PEDAGOGICAL

GUIDE

MY BOX OF STEAM

Co-funded by
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Introduction

Welcome to one of the first tools of My Box of Steam project, the Pedagogical Guide on engaging and inclusive STEAM teaching in primary school.
The project aims to enhance the involvement of elementary school pupils in STEM education while focusing on the inclusion of children with fewer opportunities, such as pupils with learning disorders and girls. By using an integrated and multi-disciplinary approach and inquiry-based learning, My Box Of STEAM wants to foster critical thinking and promote inclusion and diversity.
The first part of the guide will help you through STE(A)M philosophy and outcomes. In this chapter, you will learn more about the meaning of "A" and understand that it means way more than art! Then, we will be looking at the target audience of our project, which we want to be as inclusive as possible. We will discuss why the STEAM method is appropriate for younger students and how exposing girls to STEM activities from the earliest age will empower them individually and contribute to society's advancement as a whole. The last of this first chapter is dedicated to Steam for pupils with specific learning disorders; you will find out what inclusion is all about, how inclusion is an opportunity for all, and get tips on how to make your STEAM classes more inclusive.
The second part of this guide is designed to give you some very concrete ideas for activities that will help you to implement the STEAM method, and it will also give you some practical advice for managing your class while supporting the goals of encouraging curiosity, critical thinking, problem solving and collaboration, and while ensuring a safe and productive learning environment.
We'll finish by explaining the process of creating our first box, the sundial.

This first box has enabled us to establish a formula that will serve as a basis for creating the 35 other boxes in our project!
Let us start with STE(A)M Philosophy and Outcomes!

STE(A)M Philosophy and Outcomes

STEAM education is a pedagogical philosophy that emphasizes the integration of the arts into STEM disciplines. By combining these traditionally distinct fields, STEAM seeks to provide students with a well-rounded education that fosters creativity, critical thinking, and innovation. This approach acknowledges the powerful role that the arts play in enhancing STEM learning outcomes and preparing students for the multifaceted challenges of the modern world.
At its core, STEAM is built on the recognition that the arts bring a unique dimension to STEM education. While STEM subjects offer systematic problem-solving and analytical skills, the arts provide avenues for expression, aesthetic appreciation, and divergent thinking. By incorporating artistic elements such as visual arts, music, theatre, and design into STEM curricula, educators can cultivate a learning environment that engages students on multiple levels, encouraging them to explore, experiment, and develop a deeper understanding of complex concepts.
The outcomes of STEAM education extend beyond the classroom and into various spheres of life:

Holistic Learning:

STEAM encourages students to approach challenges from different angles. By intertwining the arts with STEM subjects, students develop a broader perspective that enhances their ability to synthesise information and tackle problems with creativity and innovation.

Creativity and Innovation:

The arts promote open-ended thinking and experimentation, fostering an environment where students are unafraid to take risks and explore new solutions. This creative mindset is essential for addressing the ever-evolving challenges of the 21st century.

Critical Thinking:

Integrating arts into STEM subjects encourages students to think critically and question assumptions. This interdisciplinary approach nurtures their capacity to analyse, evaluate, and draw connections between seemingly unrelated concepts.

Collaboration:

STEAM education encourages collaborative learning, mirroring real-world scenarios where professionals from different disciplines collaborate to solve complex problems. Students develop interpersonal skills and an appreciation for diverse perspectives.

Communication Skills:

The arts emphasise effective communication and self-expression. By incorporating arts into STEM, students learn how to convey complex ideas to diverse audiences, an invaluable skill in an interconnected world.

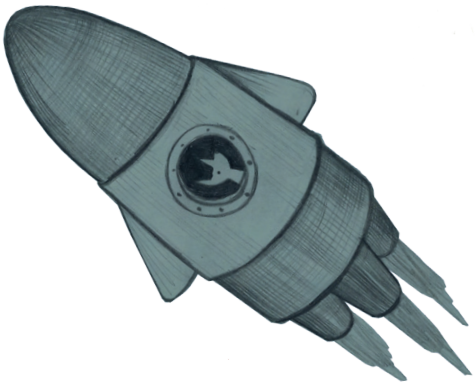
Engagement and Retention:

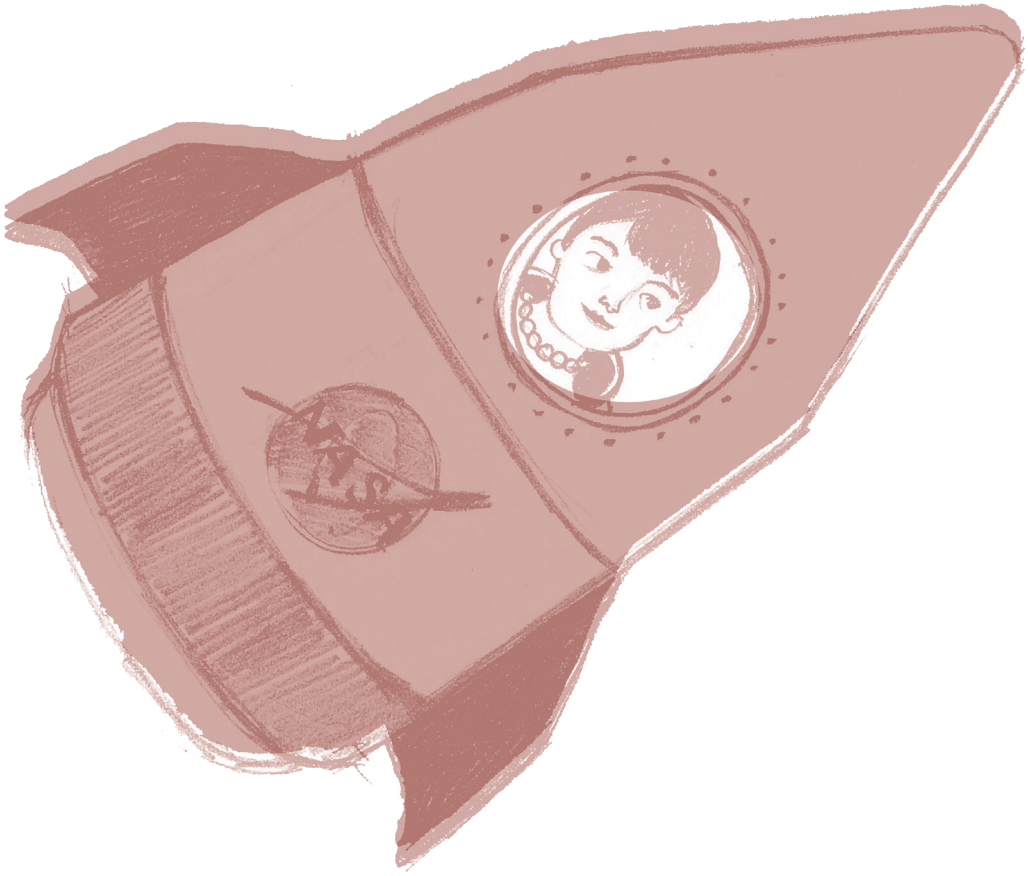
The arts can make challenging STEM concepts more accessible and engaging, leading to increased student interest and retention in these subjects.

Preparation for the Future:

The modern workforce demands individuals who can navigate complex, interdisciplinary challenges.
STEAM equips students with adaptable skills that prepare them for a rapidly changing job landscape.

