make abstract concepts as concrete as possible. For instance, using the abacus, tactile graphics, and concrete material that can be manipulated are all necessary for success.

Pupils with a home language different from the language of instruction can also experience difficulties following the curriculum. Language barriers can cause poor performance in mathematics since poor reading comprehension skills in the instruction language have been shown to predict mathematics achievement[60]. Therefore, linking the improvement of literacy with numeracy is necessary to improve their overall competencies. It is also beneficial for these pupils to include object manipulations and to write the instructions in clear and straightforward language.

Ultimately, all pupils with special needs benefit from active learning in math instruction, as it has been demonstrated to enhance their self-image and motivation to learn mathematics. Different strategies have been proven helpful for pupils with learning disorders, different home languages or disabilities. The ones relevant to the Enigmathico boxes are the following:

[57] Bishara, 2018.
[58] Reis, 2024. Short & McLean, 2023.
[59] Braward, 2016.
[60] Greisen et al., 2016.

Strategy	Description
Manipulation	Letting pupils manipulate concrete objects
Multisensory methods	Vary between visual, auditory, and kinaesthetic approaches
Contextual teaching	Linking the concepts with real-world experiences
Flexibility	Teaching different strategies for solving problems
Guided problem solving	Guiding pupils through the process through explicit guidelines
Encouraging mathematical discourse and interaction	Planning time for interaction between pupilsl to discuss new concepts
Active learning	Having pupils be active in their learning with experimentation, manipulation and problem-solving
Improving literacy skills	Mastery of the education language is necessary for math success
Being explicit	Start the lesson with an explicit explanation of the activity

To conclude, all of these strategies help promote the inclusion of pupils with different disorders, abilities, and language skills, but can also be helpful and motivating for their peers. The Enigmathico boxes are a good base for implementing all of these methods. Elodie DESABIE, a primary school teacher in a priority zone, highlighted that the most important aspect in teaching is the teacher's ability to **"Multiply approaches, improvise, resort to pupils, and accept going off course as you go along."**

B/ REDUCING INEQUALITIES

This section will discuss the link between lower social and economic background and mathematics, and what can be done to address the issue. It has been proven that the biggest predictor of mathematics success is a pupil's social and economic background[61]. This is a problem since mathematics is not just an academic subject. Having difficulties with mathematics early on can negatively impact the rest of the pupil's academic life and future career options. Mathematics is often necessary for accessing more lucrative fields, thus allowing social mobility. In this way, education can be "the great equalizer", giving everyone the

[61] Rittle-Johnson et al., 2016.

same chances of success, as stated by Horace Mann more than a century ago[62]. However, this is only true *if* education gives everyone equal opportunities and learning access.

Pupils from disadvantaged backgrounds struggle more in mathematics from the very beginning of their school education. Indeed, preschool children from disadvantaged backgrounds tend to underperform in mathematical skills, even when they work with representations of quantities without using number symbols or words.

"Most of my pupils are oral learners, so they have difficulty with literacy. This is mirrored in numeracy, where they have difficulty making sense of numbers. They associate them without reflexive thought: 789 = 7 + 8 + 9; 4 packs of 6 sweets make 10 sweets (4 + 6)."

Elodie DESABIE, primary school teacher, France

This can be explained by the quality and quantity of numeracy practice in preschool, as well as by the numeracy activities done (or not done) at home.

During primary school, the difference in level between children of different backgrounds continues and tends to worsen. This can be explained by the poorer skill set at the beginning and by the fact that children from disadvantaged backgrounds can experience fewer high-quality educational opportunities.

How can this problem be addressed? Many of the active methods discussed above are relevant to pupils from disadvantaged backgrounds. However, an important point needs to be made. These pupils tend to misinterpret the teacher's intentions when the task's meaning, goal, and methods for achieving desirable results remain implicit.

"For pupils in difficulty, there is an apprehension about numbers that prevents them from thinking. Text comprehension and the lack of habit of taking time to think before answering is also a problem. Finally, when they don't find the solution on the first try, they find it hard to accept and look for another way to solve the problem".

Elodie DESABIE, primary school teacher, France

It is thus very important to make pedagogy both visible and explicit.

