ROADMAP

MY BOX OF STEAM

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Table of contents

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Introduction

Do you want to create engaging STEAM material for your pupils? Make experiments that will inspire the younger generations to pursue STEAM studies and careers? Then, this box roadmap is what you are looking for.
This Box roadmap is a guide for all aspiring STEAM-box makers based on the observations of all partners from the start of the project. You will be provided with insights on how we built the first test box and why we did it, alongside some of the main parameters we took into account when creating the boxes: pedagogical interest, financial cost, ecological impact, and accessibility to all.
Indeed, the goal of this project was to create affordable boxes that would help teachers reach all of their pupils regardless of their gender or learning difficulties. Indeed, there are many options on the market when it comes to purchasing STEAM boxes for 6- to 12-year-old children, but we wanted to create something new, and perhaps so do you. So, what could we not find when browsing for fun, educational STEAM boxes?
The price of the boxes was the first issue we wanted to tackle. Indeed, since all pupils must be able to take part in the experiment, the boxes need to either offer activities in which all children can take part at once, or be cheap enough to recreate so that schools can purchase the items without spending all of their money. Most online box subscriptions offer their content for about 30€ per box, while we aim to reduce the cost to the bare minimum and provide options for as low as 2€ for one box. However, this reduced cost does not mean that the project boxes are less engaging than their commercial counterparts: they all feature fun experiments and storytelling resources that have been tailored for young pupils.
Part of our motivation for creating these boxes also comes from the fact that commercial boxes do not tend to provide educational content but rather fun activities that do not result in any pedagogical outcome. Indeed, most boxes allow children to create or recreate various objects or experiments that do

not fit within their school curricula: they could still find the traditional school topics boring and disengage from STEAM classes. Finally, we also wanted to provide inclusive content, and inclusion is rarely at stake in commercial STEAM boxes (exceptions exist, such as the Black Girl Mathgic boxes). The two main targets of this project are girls, who are often less exposed to STEAM than boys (or less encouraged to pursue careers in STEAM despite having the same abilities as boys), and pupils with SLDs who can find many obstacles in learning STEAM. This can be achieved by several techniques, including representation via our storytelling resources to introduce pupils to female scientists who are usually less known than their male counterparts. The activities are also designed in an inclusive way, since there are several kinds: hands-on activities for pupils to manipulate, stories for pupils to listen and speak, and pedagogical sequences with reading and writing using a hypothesis-led strategy.

Are you ready to get started?
In this guide, you will find insights about our creation process as well as good practices about the main topics of the box. The first part will focus on the creation of the materials of the box: how we rounded up the topics we wanted to address, how we created a box from our first ideas, and how we created the storytelling resources to make the boxes more accessible to all. The second part will focus on the importance we give to making our boxes inclusive to all and how we manage to do so, while the third part will focus on gathering feedback and using the material learned after the activity. Feedback from pupils or observations that teachers may have in class will ensure the success of the next boxes, by identifying the main difficulties and the main points of interest. Finally, one last part of this roadmap will consist of a list of good practices that have been observed throughout the testing phase of the My Box of STEAM project. You may, of course, add your own observations to this list as a way to improve your own activities.

Let's dive in!

Sylvia Earle

Chapter 1: Creation of the material
First idea & the sequence

Find the curriculum-related ideas.
The first step in the creation of a STEAM box is… well, getting an idea! When creating a pedagogical box, the most obvious place to look at is in the school curriculum, either in your school's or at the national level. What do pupils need to learn? Make a list of the STEAM subjects you would like to tackle, and write down ideas of experiments you could do that are linked to those subjects. Do not forget that several topics can be adapted to fit the needs of your classroom. If you need more inspiration, don't hesitate to take a look at existing boxes, such as this project's or commercial ones. Many subjects are addressed, and they might give you just the right idea. If you have the chance, ask your colleagues what they would like to study too: pupils could study the same material under different angles in their school time.

What else needs to be taken into account?
First, make sure that you have enough material to involve all the pupils from your class: you may either use material that is already at your disposal and create additional low-cost materials or start from scratch and define your own needs. You do not necessarily need to give one box to every pupil in your class; instead, you may ask them to work as groups and ensure that all pupils have something to do: either they need to complete a specific task in completing the box, or they can be given specific roles.

Need an example? The first box of the My Box of STEAM project was the creation of a sundial by the pupils. Besides the storytelling – which we will address later in this guide – and the sequences, the creation of a human-sized sundial is an activity that can be carried out by a group of pupils: actually, it might just be too much work for a single pupil.

For that box, pupils were given tasks to complete as a group: one group was calculating the time zones of the sundial, one group was tracing the sundial on the ground with a piece of chalk, and one group had to check that no mistakes were made. Working with groups also allows to carry out the activity faster: instead of tracing one line at a time, children could trace at least two. This more dynamic activity also ensured that all pupils were invested in the process.

Link it to other subjects

STEAM subjects can offer a lot of possibilities… although, perhaps, you may not want to stick to one subject only. First, think of the various possibilities you have when mixing several of the STEM subjects together: sciences and maths together can give a more theoretical approach to science subjects, science and engineering a more practical one, and adding technology to any other subject can allow pupils to manipulate and create the concepts they are studying.

The ‘A’ that stands for Arts in ‘STEAM’ allows you to look for more opportunities when it comes to the subjects you want to deal with. Indeed, you may want to tackle more than just STEM subjects, and the arts are a way to boost creativity and self-expression (Land, 2013). This means that children (and this applies to older students too) become more able to solve issues using a wide variety of strategies. Additionally, the concept of “art” must be taken as a way to create objective-driven assessments and as a way to introduce pupils to a problem-solving methodology.

However, there are many more topics you may explore while creating STEAM boxes: be sure to show your pupils the application of STEAM subjects in the real world. Pair up science subjects and civics to demonstrate gender differences regarding scientific inventions by showcasing woman inventors who have been ignored by history.