In conclusion, the STEAM philosophy enriches traditional STEM education by recognizing the complementary role of the arts in fostering holistic learning and creative innovation. By embracing STEAM, educators empower students to become well-rounded, innovative thinkers who are prepared to address the complexities of our interconnected world. As technology and society continue to evolve, STEAM education offers a dynamic approach to preparing the next generation for success across various disciplines and endeavours.





The meaning of 'A' in STEAM

The meaning of 'A' in STEAM

The STEM method of teaching and learning (born in 2000 in the United States) has evolved a lot in the last twenty years, combining not only the four disciplines that make up the acronym Science, Technology, Engineering, and Mathematics, but above all thinking of them in a real-life context, in an inclusive way that cancels out differences in gender and socio-cultural context as much as possible.
In this constant drive towards inclusivity and alternation between theory and practice, in 2017, researcher Georgette Yakman proposed with her STEAM Pyramid an even more complete approach, proposing a humanistic dimension of the scientific disciplines, integrating the letter "A".
"A" for ART? Not only! Art as artistic expression but also as all humanistic, social, and ethical disciplines, also understood as ideals that can guide us in life, that enable us to extend and enhance aspects such as creativity, collaboration and communication. Our project's BOXES are designed with the aim of offering teachers materials that can stimulate children through the use of orality and a range of creative tools, as well as unite and channel multiple disciplinary experiences.
This multi-disciplinary method, which integrates the various subjects, aims to develop critical thinking in students, to spur them on towards research and confrontation by giving relevance to all disciplines in an equal manner so that the enrichment they obtain is as harmonious and complete as possible.
STEAM takes STEM to the next level, removes limitations and replaces them with wonder, critique, inquiry, and innovation.
The years of the pandemic have significantly widened the gap by increasing not only the percentage of children in absolute poverty but as a direct consequence also cultural and educational poverty with a high risk of exclusion from society.

(According to Eurostat AROPE rates, the risk of poverty or social exclusion for children in the EU increased from 24,0 % to 24,4 % between 2020 and 2021)
It is therefore necessary for schools, through education and learning, to help mend this rift. The STEAM method focuses on transversal competencies, so that firstly teachers, and through these, students, can develop their skills in a collective and inclusive manner so that everyone can find their own way.
A society of individuals working together in a creative and innovative way where everyone can find their place.
The "Arts", in the broader sense described above, thus become the keystone: if scientific subjects are necessary to solve problems and evolve on the basis of logical and precisely scientific thinking, the arts possess a transversal, freer and easier-to-understand language that can and constitutes the gateway to the other disciplines.
G. Yakman writes that the world we live in has evolved thanks to science that cannot be understood without technology. Consider, for example, how far the invention of the telescope has advanced discovery. Technology is strongly connected to engineering and its development. Engineering is based on mathematics but also on the arts. Think for example of a bridge or a building.
This concept thus shows how the "Arts" are an integral part of the method and approach, as if each discipline represents a piece of a puzzle that needs the others to complete the picture and make it readable. This interconnected vision led Yakman to the conception and writing of a new acronym that implies a deeper meaning: **STEAM: Science and Technology, interpreted through Engineering and the Arts, all based on the language of Mathematics.**

Every individual in their lives is expected to develop four dimensions through learning, the cognitive dimension in order to learn to know, the instrumental dimension in order to learn to do, the individual dimension in order to learn to be themselves, and finally the social dimension in order to learn to live in society together with other individuals.
Thus, the STEAM method can provide the means because the philosophical approach, the creative and emotional vision that these subjects offer, allows one to raise both the level of learning and the level of inclusion, because the method stimulates pursuing self-knowledge, managing emotions and stress, developing communication and problem-solving skills.
Designer John Maeda (President of Rhode Island School of Design 2008- 2013) said: **"... artists ask the deep questions about humanity that reveal which way forward actually is."** This phrase encapsulates the challenge that the STEAM method has long taken up. Not only to redevelop and give new meaning to school and teaching but to help students discover their talents through concrete experiences that will enhance them.
The study as a discovery of the past, of history, the study as a collective memory that becomes a means of preserving and decoding what has been in order to reread it, elaborate it and bring it into the future as a founding element to build, create and invent what will be, in a participatory, respectful and conscious manner.
The creativity also understood as pure imagination, which thus becomes a key that encourages and raises thinking.

On the homepage of our blog stands Albert Einstein's phrase, "The greatest scientists are artists as well." because “artistic” vision allows for boundless vision and perhaps makes it easier to imagine solutions that reason cannot always see.
So, to continue quoting Einstein, we can conclude that:
"Art expresses in a simple way, the deepest thought of the human being."

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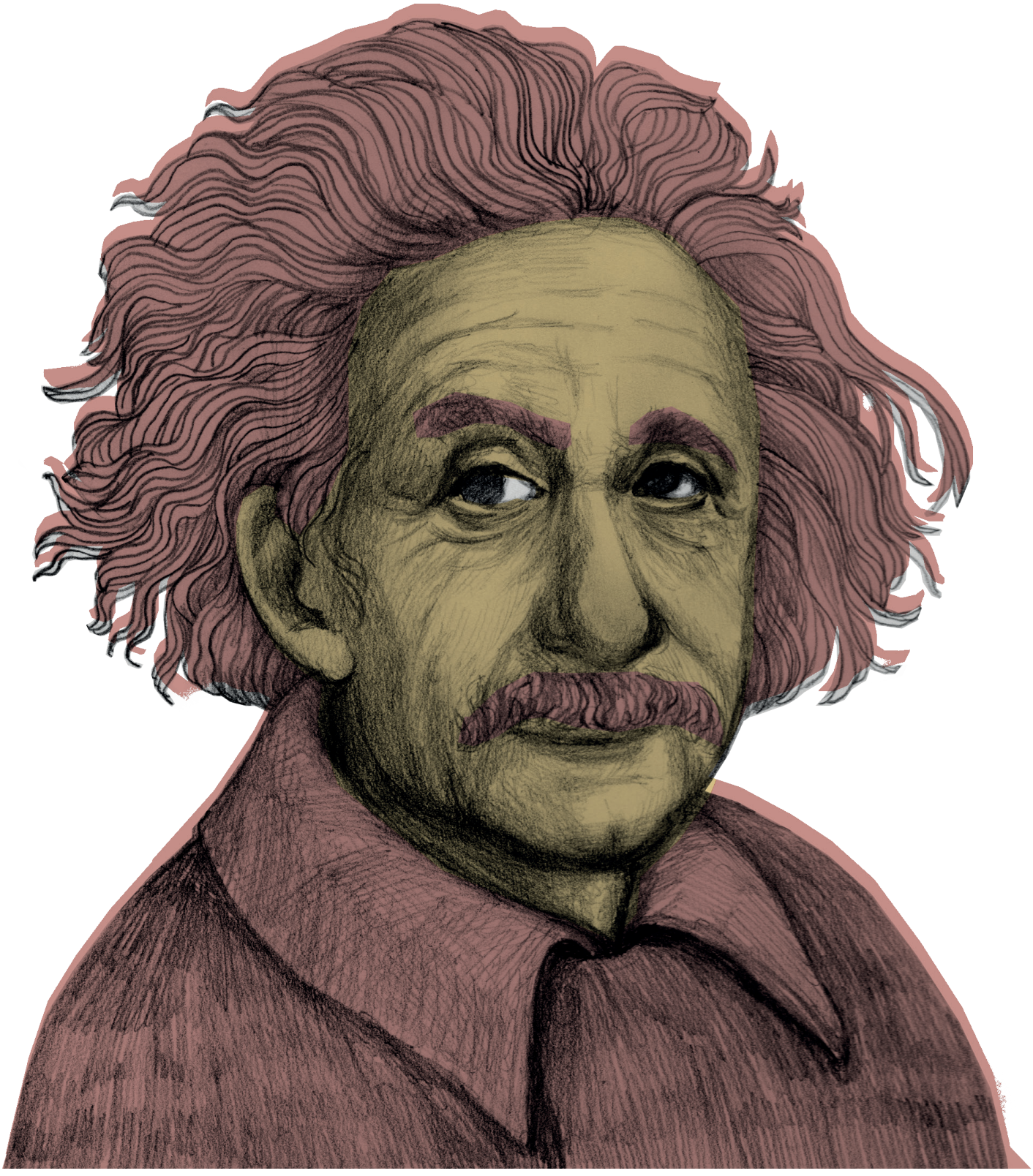