[62] Duncan (2025)

Three methods useful for these pupils have been extensively studied:

Method	Advantage	Attention points	Good practice
Collaborative problem solving	Agency of the pupils, engagement	The methods for achieving results need to be made explicit.	Ask pupils to explain how they solved a problem and give extensive feedback.
Gamification	Enjoyment, fulfilment	The goal of the activity needs to be made explicit.	State the learning goal of the activity before the start and ask the learners what they learned at the end.
Contextual teaching	Relevance of the subject	The translation of real-world problems into math concepts can be challenging.	Provide support and make the transition between informal problem solving and mathematical concepts explicit.

These strategies support not only pupils with specific learning challenges but also help to create an inclusive learning environment that benefits all pupils, addressing inequalities in math education. The Enigmathico method can address all these aspects and answer the need for high-quality, low-cost, and easily implementable pedagogical tools. The goal is to ensure that all schools, regardless of resources, can participate.

C/ CULTURAL REPRESENTATION AND VARIED THEMES

The previous aspects discussed in this chapter cover different facets of inclusion. The last, but not the least important aspect, is that of **representation**. It is well known that STEM studies and careers often show a lack of diversity. There is not only a gender gap, but pupils and professionals from different ethnic, national and cultural backgrounds, with different abilities, etc, are underrepresented. It is important to support the empowerment of these groups by adapting teaching methods and improving representation.

As the Enigmathico novels link storytelling and mathematics, it presents an excellent opportunity to represent groups often not associated with math success in the collective imagination. By integrating diverse cultural narratives, this approach also aims to break down stereotypes surrounding mathematics and to make it more inclusive. Moreover, representing positive and diverse **role models** can help pupils feel proud of all aspects of their identity and counteract the general preconceptions about who is good at math. Seeing their unique interests and intersecting identities represented in learning materials can be very motivating and engaging.

A promising developing field of research is **ethnomathematics**. It focuses on the cultural aspects of mathematics, exploring how mathematical understanding varies across cultures and how it is applied differently to solve real-life problems. Ethnomathematics is also crucial in making learning more inclusive, as it shows pupils that mathematics is not a universal language but one that is shaped by culture and context. Relating math to the experience and culture of the pupils can improve the ability to make meaningful connections, connect mathematics and daily life and deepen the pupils' understanding of mathematics. To be applied, teachers should have an understanding and respect for the culture of their pupils. Then, by using real-life cultural objects and problems, the teachers can help go from informal problem-solving to academic mathematics. This is also useful for improving critical thinking skills.

Examples of ethnomathematical practices	How to apply
Studying traditional patterns and geometry	– Pupils can analyse and reproduce geometric patterns found in their own cultural heritage. – Teachers can introduce symmetry, transformation, and fractals by examining real-world cultural artefacts.
Architecture and Construction Mathematics	– Pupils can study local architectural structures to understand how geometry and physics are applied. – Teachers can assign hands-on projects where pupils design a simple building or bridge using mathematical calculations.
Cultural Counting Systems	– Pupils can research and compare different cultural counting and measurement systems.
Street Mathematics and Everyday Problem-Solving	– Teachers can create role-playing activities where pupils act as market vendors, making real-time calculations without using calculators

These practices can demonstrate to pupils that math is connected to various real-world situations, problems, and opportunities, helping them assert their personal identities and broaden their understanding of different cultures.

In conclusion, creating educational content that reflects Europe's and the world's cultural and social diversity, adapting pedagogical practices, and using non-formal methodologies to make mathematics accessible to diverse groups of pupils can benefit everyone.

PART 5: EVALUATION AND CONTINUOUS IMPROVEMENT

When addressing evaluation, we need to encompass the concept of learning, which is tightly intertwined. They influence each other and, by extension, they influence what we learn[63]. Over the last years, European schooling policies have focused on the concept of assessment through three lenses:

- Assessment **of** the learning.
- Assessment **for** the learning.
- Assessment **as a** learning method.

Using evaluation as a learning strategy enables pupils to better understand their learning, preparing them to be **autonomous learners able to self-assess**. Nonetheless, evaluation as a learning method requires European schools to constantly develop and implement **new assessment tools**[64]. Therefore, we deem it essential to equip teachers with a set of evaluation tools to measure the impact of the Enigmathico's method on pupils and the learning environment. The following chapter provides you with qualitative indicators, evaluation strategies, as well as future perspectives to anchor the project's impact on the long-term. These tools are easily adaptable to different educational contexts.