You may use geography to illustrate some challenges of scientific experiments, such as the difference in temperature or humidity. Or, you can use history as a way to illustrate the approach of mathematical concepts in various times and parts of the world. Don't forget that, in the past, "hard" sciences were linked to philosophy and religion: those topics could be a bit hard to grasp for your pupils, but if you can find the right approach, go for it! Overall, the STEAM methodology promotes multi-disciplinary teaching: teachers and pupils must explore new ways to approach hard science and elaborate new ways to answer the problems they face.
Do you need an example? The first boxes of the My Box of STEAM project include several other topics to study besides the main subject of the boxes. The Sundial box, which was our first box in the project, paired up science and technology as primary subjects (with the study of time and how to build something that can help measure it) with secondary subjects like history (who were the first people to create such an item, what was it used for?) and literature (pupils can be asked to do some research and create a presentation about sundials to show that they understood the topic they are working on).

This box is a great example to illustrate the three multi-disciplinary options that you can address when creating your box:

- Multiple STEM subjects studied in one sitting (science and technology)
- The arts to create problem-solving dynamics
- The use of other subjects (history and literature) to increase the scope of the pupils in regards to science as a subject that is part of the real world (and thus connected to many aspects of everyday life).

If you are looking for other examples of how to pair up STEAM subjects between themselves or with other school subjects, be sure to check out the next boxes from the project. In the meantime, here are some other examples from the first batch of boxes:

- The Geometric figures box pairs up mathematics with literature, as pupils are led to create stories using the pieces of a tangram.
- The How to use a map box mixes computer science and
- mathematics with history when pupils discover the pioneers of computer programming and the basics of their reasoning.
- The solid figures box pairs up mathematics with a quick
- introduction to philosophy as pupils are led to re-discover the world through the eyes of Antiquity mathematicians.
- The Water cycle box blends science and digital literacy as pupils research and recreate simple experiments around the water cycle.

Be sure to check out our other productions if you are looking for more ideas!

Create several sequences per box to vary the challenges.
Pedagogical STEAM boxes include the creation of pedagogical sequences to assist the teacher in the creation of the activities with the class. Indeed, boxes created within this project aim to have an impact on the education of pupils in STEM subjects. Therefore, the sequences need to address at least one aspect of the curricula for pupils of the targeted age. Since this project was created on a European level, the age groups are rather vague and can be adapted to the necessities of the teachers ; perhaps some of the age groups will not fit the pedagogical requirements of some countries. For people who aim to create their own boxes, you may take as your school or national curricula as a reference to adapt the content of your box.

Since you aim to create STEAM boxes, you need to keep in mind the STEAM approach to education: your pupils need to observe, discover and experiment with what they have learnt. Once they have completed the activity, they need to be able to explain and recreate what they have done, and make some links with other subjects (as explained in the previous chapter). Overall, you need to create a sequence that will inspire wonder from your children and lead them to ask questions – don't answer them yourself, let them some time to figure out by themselves!

In the case of our project – and we advise you to do it too – we created not only one but two sequences per box. The reasons are multiple:

- Adaptability: the boxes can be used by pupils of different levels, either from different classes or who are ahead on the programme. This can ensure that no one gets bored while using the boxes and help you offer different activities to pupils from the same classroom with a different level.
- Reusability: the boxes can be used on several occasions during the year. If the two sequences follow each other, you may complete the second one a few days or weeks after the first

one, to create a continuity within the programme.
- Economy: creating several sequences for one box guarantees that the cost of material per sequence remains low. The material used in one box can be reused in other activities, which means that the boxes also have a reduced environmental impact.

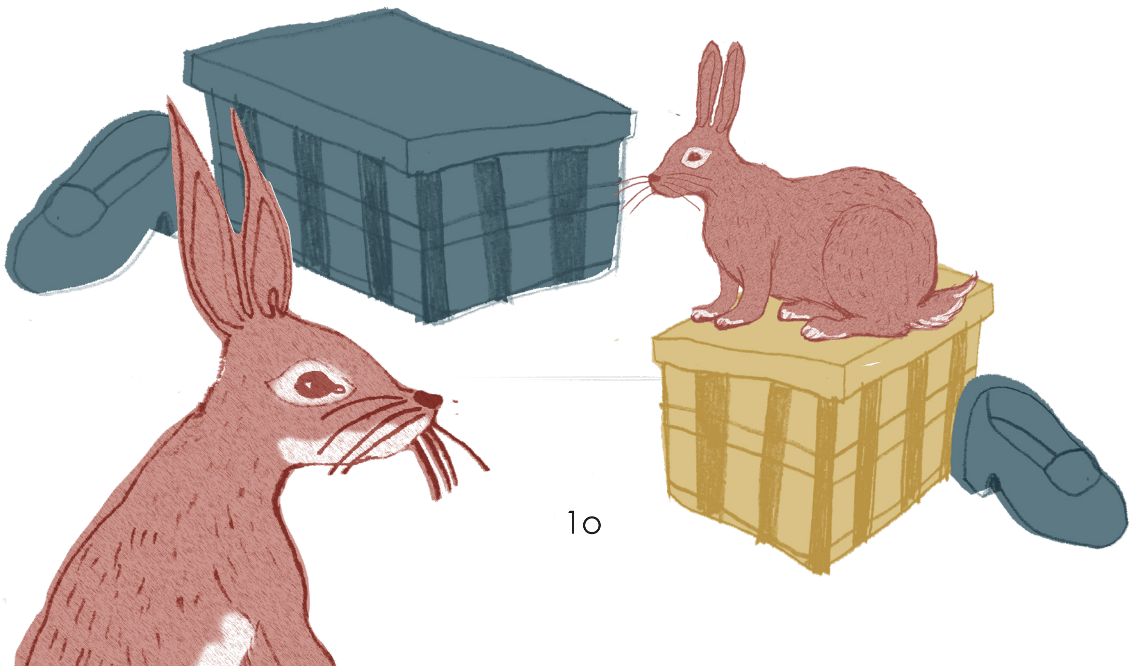
The sequences created within the My Box of STEAM project allow teachers to either use the boxes in several classes or to use the sequences one after the other in a progression logic.
For example:
- The Sundial box was created with a different-level logic in mind. The two sequences achieve the same result (i.e. the creation of a sundial) but in different fashion. The first sequence would start with an introduction to pupils about what a sundial is, and would lead pupils to the creation, while the second sequence only starts with a question about how to calculate time: pupils are then led to create the sundial based on their research and observations.
- On the other hand, the Solid figures box can be used either as a progression within the same classroom but at different times of the year (since the second sequence is in the continuity to the first one), or in two classes.
- Finally, some boxes, such as the How to use a map box, offer two sequences on very different topics that can be used in different classes or contexts. Although the core theme remains the same, the activities offer very different perspectives on the subject.