STE "A" M for younger pupils

STE "A" M for younger pupils

Reading and writing are capacities that children learn during their schooling. They are, therefore, not innate abilities that require an application and teaching through knowledge of the letters that make up the alphabet, that form syllables, words and then sentences.
The transition from spoken to written language requires a great deal of effort on the part of children. Many may not be aware that "counting" is an innate and spontaneous ability, defined as the intelligence of "quantity"; human beings from an early age know how to distinguish and recognise "one" from "many".
We can therefore say that we are able to count before we can speak. Applying mathematical rules, on the other hand, is a different matter, and to learn how to do this, it is necessary, as with writing, to go to school. Recent studies show that teaching mathematical thinking from an early age is a form of training for the brain, which thus teaches students to approach problems in a more direct way by developing numerical intelligence. This is where the STEAM approach comes to the rescue: through play, art and exploration, it is possible to teach children to approach not only mathematics but also all other disciplines. However, it is important to emphasise that with young pupils, the role played by parents is just as important. Their attitude, and the experiences they choose for their children will depend on their development and ability to approach these subjects.
Children who have had these early experiences with their parents, and who retain not only a memory but also a pleasant recollection of them, will have fewer learning difficulties.

However, it is important to emphasise that even today, as in the past, and as recent studies show (Muntoni and Retelsdorf, 2019; Starr et al., 2021), parental gender stereotypes affect children. The mistaken belief that only males have aptitudes towards science subjects or mathematics leads parents to behave differently towards their children: giving stimuli and information to the ones and "misinformation" to the others, thus creating a profound imbalance, which the STEAM method seeks to remedy.
Every child is endowed with specific visual-spatial abilities that constitute so-called **non-verbal intelligence**, i.e. those skills related to thinking and visual and perceptual abilities that enable us to assess spatial relationships, between us and the environment and objects around us. This ability is particularly important, and it is crucial to increase, stimulate and improve it because it is also closely linked to the ability to learn mathematics.
There are various "games" that parents and schools can play in early childhood, e.g. board games (such as puzzle), body games or grapho-motor games. However, it is also important that children acquire self-confidence, and that they also develop speaking skills, precisely because talking, telling stories, and being able to describe experiences, are everyday activities that are part of school and life.
Oratory skills are, therefore also an art and, as such can be counted and included in the "A" of STEAM.
Through oracy, in fact, and with the appropriate use of narrative tools, children can be helped to better understand what is being narrated and taught.
Therefore, introducing the STEAM method from preschool age and then into the school curriculum, transforming a learning moment into a multidisciplinary experience, in which scientific disciplines intersect with the arts and humanities, can and must become a practice that will accompany children in an inclusive way, without distinction, in their growth path.

STE(A)M for girls

STE(A)M for girls

We live in a fast-changing, technology-dependant society which also shapes the labour market and is seeing an increase in the automatization of jobs. STEM expertise is more and more sought after, in all types of work, because those jobs are changing, and the workers need technical skills to manage them. Naturally, the higher demand also influences the wages, so STEM jobs are better paid and have better work conditions and benefits.

According to Eurostat, in 2021, the number of female engineers and scientists in the EU was on the rise with a total of 41%. While it indicates that the number of women and men in those fields isn't equal, the situation doesn't look particularly alarming.

Unfortunately, after analysing it further, we come to the real worrying data. Only about 1 in five workers (22%) in high technology sector are women. Seeing that those are some of the best-paid jobs with high social status, it is easy to see that there is much more space for improvement.

While there are certain differences in the cognitive capabilities of boys and girls, research consistently shows that those differences are relatively small in preschoolers. Those differences do get bigger as children age and are exposed to different social and cultural influences. The girls are traditionally expected to be caring and kind, while the boys are thought to be more proactive and independent. While expecting someone to be caring is not only good but also necessary, there shouldn't be different expectations based on the children's gender.

Unfortunately, different expectations can also be visible in the school system, where boys who don't do well in math and other science subjects are often considered lazy but with potential, while the girls who do well are seen as hard-working. Studies have shown that girls are more likely to have lower self-concepts in math compared to boys.

This means that girls may perceive themselves as being less competent in math, even if their actual abilities are on par with boys.

The way that certain subjects are presented, and the expectations that the teachers have for students can greatly influence their choices and preferences. It is for this reason that it's crucial to expose girls to STEM activities from the earliest age. Be it through regular classes or motivating them to join an extracurricular activity, it would be beneficial for everyone if more girls get interested in the STEM field. Diversity in the STEM field leads to diverse perspectives, which can foster greater innovation and problem-solving. Including girls in STEM brings different viewpoints, approaches, and ideas to the table, leading to more creative solutions to complex challenges.

Incorporating girls into STEM education requires creating supportive learning environments, offering mentorship programs, challenging stereotypes, and actively promoting the value of diversity in STEM fields. Ultimately, by fostering an environment where girls can excel in STEM, we not only empower them individually but also contribute to the advancement of society as a whole.

Steam for pupils with specific learning disorders

Steam for pupils with specific learning disorders

One of the main aims of the My Box Of Steam project is inclusion and diversity. The project aims to include all pupils, in particular by encouraging the reduction of inequalities between men and women in the field of STEAM, but also by taking into account the needs of pupils with special needs. Indeed, according to the European Citizens' Group on Dyslexia and Specific Learning Disabilities, 10-15% of the EU population is concerned by one or more learning disabilities. It is, therefore, essential to disseminate inclusive teaching practices.

What is inclusion?

Inclusion means making learning and the materials flexible, accessible and understandable to all learners. It requires a constant re-evaluation of pedagogical approaches to ensure the active participation of all students. The concept of "inclusive design" aims to review the initial design of the process and build it most inclusively and effectively for all learners.

Specific learning disorder

Specific learning disabilities are long-lasting conditions that impact an individual's learning pathway. They have a neurobiological origin influencing the brain's information processing, including reception, integration, retention and expression. As a result, they can disrupt the cognitive development of learning abilities. However, there is no link between a person's level of intelligence, individual effort, physical impairment, socio-economic status or cultural background, and a learning disability.