A/ EVALUATION INDICATORS

How to measure the impact of the Enigmathico approach on pupils' skills?

A variety of accessible and practical tools can be implemented to measure the impact of Enighmathico's approach. Each strategy targets different objectives that you need to define beforehand so that you choose the most relevant tool. There are four main aspects you can assess regarding Enighmathico's method:

Mathematical Skills Development

We recommend systematically including **pre- and post-tests** to guarantee a long-term tracking of the pupils' progress and enable a comparison before and after the method's implementation.

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[63] European Commission: Directorate-General for Education, Youth, Sport and Culture, *Key competences for lifelong learning*, Publications Office, 2019, **https://data.europa.eu/doi/10.2766/569540**
[64] *Assessment Tools for the Primary Cycle of the European Schools, Schola Europaea / Office Of The Secretary-General Pedagogical Development Unit*, September 2024. https://www.eursc.eu.

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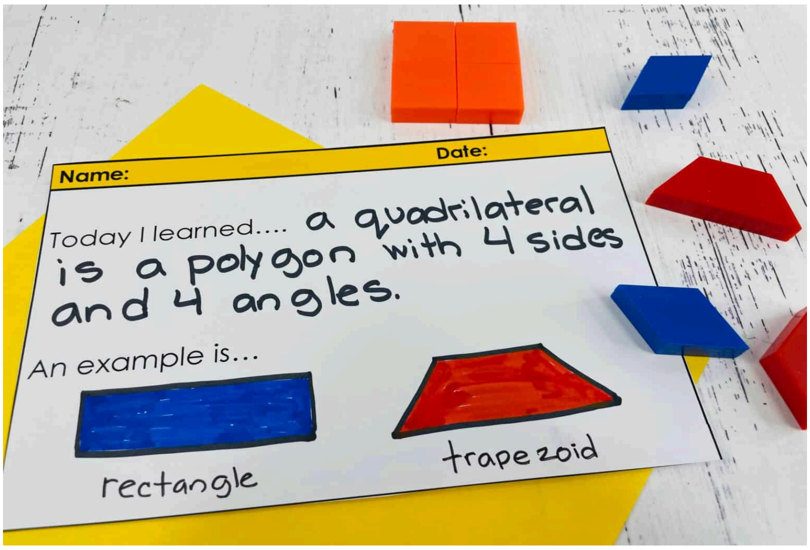
- These tests target the mathematical competences covered in the boxes (reasoning, problem-solving).
- They can take the form of **self-assessment questionnaires**, which develop the pupils' autonomy and metacognitive skills (thinking about their learning). For instance, you can use the 3,2,1 method at the end of an activity:
  - 3 things I've learnt
  - 2 questions I've got
  - 1 insight I've had[65].

Observation is another key learning and teaching practice. The assessment tools and your professional judgement inform you how the pupils **engage in Enigmathico activities**. Observation guarantees an empirical evaluation taking place during the boxes' implementation and an external viewpoint from the pupils' perception.

Literacy and Numeracy Integration

Given that Enighmathico's activities resort to literacy, we invite you to extend this cross curricular dimension to the evaluation methods. For instance:

- Have pupils write **short reflection logs** on how they solved an enigma or explain mathematical concepts in their own words. This exercise develops critical vocabulary and thinking and, as a result, strengthens literacy skills.



Source: https://mrelementarymath.com/student-math-reflection/

[65] "Peer and Self-Assessment for Students", January 6, 2025. https://education.nsw.gov.au/teaching-and-learning/professional-learning/teacher-quality-and-accreditation/strong-start-great-teachers/refining-practice/peer-and-self-assessment-for-students#tabs2.

- You can also introduce constructive critical dialogue through **peer-assessment**. This method requires pupils to understand the evaluation objectives and criteria. You can develop them together so that pupils understand what is meant by quality when it comes to learning.

You can find some peer-assessment strategies here.

Engagement and Motivation

Besides evaluating the impact on pupils' numeracy and literacy skills, you can observe their engagement with the material. This informs you on the efficiency of the tools and on the changes to be made.