The box & creation of the elements

Easy to store

When it comes to creating the boxes, there are a few parameters to take into account, so that they do not become too hard to create or too difficult to store. Indeed, while we encourage you to be as creative as possible, the creation of the boxes must remain a fun activity to do and not represent a burden to you, your class or your school.

The first step in achieving that is to create a box that is easy to store: it does not mean that it should be less fun, but it has to take as little room as it possibly can. The main reason for this is that every pupil needs to be able to use the boxes, so you will need to create one box for every pupil or one for every two or three: in some classes, this means creating 12 to 35 boxes for one activity, which requires a lot of space. If you want to save a lot of space, we advise you to create activities that fit in an envelope – this is the case for several boxes of the My Box of STEAM project. For larger creations, you can store them in shoe boxes, for example, although keep in mind that those boxes tend to become quite bulky after several creations: save the shoeboxes for larger creations that can be used or seen by your whole class, and keep the individual activities in smaller containers.



So, what exactly can one do with an envelope? Of course, creating an easy-to-store activity must not compromise the quality of the overall box. However, several options can help you create the most engaging educative box without taking too much space!

First of all, think about the ‘Art’ in ‘STEAM’: your creation in that regard can be a storytelling resource like the ones in the My Box of STEAM project. Don’t hesitate to take a look at our boxes for inspiration! You will see that plenty can be done out of cardboard or paper: you can create interactive stories for examples, or use original visual supports to display images that can inspire your pupils. Check out the storytelling section below for more information on the matter.

When it comes to the STEAM activity, there are several options to create engaging practical activities without too much material. For example, if possible, use your creative material as part of the activity: in the first box of our project, the storytelling resource could be transformed into a sundial, and the same technique was applied to the How to use a map box. Additionally, depending on the subject you are studying, you may use the pupils themselves as part of the activity (so there is no need to store them!).
This was the case in one of our alternative activities for the Sundial box, where the pupils themselves were used as a gnomon to look at their own shadow. Apart from that, a wide variety of components can be stored in an envelope, or found outside: think about small electric components with short wires and mini batteries, or tap water that does not need to be stored (and that you may reuse once the experiment is over!). Our approach differs slightly from commercial boxes, as those traditionally have a lot of content to provide: we aim to create one engaging activity that can be reused at least once with another approach and, if possible, for several years.

Easy to purchase
Part of our engagement when creating the boxes for this project is to make them as cheap as possible, while creating quality activities. This means we lean into art a little bit more than commercial boxes with the creation of storytelling resources for each box, which contains both a story and visual elements.
While each teacher can adapt the material to fit their budget, we aimed to give everyone an option to make engaging material with the smallest financial cost.

How do we achieve that? The first step consists in making a lot of the material – such as the narrative resources – by yourself, using your computer, a pen and paper. This first step needs a bit of preparation and experience in making those resources, however you can gather inspiration from the boxes of this project's website, and the creation process will be explained in the storytelling section. There, you will find numerous ways to build an engaging story, but remember that arts can allow you more than that.

Next, the materials need to be easy to find and to purchase and, of course, cheap to buy or to make. Easy-to-find materials will ensure that all teachers can buy the materials without having to search for too long and limit the carbon footprint of the boxes (developed in the next section). Additionally, easy-to-find materials will ensure that you have a sufficient amount to share between your pupils: remember that each box has to be completed by groups of 1-3 pupils.

The cost of the materials also needs to be studied to ensure that you can provide enough boxes for everyone. The boxes of our project are very cheap to create (the base version of the Sundial box only requires teachers to print a few sheets of paper), but you can create yours depending on your budget. Just know that you can find cheap options on this website! In order to limit the costs, don't forget to use reusable materials or natural ones such as dirt, water or rocks, glass containers and well-stored pieces of cardboard.

Eco-friendly

Finally, the boxes need to be eco-friendly, which means that teachers should look for ways to limit their carbon footprint when creating or purchasing the materials for the boxes. Here are a few tips to stay in control of your environmental impact:

- Buy less, buy local: only purchase what is necessary for your boxes. Although it is important to provide enough for all pupils, be careful about not buying too much of something that you are not going to use. Additionally, buy local items whenever you can, and avoid online platforms such as Amazon or Shein: their prices might look like a great deal, but their carbon footprint is very high due to cross-continental transportation.
- Reuse: insert reusable content in your boxes. This takes into account items that can be used indefinitely or until broken (such as a glass), or materials that can be used several times before you need to change them, such as sheets of paper and cardbo ard. If you plan on studying natural materials, pick some outside if you can instead of buying them: it will anchor the concept you want to study into the real world.
- Recycle: give a new life to items you are not using anymore. Use old shoeboxes to store your activities, transfer the material from one box to another if you want to create a new activity so that you do not have to purchase anything new, and put overused or broken content in the appropriate bins. When using tap water, pour it into the school plants after the end of the activity so that it does not go to waste (do not do this with purified water, since it will harm the plants). If you mixed several substances, be sure to check out any options of reusability before throwing them away!

In addition to these reflexes towards creating low-emission boxes, keep in mind that there is one more step you can take to reduce your ecological impact: educate the children! Indeed, while you do not have to do it with every box, it is important to show that the protection of the environment can be done in many ways. Include activities that focus on the consequences of pollution on the environment, for example when studying the concept of solutions in chemistry. Giving your pupils guidelines to avoid polluting too much is a way to reduce the carbon footprint with the generations to come.

Storytelling, box notice & class activities

Why and how to create a storytelling resource

Storytelling does not only refer to the art of writing a story; it is the art of telling one using various means to make the audience appreciate the tale. Telling a good story requires a good intonation by the speaker, pictures to help represent the scene, and of course, the right choice of words to provoke feelings. The art of storytelling has been used for millennia as it was a way to perpetuate history, tradition and experiences: a well-told story is much more impactful than a logical, well-rounded scientific demonstration. Indeed, the story makes the subject appealing for pupils and has a more lasting impact as the children become emotionally engaged with it.