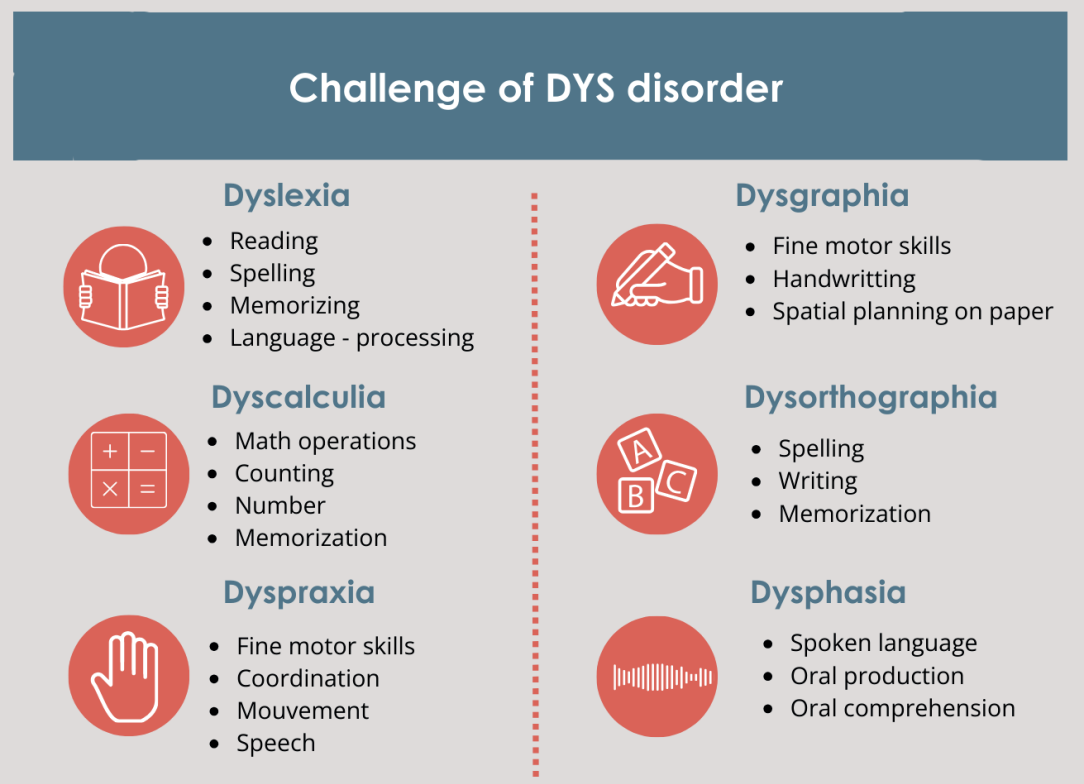


Figure1 Source: Logopsycom

Inclusion is an opportunity for all

Diversity is a source of enrichment, and implementing inclusive teaching methods is an asset for everyone: the student, the teacher, the other students and society in general.

Implementing an inclusive pedagogy will enable students with learning disabilities to apprehend their challenges better. Inclusion enables them to develop the skills they will need to flourish in their future professional and personal lives.

Other students will benefit from including different pupils in their class, broadening their horizons and developing their tolerance. It will also help them to understand the importance of teamwork.

From the teacher's point of view, inclusion will make it possible to maintain a more regular class rhythm, and pupils will be less likely to fall behind.

For society, including greater neurological diversity provides a different perspective on things and brings different solutions to tomorrow's problems. People with learning disabilities often develop complementary skills that are just as useful and essential.

Inclusion in STEAM education

Implementing a few essential tips and adjustments can significantly improve the inclusiveness of any classroom and STEAM courses. Boxes, we produce in our project My Boxes of STEAM, due to their practical approach, are helpful to pupils with SLAs.

Structure of the lesson:

It is recommended to start the lesson by providing a clear and explicit description of the activity, offering concise guidelines and, if necessary, breaking tasks down into smaller steps. Use visual aids to illustrate concepts and bullet points to structure procedures. Ensure that sufficient time is allocated to each task and that all students have understood the task in advance.

Tasks and instructions:

Incorporating various short exercises is an effective way of training students to cope with different situations, as it encourages them to concentrate on one task at a time. It is advisable to prioritise logic-based exercises rather than those that call on memory. To avoid multitasking, it is advisable to reduce tasks that require fine motor skills, such as writing, and to avoid complex manipulations. This approach allows pupils to concentrate on the lesson's content rather than dwelling on ancillary tasks. Similarly, when giving instructions, ask for one task at a time. If the instructions are given orally, you can keep track of the action verbs using pictograms on the board.

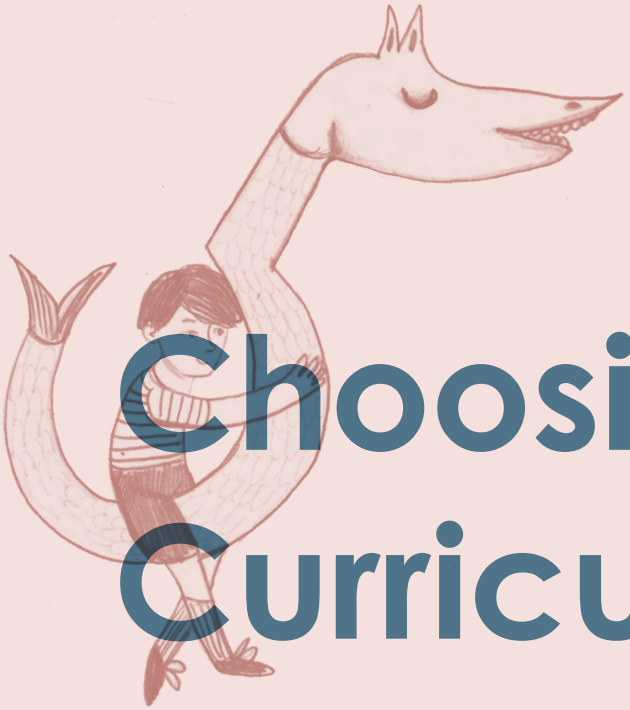
Media used:

The presentation of written documents can be problematic. It is therefore advisable to present the text as follows: left alignment, use of appropriate fonts such as Arial, Century Gothic or OpenDys, 1.5 line spacing and a font size of between 12 and 14. It is also

advisable to divide the text into manageable units with concise, clear sentences using paragraphs. Incorporating sub-headings, colours (while maintaining consistency with colour codes), and bullets can be useful. Printed material should be printed on one side only. Off-white paper is ideal.

Conclusion

As we have seen, adopting an inclusive approach benefits not only individual students but also teachers and society as a whole, ultimately enhancing the potential of the group.



Choosing Curriculum and Classroom Management

Choosing Curriculum

Nowadays, we are able to access different STEM curricula online. Universities, technology companies, robotics manufacturers and different web application environments have made them easily accessible.
You can access Curricula via different online platforms such as:
Tynker - www.tynker.com
Code - www.code.org
Lego Education - https://education.lego.com/en-us/lessons
STEMpedia - https://thestempedia.com/curriculum
TeachEngineering - https://www.teachengineering.org

These materials are free for use, and you are able to adapt them for your needs. Also, they are very well categorised, and you can find what you need quickly.

How to make the right choices to implement the STEM curriculum?

● You can create a curriculum by yourself or choose one from the existing ones. There are many factors to consider when you create a curriculum or adopt one created by someone else.
Stay focused on your needs;

● Difficulty of the curriculum should be adequate to the age of students and keep them active;

● Make sure that the length of your lesson plan suits the length of the lessons at your school;

● Identify which technological tools are available in your school;

●Find out what are your school's financial resources in order to provide missing yet necessary tools;

●Make sure that the physical size of the classroom is adequate;

●Before you start teaching STEM subjects, ask your students what their expectations and interests are. Choose what activities you are capable of guiding and are interesting to you as well.