- Introduce **quick student surveys**. After completing an Enigmathico activity, pupils can rate their engagement and enjoyment on a simple scale (e.g., "How engaging was this activity? What did you like most/least?").
- **Teacher-led observations**: How often do pupils voluntarily participate? Are they more engaged when working in groups or individually? Do they show persistence in solving challenges? Are they spending more time on traditional exercises or on the gamified math activities?

Inclusivity Impact

Inclusion is at the heart of Enigmathico's approach, here are some indicators that you can observe in order to ensure inclusion:

- **Adaptations for pupils with special needs**: Did pupils with SLDs benefit from the storytelling approach? Were hands-on elements, such as tactile STEAM boxes, effective for pupils with SLDs? Have you been able to adjust the boxes to the different pupils' needs?
- **Student collaboration**: Are pupils helping each other solve problems? Are pupils from diverse backgrounds equally participating?

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Teacher Impact

Evaluating the impact of the method is not restricted merely to pupils. We advise you to document and assess the effectiveness of teachers' practice as well, to refine the methodology and adjust the tools to their needs. Here are some indicators that you can measure:

- **Relevance with the curriculum:** You can develop lesson plan templates to document the adaptations you might do to match the national curricula. Those documents can be shared within the school or with your focus groups to think collectively about potential improvements.
- **Training effectiveness**: Post-workshop surveys can measure your confidence in applying Enigmathico strategies. Identifying the gaps contributes to adjusting and enriching the training needs.
- **Implementation log**: We encourage you to keep a log to document the implementation and the iterative improvements.

B/ USER FEEDBACK

While the previous section focused on how to assess Enigmathico's effectiveness, this part addresses how to gather feedback. This task is crucial to refine and enhance the tools to suit their users' needs. We encourage you to implement a structured feedback collection system to ensure continuous adaptation of the methodology.

Methods of Data Collection

Here is a series of tools that can be used in your classroom:

- **Teacher and Student Surveys**: Keep them short and accessible to fit within your existing workload. They can be distributed before/during/ after the activities to monitor the impact at different stages of the activity.
- **Focus Groups**: Regular discussions in school workshops or meetings to exchange good practices based on valuable qualitative feedback. Those discussions promote different viewpoints and experiences that enrich the boxes.
- **Classroom Observations**: Standardised observation templates that can be filled during the project's implementation. These observations document the pupils' responses to activities, their engagement, and their ability to work in groups and problem-solve.

→ **The Office of the Secretary-General of European schools has gathered a list of useful assessment tools:** see the tools.

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Data Utilisation

The data gathered serve to refine the materials and adjust your methodology. Here are some suggestions on how to mobilise them:

- **Activity adjustment**: Modify the activities based on your observations and feedback about pupils' engagement and comprehension levels. For example, if pupils struggle with a particular puzzle format, provide alternative techniques or additional hints.
- **Accessibility enhancements**: Adjust resources to better support diverse learning needs based on your pupils' profiles and the needs you might have observed. For instance, some of the activities can be developed in different languages, some can be adapted with sensory materials.

FUTURE PERSPECTIVES

The Enighmathico's resources and activities are designed to be **accessible, sustainable and impactful** to teachers and professionals unfamiliar with the method.

One of the project's main goals is to be integrated into the **national curriculum**, enabling the innovative methodology to promote an inclusive and non-formal teaching of mathematics. In that regard, the resources are thought to be adjustable to the different needs and teaching realities. They are also designed to be available after the project funding, are all open-access and feasible in low-budget settings.

The focus groups are the perfect occasion to lead a reflection on how to integrate Enigmathico on your school curriculum and teaching plan, for instance. This can result in peer-to-peer mentoring sessions to train future users, or webinars in which you can talk and share your insights, success stories and challenges.

Our aim is that the Enigmathico method remains a **dynamic and evolving** tool, equipping teachers across Europe to foster deeper learning and engagement in mathematics for years to come.

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ENIGMATHICO

Enigmathico is a project led by six European organisations aiming to combat learning inequalities regarding the teaching of STEM.
By bridging literacy and mathematics, our partnership seeks to develop a methodology rooted in non-formal education to meet the needs of all pupils.

Discover the Enigmathico boxes and our other ressources on the website of the project:

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