The story is not only the teacher's to tell: the goal of this activity is to have pupils participate in the tale. The first way to achieve that is to create characters with whom the children can identify: do not shy away from including more women in your stories, as it will show young girls that they too can aim for STEAM-related careers. If you lack inspiration, check out the famous women we included in our stories, such as Ada Lovelace or Jane Marcet, or create fictitious female main characters when telling a made-up story. Second, pupils must be able to interact with the story to better grasp the concepts of the pedagogical sequence:

they can either be asked to answer a few questions from the narrator (in the Sundial box: what is time? How would you measure it if you had no phones or watches?) or they can be asked to create the story themselves such as in the Water cycle box. This results in the same phenomenon as with the other activities in the boxes: the boxes consist of practical experiments since hands-on activities have more impact than theoretical ones (Holsterman et al., 2010) and increase the interest of the pupils in the subject. Although pupils can enjoy a good story, it will have more impact if they are asked to interact with it.

Why and how to create graphic elements

The aim of the graphic elements of the story is to push the pupils to participate in the story. As mentioned before, it is of utmost importance to have children be actively involved in the creation of the box and the story, and the images aim at doing just that.

The images aim to create a universal language that all pupils can understand, whether they are good in STEAM subjects or not. They are used to make things understandable, like paintings on Stone Age caverns: they do not need to carry too much detail or be too realistic, but they have to spark off emotions and conversations. Remember that such imagery has been used for centuries in churches for example, where illiterate people could still participate in religious ceremonies and feel part of a whole just by looking at the pictures displayed in the building: sculptures, paintings and stained-glass windows.

Those pictures will enable pupils to either make sense of the STEAM world and see its application in context or at least to participate in the activity. This, alongside storytelling, also consists in a way to bring pedagogical content to pupils with SLDs and who have a hard time understanding theoretical subjects through “traditional” methods. The practical application, which is both the subject of the storytelling resource and of the box, allows them to manipulate and reflect on the lesson.

“What about creating your own box when you cannot draw?”. The task of drawing meaningful pictures can seem quite daring for teachers who are not comfortable with their artistic skills and who want to create their own box with graphic elements. However, there are solutions to overcome this difficulty:

- Make pupils actors of their own learning: you can focus on writing the story and, as you tell it, have pupils draw the main steps. Be sure to leave clear instructions: what they need to draw on (a paper sheet, a specific model to build a 3D picture, a material other than paper…?), and what they need to represent. Look at our boxes to find inspiration on the various supports you can involve in your lesson.

- Use pictures from the internet, such as free images or AI generators, to have engaging visuals. Do not forget to credit the source every time you download a picture.

Now that your storytelling and visual elements are all set, it is time for the last piece of advice about conducting class activities with this material.

The attitude towards STEAM activities

Probably the most important part of STEAM teaching is the fact that pupils are not only allowed but almost forced to fail and repeat: this is part of the experimentation process after all!

Although failing to complete a task is usually not well-seen, you need to ensure that your pupils are well aware that they will fail some of the experiments. How can you make sure of this? First, create a safe working space where your pupils will not feel ashamed for giving a wrong answer. This works for every subject, so we can assume it is already the case in your classroom!
Second, have your pupils formulate hypotheses: this way, they will have correct and wrong ones, so they will feel rewarded for having guessed some of them right. Finally, you can also lead them to make attempts that will fail: taking the solid template tongues into account when calculating the area of the figures, creating electric circuits with an insulator, etc. The feeling of success when the experiment works will largely compensate for the failed ones.

In some cases, the pupils may fail an experiment that should have succeeded. Ask them to describe their creation process on paper, and to check if the instructions have been respected. Sadly, in some cases, the experiments may fail because of the materials (especially when using electric components), or because of unexpected phenomena (colour pigments that are not "pure" in the Learn the colours activity, or non-magnetic items that are attracted to a magnet because they carry magnetic particles).

In those cases, make sure that the methodology of your pupils is right, and let them try again with material from another group so that they can succeed. Do not let them end the experiment on a failure: pupils all expect to succeed in this activity, and they would be disappointed if they failed. Gianni Rodari even said that failure leads to enhanced creativity, so children can find ways to overcome the obstacles they encounter when they are unsuccessful.

"Mistakes are necessary, useful like bread, and often even beautiful: for example, the leaning tower of Pisa."
Gianni Rodari

Chapter 2 - Inclusion
Creating inclusive educational boxes

Our My Box of Steam project aims to be inclusive and to reduce gender inequalities in the STEAM community and also to focus on the needs of students with learning disabilities. According to the European Group of Citizens with Dyslexia and Specific Learning Disabilities, 10-15% of the EU population is affected by one or more learning disabilities, so it is essential to spread inclusive teaching practices.

Specific learning disability

Specific learning disabilities are lifelong neurodevelopmental disorders. They are often referred to as Dys- for example, dyslexia, dysphasia, dysorthographia, dyscalculia, dysgraphia and dyspraxia. Research has shown that these disorders have several causes, including genetics and a combination of difficulties in the cognitive development of skills such as phonological processing, working memory, rapid naming, sequencing and automaticity of basic skills. These disorders are, therefore, unrelated to intelligence, individual effort or socio-economic position and are not the consequence of a visual, hearing or motor disability.

Specific learning disabilities can affect the cognitive development of speaking, reading, writing, mathematics and the planning or coordination of motor tasks. They are not easy to identify, but the earlier they are identified, the better they can be managed.

Universal design for inclusive learning

Pupils with learning disabilities sometimes experience very different challenges. So, how do you include these students, giving them the help they need while teaching a whole class?

This is the objective of Universal Design for Learning (UDL), which aims to provide an educational programme and a flexible learning environment that enable learners with different opportunities and abilities to access the mainstream educational programme and

achieve the outcomes set out in the educational standards that have been established for all students.
Universal design highlights the diversity of students and builds the programme to be more flexible and adapted to everyone's needs.
UDL is a framework for developing lesson plans and assessments based on three core principles: presentation, demonstration and participation (Meyer, A., Rose, D.H., & Gordon, D,2014).

Presentation
Universal design in education means offering different ways of presenting information so that students can choose what is best for them to receive and learn.

Demonstration
The aim is to allow students to choose the method that suits them best for demonstrating what they have learnt.

Participation
UDL offers different ways of attracting attention, stimulating student interest and therefore increasing motivation.
UDL helps all learners. However, here are some of how it can be particularly useful to the one in five children and adults who learn and think differently:

- Makes learning more accessible in general education classrooms
- Presents information in a way that adapts to the learner rather than asking the learner to adapt to the information.
- Gives students more than one way to interact with the material. UDL offers flexibility that allows learners to use their strengths and work on their weaknesses.
- Reduces stigma. By offering a variety of options to everyone, UDL does not isolate the few who benefit from formal accommodations because of a disability.