Selection of appropriate activities

Consider the age group of students you are guiding - many STEM activities are suitable for different age groups, however, the level of the tasks needs to be changed. For example, distance and speed problems can be solved more playfully in grades I-II if there are compact robots such as MeetEdison (59 USD, 2023), with a simple visual programming language that lets students derive formulas based on test results.
The teacher's guidance on how to format the test results is necessary. Of course, there are lessons that are not suitable for all age groups. Younger students can find tasks where a lot of proof and use of argumentation is needed. For younger students, the construction of the water filter is easy, but measuring water turbidity with a Vernier turbidity sensor, collecting data with a Vernier data collector and drawing conclusions from it is too challenging. Sometimes the choice is based on time.
Some learning activities may not be suitable because they take too much time and using the classroom for a longer period of time is not possible. Sometimes, the classroom is not suitable; for example, there is not enough space to conduct experiments. Some activities require materials that can be expensive or difficult to obtain, such as batteries, different robotics kits or different sensors. (The-Global-STEM-Toolkit,2023)

Mapping of interests, needs and comparison with the current school curriculum

Before using the curriculum identify students, their parents and community preferences. Find a lot of common interests in mapping; that way the rate of engaging in activities can be higher.
Be sure to be familiar with the school's current curriculum and find out which STEM subjects are covered in which classes. Integrate these activities into your curriculum experiments. However, when reviewing major curricula, you come to the conclusion that some topics of the science subjects are not taught at all; add them to your curriculum. (Hendrikson, 2023)

Selection of appropriate activities

STEAM (Science, Technology, Engineering, Arts and Mathematics) teaching involves a hands-on, interdisciplinary approach to education that encourages critical thinking, creativity, problem-solving and collaboration. Here are various activities and strategies you can use to teach STEAM effectively:

Experiments and hands-on investigations:

Conduct scientific experiments and investigations to explore natural phenomena.
Build simple machines to demonstrate engineering principles.
Explore the properties of materials through hands-on activities.

Coding and programming:

To get started in coding, it is perfectly possible to carry out activities without a computer and without a programme
and after that teach basic coding skills through platforms such as Scratch or Python.
Introduce robotics and encourage students to program robots.
Create interactive digital art projects using code.

Maker Projects:

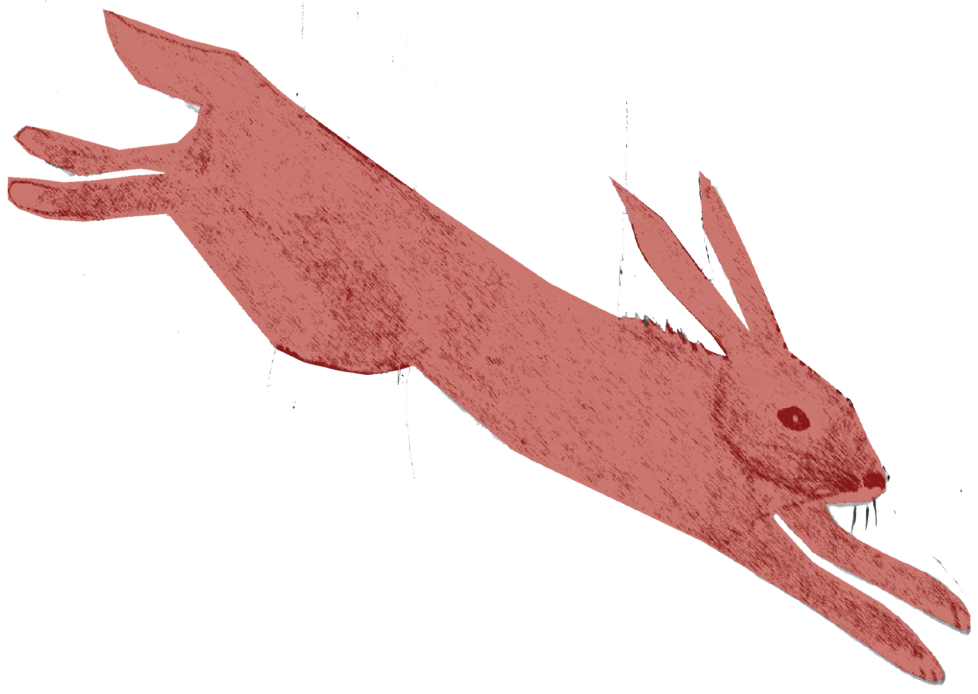
Set up a makerspace where students can design and build projects using various materials.
Encourage students to invent solutions to real-world problems.
Use 3D printers and laser cutting devices to bring students' projects to life.

Integrate art:

Incorporate art into STEM lessons to stimulate creativity.
For example, design aesthetically pleasing bridges or infographics.
Explore connections between math and patterns in art.

Collaborative challenges:

Organize group challenges, such as building a Rube Goldberg machine or a bridge that can support a certain weight.
Engage in design thinking projects where students must brainstorm, prototype, and refine their ideas.



Outdoor exploration:

Take field trips to observe and document natural ecosystems.
Use outdoor spaces to teach the principles of environmental science and ecology.

Analyze and visualize data:

Analyze data sets and create visual representations using tools such as Excel, Google Sheets, or specialized software.
Explore concepts such as statistics and probability through real-world data.

STEAM challenges and competitions:

Participate in STEAM contests or challenges, such as robotics contests, science fairs, or coding contests.
These events can motivate students and give them a focus for their STEAM projects.

Guest speakers and experts:

Invite professionals from STEAM fields to speak to students about their careers and experiences.
Arrange for experts to provide workshops or hands-on demonstrations.

Cross-curricular projects:

Integrate STEAM concepts into other subjects, such as history (e.g., building historical models), literature (e.g., analyzing data from a novel), or geography (e.g., making maps using technology).

Interactive simulations and virtual labs:

Use online resources, virtual labs and simulations to explore complex scientific concepts.
These tools can be particularly valuable when hands-on experiments are not possible.

Reflection Journals and Portfolios:

Ask students to keep journals or digital portfolios to document their STEAM learning experiences and reflect on what they have learned.

Remember that effective STEAM education encourages curiosity and exploration. It is important to adapt your teaching methods to the age and skill level of your students and provide opportunities for them to think critically, problem solveproblem-solve and work collaboratively in a creative and supportive learning environment.

Classroom management

Effective classroom management is essential when teaching STEAM (science, technology, engineering, arts and mathematics) subjects. Here are some classroom management strategies specific to STEAM teaching:

Clear expectations and procedures:

Set clear rules and expectations for behavior and participation in STEAM activities.
Explain and demonstrate safety procedures for labs, experiments, and hands-on projects.

Structured environment:

Organize classroom set-up to facilitate STEAM activities.
Make materials easily accessible.
Designate specific areas for different types of activities, such as a makerspace maker space or computer station.

Time management:

Plan and allocate sufficient time for STEAM activities, taking into account preparation, exploration and clean-up.
Use timers or visual cues to help students stay on track during tasks.

Grouping strategies:

Group students strategically for collaborative projects. Consider a mix of abilities and personalities.
Teach students how to work effectively in teams, including communication and conflict resolution skills.

Materials management:

Implement a system for managing and distributing materials and resources. Label and organise materials clearly.
Teach students to handle materials responsibly and clean up after themselves.

Involve and motivate:

Use a variety of teaching methods and hands-on activities to keep students engaged and interested.
Connect STEAM concepts to real-world applications to increase motivation.