Creating inclusive sequences with UDL
Now that you know what UDL is and its advantages, let's look at how to use it to create your pedagogical sequences.

Before the lesson
Before starting the lesson, it might be a good idea to take a few minutes to review what was done in the previous lesson. This will help the pupils to understand the logic of your sequences and to make connections between them. It can also help them to fix what they have learned in their long-term memory.

During the lesson
To begin the lesson, it can be very useful to give an overview of the session and explain what will be covered during it. This helps to focus and refocus in case the students lose the lesson thread. This overview can take several forms: a table of contents or a mind map highlighting the links between the different subjects.
The smaller, the better. First of all, the structure of your lesson will be clearer if it's divided into smaller learning phases. This can help with concentration and memorisation. Worksheets, tasks and instructions should also follow this principle.
Instructions should also be short and to the point. Smaller, step-by-step instructions will make the exercises much clearer for your students.
Finally, students will be less involved and less concentrated if they have too much theory. Make sure you balance theory and exercises (or experimentation). Students with learning disabilities can also learn much better through practice (active learning) than through theory, especially when they adopt multisensory principles.

After the lesson

After the lesson, reviewing the plan and summarising what has been learned will help students to memorise better and reflect on what they have learned. Repetition and structured reflection are the keys to all learning.

Making your box inclusive

Once you have designed your lesson, the next step is to make the material inclusive. This does not mean creating different or additional material for students with special needs but rather adapting the material so that all students can use the same material without difficulty. A series of easily applicable recommendations can be established to make the material inclusive.

Inclusive layout

When creating the various elements of your box (narrative elements, student sheets, etc.), keep the layout consistent.
The following guidelines can help you create an inclusive layout:

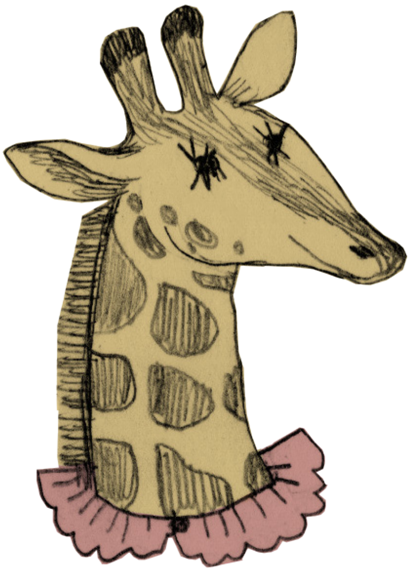
- Use a sans-serif font, such as Arial, Century Gothic or Open Sans (or choose a font specially designed for people with dyslexia, such as OpenDyslexic and EasyReading).

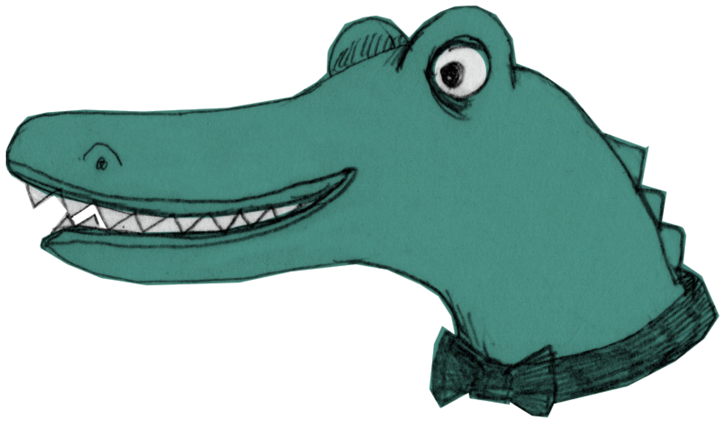
People with dyslexia prefer these font types because the space between the letters is clearer than with serif fonts (e.g. Times or Garamond) or cursive fonts, which can both seem narrower.

- The text font size should be at least 12 or even 14.
- Use 1.5 line spacing.
- Align your text to the left; avoid justified alignment, as this can make it more difficult to find your way around the text.
- To highlight the content, put the words in **bold** (no italics, underlining or CAPITALS).

This will help your students follow the lesson and study it at home.
When creating your documents, also make sure they are visually attractive; use colours, images and icons.
The judicious and consistent use of icons and colours (ensure

sufficient contrast between the background and the text) will help your students understand your document better. It also allows them to concentrate. For example, always use the same icon and/or colour for vocabulary exercises, another for grammar and another for spelling. This will help your pupils to follow the lesson and practise it at home.





Chapter 3 – After the activity

That's it, you're done, you've set up your box! But it's not over yet; there's one more essential step! It's all about getting feedback from your students.

What's feedback?

But isn't feedback rather the teacher commenting on the s tudent's performance and the mistakes they have made? This is not untrue... Feedback is, above all, descriptive, constructive and non-judgemental that forms part of a formative assessment process (Barde, 2020). This feedback can be given in several directions: from the teacher to the student, from the student to the teacher or even between students or teachers. The focus should be on learning, not on the individuals (Hattie, quoted by Anton, 2019).

Why get feedback from your students?

According to the literature review by Röhl in 2021, gathering feedback from pupils can have several effects on teachers at several levels.
At the cognitive level, several studies have reported that teachers reflect more on their actual practice (Gärtner & Vogt; Göbel & Neuber; Mandoui cited by Röhl, 2021). Feedback thus enables teachers to reflect on their teaching practices and subsequently identify areas for improvement (Barker; Gaertner cited by Röhl, 2021). In addition, teachers also gain a better understanding of how their lessons are perceived by their pupils (Gage, Thorpetal; Wyssetal, cited by Röhl, 2021).
Receiving feedback on your professional practice is not always easy. The literature review by Röhl in 2021 highlights the emotions, either very positive or relatively negative, that teachers can feel when reading feedback that is perceived positively or negatively (Brown; Gärtner & Vog; Villa).

However, it is the combination of cognitive and affective effects that will bring about behavioural change. Teachers will then improve in the areas identified, enrol in further training, reflect more on their practices or engage in discussion with their pupils (Balch; Gaertner; Rösch; Gaertner; Thorp et al. cited by Röhl, 2021).
In addition, gathering feedback from students when introducing a new practice or activity is essential for evaluating the new activity and identifying areas for improvement.

Creating a climate conducive to feedback

Gathering student feedback is all good, but creating a climate conducive to feedback is even better! Creating a culture of robust feedback in the classroom offers many opportunities to foster democracy and improve the quality of teaching while encouraging the participation of both teachers and students (Anton, 2019). To establish a culture of feedback, we must first point out that the teacher is not always the one providing feedback to students. It will then be necessary to establish a change so that learning is at the centre and not the individual. Teaching evaluation must become a shared responsibility (Anton, 2019).

This joint reflection can occur at several levels: collaboration in groups or pairs, learning processes and experiences. This practice has many advantages, such as improving teaching in the long term, increasing students' sense of responsibility and providing a better understanding of roles.
Establishing a feedback culture is also a key element in promoting citizenship education. Providing feedback regularly helps people understand the importance of freedom of expression and gives everyone a chance to have their say. To ensure that feedback takes place in the best possible way, it will be necessary to establish that opinions may differ but that all opinions have the same value. If feedback is given regularly, it can also help to boost self-esteem, motivation and mutual respect among pupils (Anton, 2019).

How to give and receive feedback

Establishing a feedback culture is important, but there are a few rules to follow to give or receive feedback in the best possible conditions.

Giving feedback :

The first step is to create an atmosphere conducive to discussion and always to remain benevolent. Next, you must ensure you give feedback quickly after the activity. As feedback is factual, you need to be careful not to pass judgment and to refer to the facts. The idea is to express the positive points and then the points to be improved and to express wishes rather than criticisms (Anton, 2019).

Receive feedback :

The first attitude to adopt when receiving feedback is to listen attentively. You should then thank the other person for the learning offer and, if necessary, ask questions. The next step is to reflect on the feedback; it is pointless and ineffective to justify yourself directly. The final step is to react and implement improvements (Anton, 2019).

To ensure that the feedback goes as well as possible, these rules need to be understood and applied by everyone (teachers and students). To involve the students more in the process, the rules can be drawn up in collaboration with them.

Gathering relevant feedback

At this point, you might ask yourself: how can I get honest feedback from my pupils? That's the whole point of this section, which is to suggest some practical methods for getting feedback from your pupils, depending on their age.

Before moving on to concrete examples, a few recommendations should be considered to obtain honest and meaningful student feedback (Astolfi, 2021).

Before the activity :

1. Tell your students

To gather relevant feedback from your students, it can be useful to let them know when and how you will question them. It's also a good idea to explain why you're asking them for feedback and what you can use it for. Don't hesitate to insist on the importance of this feedback. This way, the students will be more involved in the process. Also, encourage them to be sincere in their opinions (Cheney, 2022; Astolfi, 2021).

2. Create routines

Gathering feedback from students regularly helps to establish a routine. As with most new things, asking for and giving feedback can initially seem strange. It sometimes takes a little time for students to feel secure enough to express themselves. Establishing a routine then allows students to express themselves more freely and more quickly (Astolfi, 2021).

3. Provide information on the feedback procedure

Explain to the students how you will collect their feedback, and if it is a questionnaire, take time to read the questions with them. Once they know how to complete the questionnaire, they can provide you with information actively and honestly (Chenney, 2022).

4. Be open to feedback and let them know

To receive sincere feedback, you need to let the students know that it will be received positively. To do this, explain to them what the purpose of feedback is: to identify weaknesses and remedy them by providing solutions (Chenney, 2022).

After receiving feedback :

1. Analyse the feedback received

An effective method of analysing feedback is to group the positive points, the negative points and the suggestions. This will give you an overall picture (Langevin, 1989).

2. Follow-up

Let the students know that you have received their feedback, that you are analysing it and that you will establish ways of remedying it. Of course, you don't have to do everything the students ask you to do under any conditions. For example, if many students express the wish to do more practical work but there are concerns about their behaviour, you can say to them: "I've noticed this request, but I need to be able to count on you to behave responsibly. Show me that you can act responsibly, and next session, we can do a practical activity." If a student asks to change seats, do so if feasible; if not, engage in a conversation to explain the reasons for your decision. Make it clear in an open way that you are willing to listen and make changes if necessary. (Astolfi, 2021).

Below are some practical examples of how to get feedback from your students.

Manometer

The aim is to ask students to express the difficulty of a task by spreading their hands apart; the further apart they are, the more complex the task (Anton, 2019).

Traffic light

Pupils express their agreement or disagreement with a statement by raising a red, orange or green card. This gives a direct indication of the mood of the class (Anton, 2019).

The “Think, Pair, Share" method

This method is a 3-step process.

1. “Think”

Initiate a reflective question, for example, "What aspects of the project have sparked your interest the most and why?" Allow students one to two minutes of silence to reflect on the question. It's a good idea to write the question on the board or repeat it aloud for those who might need it.

2. “Pair”

Ask the students to turn to their neighbours and share their ideas.

3. “Share”

Finally, ask students to share their ideas individually or in pairs (Phillips, 2017).

Mood barometer

Students take a stand on a subject in class using smiley faces (Anton, 2019).

Storytelling

Ask students a question to stimulate their imagination. For example, "If I became a science/mathematics teacher, I would..." and invite them to tell a short story or draw a picture about how they would run their class.

Before asking them to imagine their own class, explain that they could choose to share what they would like the course to cover, what they already like about the course or what they have always wanted to try. Then, ask the students to close their eyes and guide them to imagine their classroom: “What are your students doing? Do you have anything on your walls? What makes your classroom unique?" (Phillips, 2017).

Minute paper

After an hour of lessons, the students collect all their impressions of a given question (Anton, 2019).

Feedback letter

Feedback letters are individual or anonymous feedback to the teacher or randomly selected class members. They contain answers to specific questions about lessons or collaboration (Anton, 2019).

Group reflection

Structured reflection in pairs, groups or classes on assessment and joint work. The results can be presented to all participants (Anton, 2019).

Questionnaire

Questionnaires are obviously an excellent method of gathering feedback on collaboration and the activity itself. They can be prepared, evaluated and presented by the teacher or groups of students. They should be adapted to classroom conditions (Anton, 2019).