Flexibility and adaptability:

Be prepared to adapt your lesson plans based on students' needs and interests.
Allow for student-led investigations and projects when appropriate.

Clear communication:

Maintain open and clear communication with students regarding expectations, deadlines, and project requirements.
Encourage students to ask questions and seek help when needed.

Feedback and evaluation:

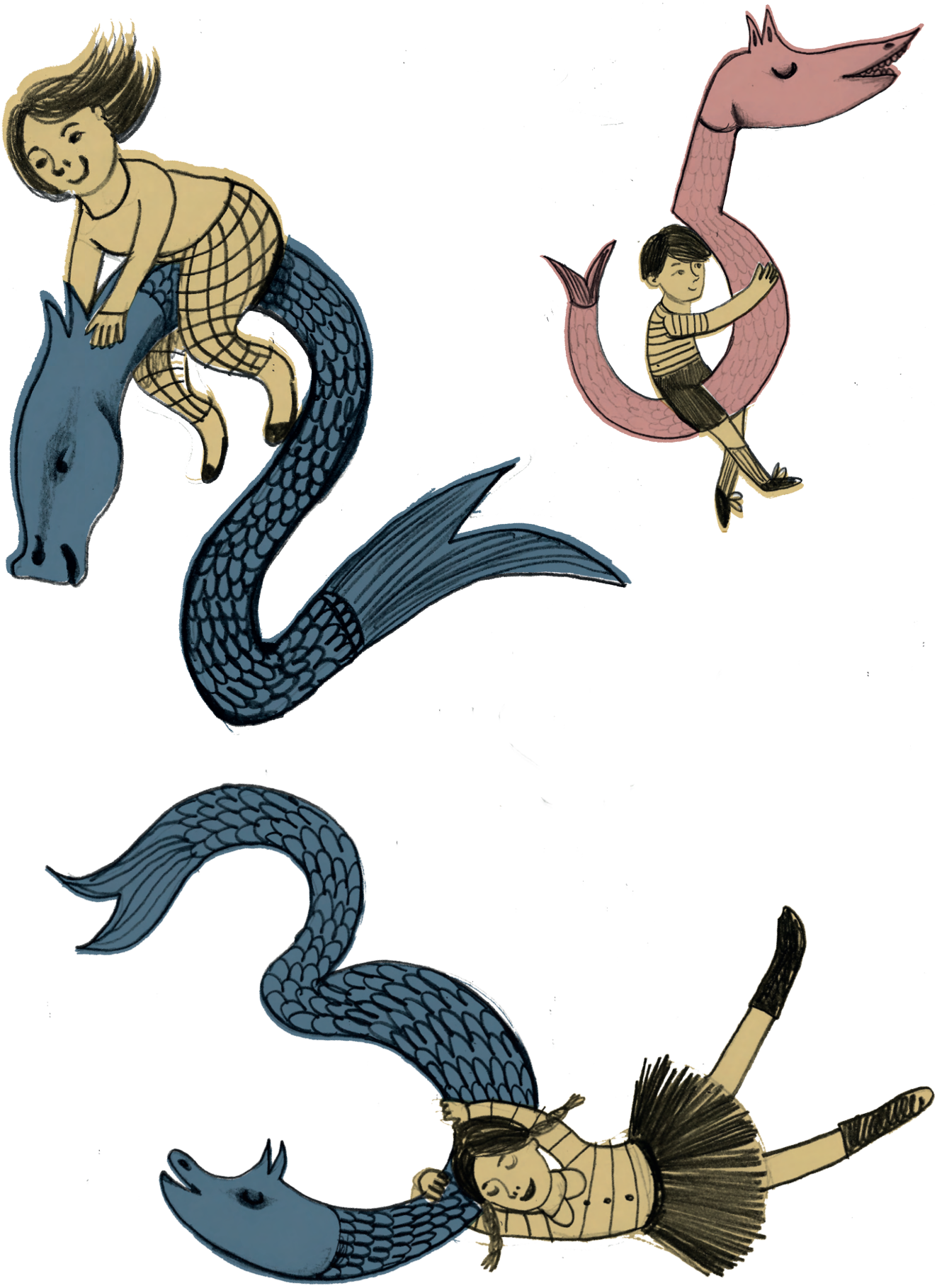
Provide constructive feedback on both the process and outcomes of STEAM projects.
Use a variety of assessment methods, including self- and peer-assessment.

Safety first:

Emphasise safety in all STEAM activities. Make sure students understand potential risks and how to mitigate them.
Supervise closely during experiments or activities that present safety concerns.

Inclusion and differentiation:

Differentiate instruction to meet the diverse needs of learners, including those with different skill levels and learning styles.
Promote inclusion and equity in STEAM education by addressing potential biases and stereotypes.



Professional Development:

Continually improve your own knowledge and teaching skills in STEM and STEAM.
Stay current with new technologies and teaching methods.

Behaviour Management:

Have a plan to address disruptive behaviour. Apply consistent consequences while providing opportunities for improvement. Encourage self-regulation and accountability.

Involve parents and the community:

Involve parents and the community in STEAM education, e.g. by organizing STEM evenings or involving experts as guest speakers.

Reflect and adapt:

Regularly reflect on your teaching methods and classroom management strategies. Be willing to adjust and improve them as needed.
Remember that effective classroom management in a STEAM classroom should support the overall goals of encouraging curiosity, critical thinking, problem solving and collaboration, while ensuring a safe and productive learning environment.
Tailor your management approach to the specific needs and dynamics of your classroom and students.

My Box of STEAM, the Sundial example

Conception in regards to curriculum standards

Contrary to most boxes on the market, the productions from this project aim to **be used by teachers**. Therefore, our boxes need to abide by certain standards: they must not only be interesting to discover, but they also need to have perks for the pupils and teachers: our boxes need to fit in the school curricula. To do so, and since all countries in Europe do not share the same school system, we relied on three sources to create our first box about the creation of a sundial: the definition of the STEAM approach, the European key competencies for lifelong learning, and general information about the curricula of schools in Europe.
For this last part, we suggested age groups that would fit each activity rather than precise classes. This way, teachers are free to perform the activities with the pupils they see fit.
The following observations on the conception of the boxes will be made in regards to the **Sundial box**, created in May 2023, with examples of how we used the previously mentioned sources.
First of all, our boxes – all about STEAM – must respect the **STEAM pedagogical approach**. This means that pupils are encouraged to try and to make mistakes, to make hypotheses and to check if they are true or not. The Sundial activity allows them to attempt to explain how the object works and to make hypotheses about how they will be able to create one of their own.
Additionally, the STEAM approach focuses on literacy and expression skills. This part is covered by the storytelling resources tied to the box: the teacher tells the story and asks questions to the class, which will help pupils understand what they are about to build or discover.
In the case of the Sundial box, the storytelling resource was used to make pupils think about the concept of time, and to start making hypotheses about the topic they were about to discover.
The boxes also rely on the **key competencies for lifelong learning**, and the Sundial box is no exception. In this box, the main topics are undoubtedly **STEAM** and **literacy**, although children also learn to learn as they try their hands at building the sundial.

The boxes also rely on the **key competencies for lifelong learning**, and the Sundial box is no exception. In this box, the main topics are undoubtedly **STEAM** and **literacy**, although children also learn to learn as they try their hands at building the sundial.
The literacy part is bound to the storytelling part, as the pupils listen and react to the story told by the teacher, but they are also made to express themselves later as they explain their classmates how to build the sundial in the most efficient way.
One of the sequences of the Sundial box also asks pupils to do some research on the history of this invention, which is a nice way for them to enhance their **digital literacy** and presentation skills.
Finally, the boxes must be part of the various European school programmes.
Although pupils do not all study the same topics at the same age, the boxes are designed with the help of teachers from several European countries and their content can be adapted to the teachers' audience.
The inclusion of **two sequences per box** allows for the topics to be made accessible to all, even the most difficult ones.
The Sundial box, for example, offers two approaches to the same subject.
The first one consists in having the pupils listen and react to the story before building the sundial and explaining how it works, while the second introduces the subject via a step of research. The pupils are then led to create their sundial based on their observations and after discussion with their classmates.
Both sequences are related to time, which is a topic that is mostly found in the later stages of primary education – both sequences therefore target pupils aged between 10 and 12. In the future, our boxes will also target the younger primary schoolers (6 to 9 years old). However, teachers are encouraged to adapt each box and each sequence to their needs.

The age group indicated on top of each sequence is a general advice, the boxes can be used with any class if their teacher believes it will benefit them.

An active classroom

One of the main challenges of the boxes is to make sure that all children are involved during the activities. This reasoning comes from our observations: first, all STEAM boxes on the market provide hands-on activities to the pupils, which is what makes them fun and engaging. When it comes to advertising for themselves, the companies often advocate for their easy-to-build, colourful and sturdy final creation. Then, **hands-on experiments** are also a **source of motivation** for pupils, who have an easier time understanding the subject of the lesson (Trna, 2008). Participating in an experiment feels different from attending a "normal" class, which adds to the general excitement.
Therefore, in order to promote easy access to STEAM topics for all, our boxes need to be **accessible to all**.
Pupils who would be left out of the testing phase would not benefit from the advantages of the method. This also means that our boxes need to be **cheap to make**, and that the activity either involves the whole class at once or is easy for the teacher to supervise: the content of the boxes must not be dangerous in any way.
The Sundial box was created bearing these factors in mind. In this activity, the storytelling resource is to be used by the teacher with the whole class, while the creation of the small sundial can either be achieved by each pupil individually, or by small groups to get to the end result quicker.
The storytelling resource aims at engaging all the pupils at once with **interactive elements** as well as learning content,
and to develop their literacy skills (Barkat, 2017).
The storytelling resources for the sundial use pictures so that the activity looks more appealing to pupils. The chosen method was to make drawings as they look less serious than photographs and can **spark discussions** more easily. The drawings are designed to tell a story: they are related to one another and represent key

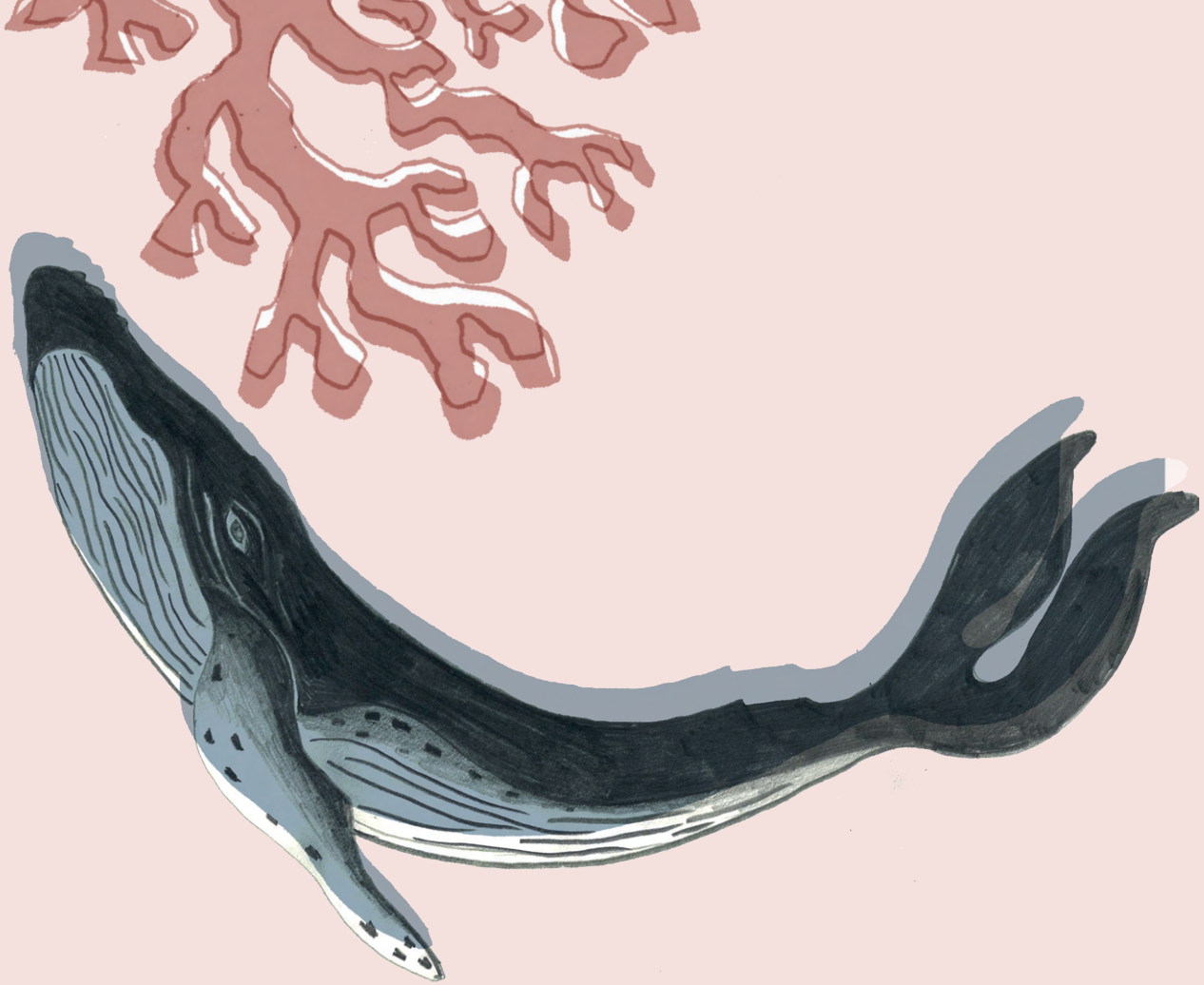
passages of the story, and can s**park discussions** more easily.
The drawings are designed to tell a story: they are related to one another and represent key passages of the story. Speaking of the story, it does not have to be long: a one-page script is more than enough to carry the first activity of the box.
Teachers have two options when writing their story: either they can write a full story, or they can write the main guidelines only.
Since the goal of the story is to **grab the pupils' attention**, they should be led to **ask questions and react to the images they see**.
If they do not ask questions by themselves, you may ask them some. For example, during the sundial activity, pupils were asked to suggest how people would tell time before clocks were invented, and then to explain how a sundial would work.
The following drawings would help them understand the concept of the sundial:

Progressively, the drawings lead pupils to wonder about the concept of time, and how people noticing their shadow would make them consider the Sun as a reliable way to be more precise about the time of the day.
This part was made complete with a short story about the oldest example of sundial in existence today, which was found in Egypt. **Anchoring STEAM concepts in the real world** will make your pupils more excited to learn about them! Plus, in the case of the sundial, the hours were not marked as we do today, but instead had drawings of the god associated with specific moments of the day. Try to add a bit of trivia whenever possible to reach a larger audience!
The second part of the box is a hands-on activity, and will usually happen after the story: this way, the pupils are hyped up by the story and can express their skills by building the actual end result. In our case, the sundial is rather easy to build: there is no need to ask for a difficult product to make since this would require a lot of attention from the teacher.
If you aim at creating **something complex**, ensure that **your pupils can work in groups large enough** for you to check on them, and that **each pupil is actively involved** in the creation process. Additionally, you may add bonus activities when creating your box: more difficult challenges for pupils or classes who succeed easily, or more ambitious productions.
In our Sundial box, we have given an example of how to build a sundial in the schoolyard. With this method – and the right material – the STEAM box can have an everlasting application.