Mini-questionnaire

A variant of the questionnaire is the mini-questionnaire: The mini-questionnaire is a tool that allows you to collect feedback from students on aspects of your teaching that you consider essential. The approach consists of developing three to five questions related to your teaching or the objectives you pursue in class and adding a response scale (Langevin, 1989).
It is entirely possible to combine different ways of gathering feedback. This will make it likely to vary the methods so as not to bore the students and to pick other information depending on the method chosen (individual, group, class) (Cheney, 2022). If you have never before carried out activities to gather feedback from your students, initially favour written or at least individual activities so that the opinions of others do not influence students. Once you have established a positive relationship with your students regarding feedback, you can organise informal discussion groups (Alstofi, 2021).

Suggestion box

Install a locked suggestion box in a high-traffic area of the classroom. Students are encouraged to submit comments about any aspect of the lessons voluntarily. The teacher should check the box at least once weekly and determine how to respond to the comments. To encourage participation in this feedback process, the teacher could post a "Question of the Month/Week" above the box (PHE Canada, 2022).

Incorporating feedback into your practice

Now that you know what feedback is, why it's important to gather it and how let's tackle the subject in the context of our project.

Improve the box using student feedback

When setting up an educational box, it's essential to gather feedback from students so that you can improve your box, especially if this is your first experience of creating boxes.
As mentioned in the previous point, there are many different methods for collecting student feedback, so it's up to you to choose the method that best suits your needs and those of your students. However, while the methods may differ, the points to be addressed will be broadly similar. We have prepared a list of questions as a guide, which you can then add and select the questions that best apply to your teaching box.

Student Preparation

- Do you think you were sufficiently prepared to make the box?
- How could you be better prepared to make the box?

Box element

a. General experience

- How did you feel during the sequence?
- Which part of the sequence did you enjoy the most?
- Which part of the sequence was the easiest/difficult and why?
- How would you assess your performance?

b. Storytelling elements

- Did the story/storytelling elements help you to understand the subject?
- Were the story/storytelling elements appropriate to the subject of the sequence?
- What did you like/dislike about the story/storytelling elements?

c. The experience

- Are you satisfied with your contribution to the experiment/construction?
- Did the experiment/construction help you to understand mathematical/scientific concepts?
- What did you like/dislike about this experience?
- Did you have a specific role in the group?

d. Questions on learning objectives

- Do you think this educational box has improved your maths/science skills? Why or why not?
- What were the main challenges you faced in learning science/math?

e. Questions on soft skills objectives

- Do you think you were creative in making this box?
- Did you communicate respectfully with the members of your group?
- What aspects of the group work did you like/dislike?

The answers to these questions will give you an overall view of how well your educational box has gone. You can then sort the feedback into three "columns": what was appreciated, what was not appreciated and suggestions for improvement. This sorting will enable you to identify what to keep for future boxes and what to improve.

Chapter 4 – Good practices

The last part of this guide is intended to provide examples of best practices observed during the first test phase of our pedagogical boxes.
Here is a list of best practices in terms of the creation of the elements and inclusion:

- **Create boxes that cover several subjects.**

Cross-curricular activities create links between subjects, giving meaning to activities by showing their concrete application. As a result, students will be more motivated and have a deeper understanding of concepts, you can also ask your pupils how the box relates to something they have studied earlier this year or in previous classes.

- **Accompany the boxes with storytelling material.**

Storytelling material has several benefits: it helps contextualise learning, develops students' creative spirit by asking you pupils to tell a new story, offers several means of representation (ideal for meeting the needs of all students) and makes the activity more interactive. Storytelling material is a good way of motivating and engaging students in the task.

- **Create inclusive material.**

To enable all students to create your educational box, be sure to adopt an inclusive layout by modifying the text size (between 12 and 14), structuring the text in paragraphs, creating a colour code and highlighting specific passages in bold. Pay particular attention to students with learning disabilities, and check that they don't have any difficulties making the box.

- **Create visually appealing material.**

When creating material, don't hesitate to use images, diagrams or other visual representations to show different ways of representing information. Ensure you also create visually appealing material, using colour codes and paying attention to overall aesthetics. Students will be naturally drawn in and more motivated for the activity.

- **Reuse familiar tools by adding storytelling material.**

Just because your students have done Tangram activities before, for example, doesn't mean they'll stop being interested. In fact, adding storytelling material allows them to rediscover this tool and offer a different vision of it. In addition, being familiar with the concept can be motivating, you can consider creating new boxes that call back the tools they already used.

- **Let students discover and experiment with the box freely**

Allowing students to experiment with the box will enable them to develop their problem-solving skills. Let them search, make mistakes and correct themselves. Of course, always be there to keep the noise level acceptable and to answer questions.

- **Think about the ecological footprint of your box.**

When creating your box, include recycled materials or ensure they can be reused in other educational boxes. Buy from local stores to reduce the ecological cost of transport. Don't hesitate to think about this aspect with your students to raise their awareness of the importance of respecting the environment.

- **Make the box your own.**

Feel free to adapt the sequence to the needs of your class, mix the two sequences to suit the level of your students, add activities or make links with other lessons.

- **Play the box game.**

If you're enthusiastic, the students are bound to be too, so play along, read the stories, put yourself in the characters' shoes, set the mood and have fun.

- **Think about box storage.**

When creating your box, don't neglect its storage. Make sure you create material that's easy to store (foldable, for example) in practical, easy-to-file containers. You can use envelopes, for example, or shoeboxes. Once you've built up a collection of boxes, you'll also want to think about a classification and labelling system for easy retrieval.

- **Good practices related to feedback**

Create a questionnaire to gather information from your pupils. If you do not have time, ask your pupils how they felt right after the activity. Take their comments into account – if they have any. And if your pupils are too shy to express their opinion, do not hesitate to collect them during your next activity. As we mentioned earlier, creating a feedback culture will help pupils become more used to expressing their opinion and thus be less shy about it or, if need be, you may also conduct anonymous surveys to receive honest feedback.

- **Reuse the content of the boxes**

The boxes are not meant to be used outside of the school curriculum, but rather to fit in the curriculum and to accompany more traditional teaching methods. One of the teachers we worked with used the Water cycle box as an introduction to his sequence on the environment. Either the physical materials of the box (pen, paper, scissors, containers) can be used for other experiments, or the pedagogical contents can be part of a class routine when addressing a new topic ("Do you remember when we worked on xxx, what do you remember from that activity?").