Pupils can also be excited about building a large-scale sundial in the schoolyard, and this activity can involve all pupils to perform specific tasks: the creation of the sundial requires planning, execution and evaluation, which are all part of the STEAM approach to education. Finally, as we mentioned in the previous part about STEAM for pupils with SLDs, the various tasks involved in the creation process allow all pupils to find their strengths and leave no one behind. If the children do not know their strengths just yet, the teacher can use the boxes to give different roles to everyone throughout the year. For example, when building the sundial with a group of 7-8 pupils in the schoolyard, some of them were asked to plan how to draw the lines of the constructions, some to draw the lines and some to check if they were placed correctly or straight enough, and to suggest another method if it was not the case. Eventually, all pupils were involved in at least one of the steps.

Last words on the Sundial box

We used the Sundial box to prove that STEAM boxes can be fun and engaging and that they can be used in a school environment. Thanks to the feedback of the teachers and all partners from the project, the formula of that first box has been improved and will be used in the creation of the next 35 boxes. Head over to the My Box of STEAM website to discover what we have to offer, and how we have applied all our previous observations to the upcoming boxes!



Summary

This pedagogical guide written by all partners from Martna Põhikool (Estonia), SCS LogoPsyCom (Belgium), YuzuPulse (France), Scoala Gimnaziala Nr. 16 Take Ionescu (Romania), Nansen Dijalog Centar (Croatia) and ASSOCIAZIONE CULTURALE GRIMM SISTERS ETS (Italy) is the first bigger product from Erasmus+ project My Box of STEAM.

It introduces the teachers to the importance of STEAM and its philosophy, with a focus on learning disabilities and girls, especially at the primary and secondary levels of education.
STEAM education is a pedagogical philosophy that emphasizes the integration of the arts into STEM disciplines. By combining these traditionally distinct fields, STEAM seeks to provide students with a well-rounded education that fosters creativity, critical thinking, and innovation.
This approach acknowledges the powerful role that the arts play in enhancing STEM learning outcomes and preparing students for the multifaceted challenges of the modern world. It also helps to manage the classroom and find good solutions to lesson plans. All of these are important goals that the learning materials we create address.
Here is a good example of how to integrate storytelling as an essential skill in a STEAM lesson - in the form of sundial lesson materials. It demonstrates how such a lesson contributes to the development of key competences.
The activities we propose, combined with the development of storytelling skills in lessons, should support the overall goals of fostering curiosity, critical thinking, problem solving and collaboration, while ensuring a safe and productive learning environment. In using these teaching materials, each teacher can adapt his or her management style to the specific needs and dynamics of his or her classroom and students.
As the creators of this way of learning, the project participants believe that this material is very useful for teaching students with special needs and girls in particular in STEAM subjects and will be widely used by colleagues.

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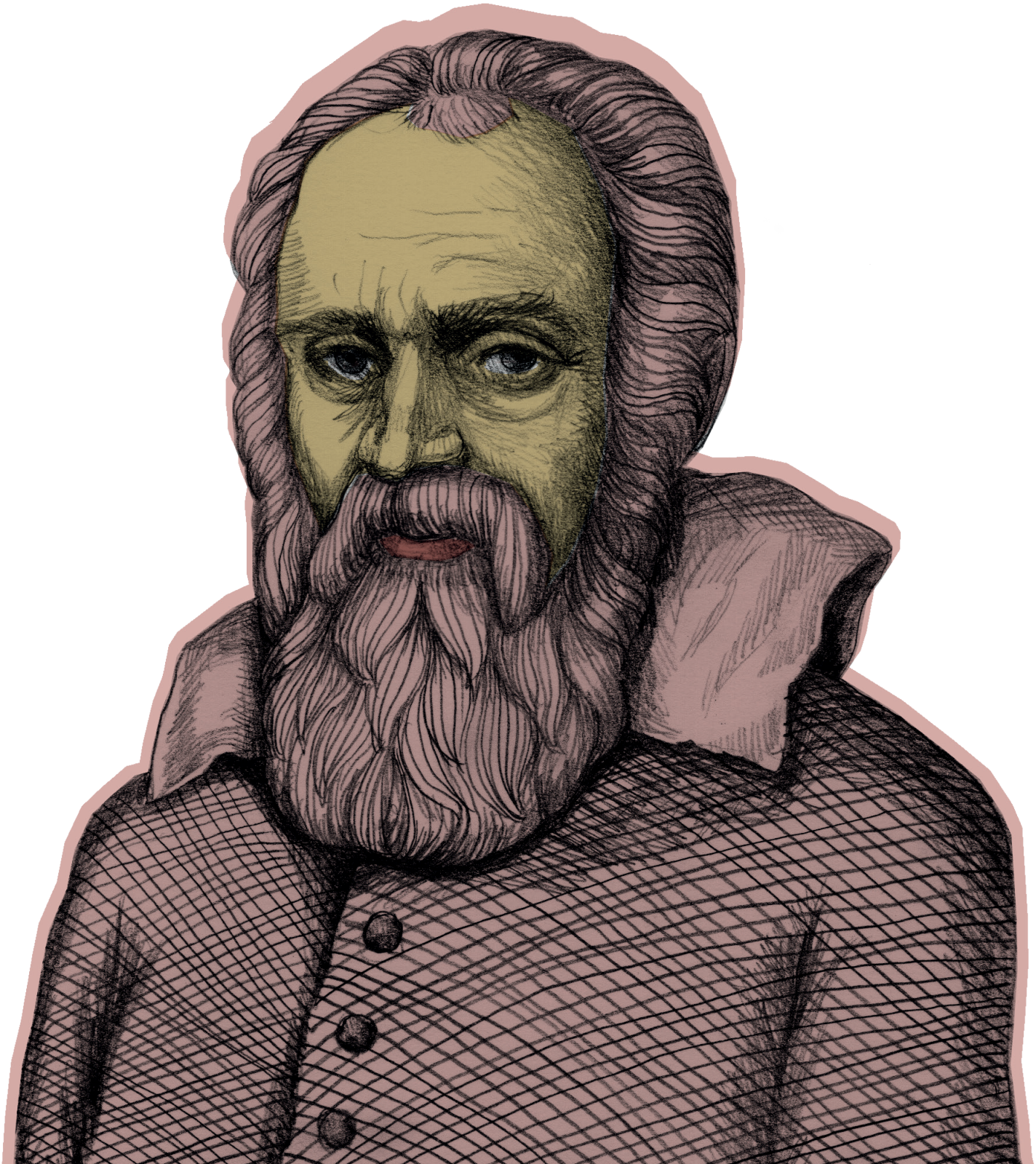
Behind every problem
there is an opportunity.

Galileo Galilei



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