As it can be the case with young pupils, you may also conduct the experiment before the weekend and start a sequence related to what you have studied at the start of the next week.

- **Transform the boxes to create new activities**

After the testing phase, one of the teachers used the box to create a short play in English (which was not the native language of the pupils). If you are using any content from the My Box of STEAM project, do not forget to cite your source materials (us) and remember that you are responsible for what you create: neither the project partners nor the EU can be held accountable for any misuse of the original content.

- **Implement the STEAM approach in your classroom for good**

The activities from the boxes offer general guidelines to conduct inquiry-based learning with your pupils. Now that the activity is over, you may start using this method with any subject to motivate your pupils: after all, inquiry-based learning is used with scientific topics as well as arts (with the storytelling resources) and any other topics related to the boxes: ecology, computer science, history, and more. So why not use this in other classes too?

Leonardo Fibonacci

Summary

That’s all we have to share for this guide! Do you feel ready to create your own boxes now?

As for any pedagogical activity, be it a sequence or a shorter task, you will need to draw up a plan of what to do before, during and after the activity. What changes when building a box is the fact that this is a practical and multi-disciplinary task that needs to be somewhat entertaining to engage your pupils. Think about building a story as we did with our own boxes: the pupils loved them, and it allowed those who do not usually like science to take part in the activity.

This guide also provides you with tools to create inclusive boxes: it would be a shame if some of your pupils could not engage with the activity just because they do not have the right tools to do so. To make it short: vary the materials within the boxes – and vary the themes of the boxes – to ensure that everyone can be involved equally. You may find inspiration by looking at the boxes developed in this project!

Additionally, you will have to gather feedback from your pupils after the activity to make them part of the creation process: their ideas matter and could give you insights on what to create next! Although this is not quite the topic of this project, you may use the STEAM approach to create boxes on many non-scientific subjects, such as history or literature. Inquiry-based learning can be applied to any subject, and the boxes, as shown in the My Box of STEAM project, can address many topics. How about you give it a try?

Finally, do not forget that your boxes need to be challenging, for several reasons: first, your pupils will not engage if the content is too easy, second, having them write hypotheses is a big part of inquiry-based learning (and it will help them in future classes), and last but not least, the boxes provide a safe environment to make mistakes. The role of the experiments is to see the pupils succeed after a series of approximations (hypotheses) or failed attempts, to show them that being unsuccessful at first is part of the scientific process!

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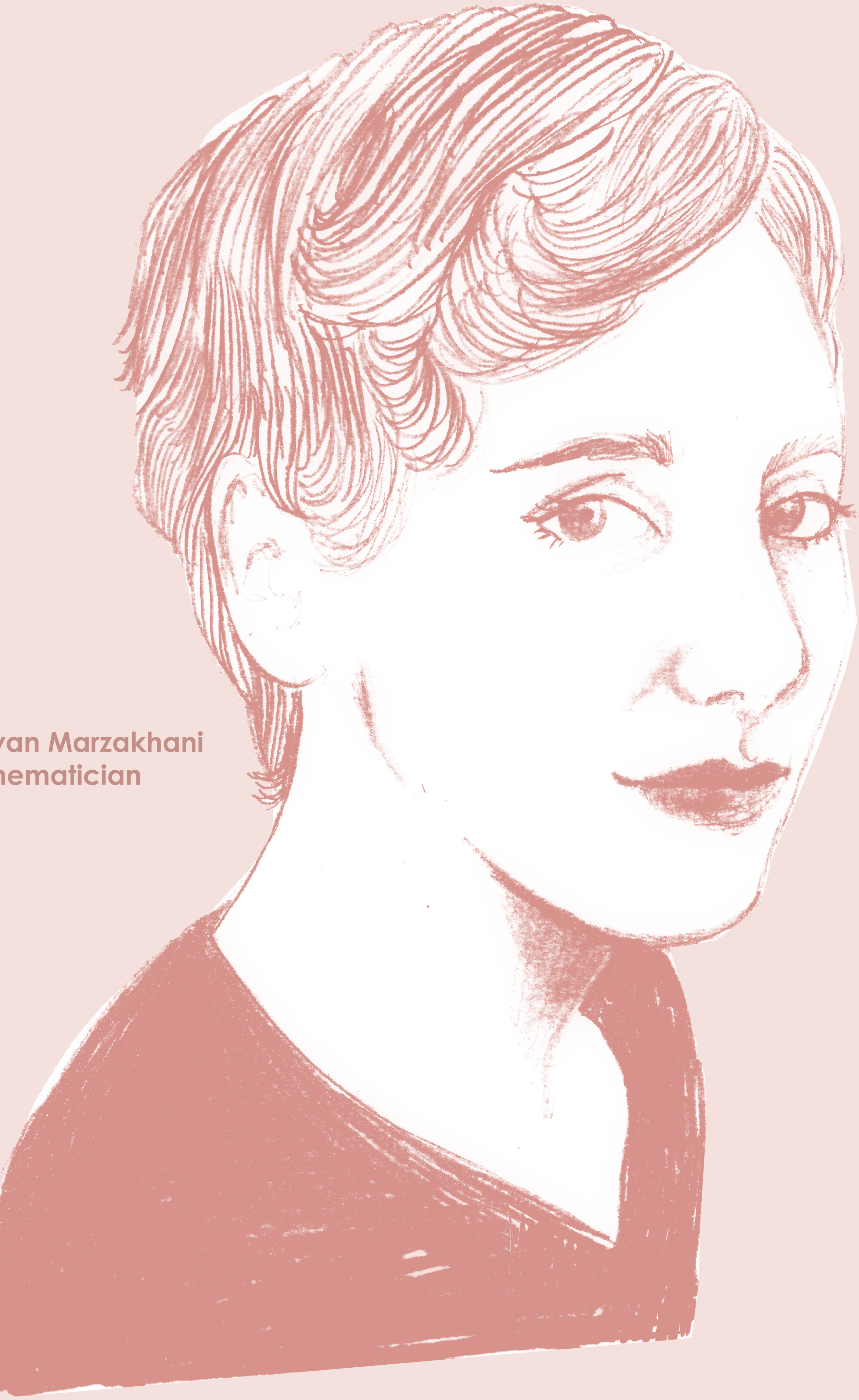

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