

# MonTech Guide

Teaching Creative Technologies using  
a Montessori Approach

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Sept 2022





The MonTech Guide: Teaching Creative Technologies Using a Montessori Approach  
This guide is one of the results of a 3-year European project called “MonTech – Blended Montessori-Creative Technologies approach for successful inclusion in Multicultural Schools”  
Reference: 621461-EPP-1-2020-1-ES-EPPKA3-IPI-SOC-IN

This project has been funded through the support of the Erasmus+ program of the European Union.

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Many ideas in this guidebook, including structure and content, have been inspired by, remixed and taken directly from open resources created by the MIT Scratch team (directly extracted from <https://scratch.mit.edu/>) and from the guide: Brennan, K., Haduong, P., Williamson, M. A., Peters, L., Smolevitz, S., & Yu, B. (2021). *Getting unstuck: An intermediate Scratch curriculum to support design studio culture in the classroom*. Creative Computing Lab. Retrieved from <https://gettingunstuck.gse.harvard.edu/> and the Creative Computing Curriculum: <http://scratched.gse.harvard.edu/guide/curriculum.html>



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Several other activities have been inspired from other sources. These are referenced accordingly in the activity description.



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## What is this guide about?

This guide aims to unite two worlds that were born in different time periods, and that developed and evolved in different ways. These two worlds are:

- On the one hand, **Montessori Pedagogy**, which began in Italy in the early 20th century, developed by Dr. Maria Montessori, and that was based on her experiences with children at risk of exclusion in the slums of Rome. She based her ideas on respect towards children and on their impressive capacity to learn. She postulated that independence should be our main educational goal and that children must be given freedom of choice to develop their full potential. This educational methodology is now known all over the world and there are thousands of schools that implement it.
- On the other hand, **Creative Computing**, which covers the interdisciplinary area at the cross-over of creativity and computing, is an educational trend that has its roots in learning theories such as *Constructionism* or in movements such as *Maker Education*, both of which were developed mainly since the 1970s, thanks to pioneers such as Seymour Papert, who explored ways to use technology to promote creative learning, and to transform technology into a medium of expression that would give children a voice. Current concepts such as *Computational Thinking* or *STEAM* methodology are based on these ideas.

The idea of the MonTech project was to explore the connection points between these two worlds, a priori separated, as traditionally the Montessori methodology has not given much importance to digital technologies, and Creative Computing has developed independently of any particular pedagogy. The project was inspired by a question: ***If Maria Montessori were alive today, how would she use technology in the classroom, with children and teachers, without betraying the principles of her methodology?***

This teacher's guide attempts to answer this question practically: through real activities, designed by experts in both fields, aiming to be loyal to the basic principles of both Montessori and Creative Computing.

Moreover, just as the Montessori methodology was originally designed to help poor children from disadvantaged backgrounds, the MonTech project and this guide are designed to help especially multicultural schools, with children at risk of exclusion. The guide offers materials and methods to help teachers in elementary schools foster social inclusion and equity in these multicultural classrooms. To do that, MonTech proposes highly innovative and engaging activities based on a new approach that combines the Montessori method with cutting-edge learning experiences based on Creative Technologies and Maker Education.

This guidebook offers **a collection of activities for children from 6 to 12 years old** (or in some cases also for older children) to work on topics related to technology, in a

cross-curricular way, and following the most important Montessori principles of auto-education, hands-on learning, and freedom of choice. It must be noted, however, that although the guidebook is written with those principles in mind, this is not an official guide to the Montessori Method, and all activities described in the guide can be implemented in mainstream schools.

The proposed vision of technology in this guidebook, with special emphasis on coding, is to perceive digital technologies as tools that can give "superpowers" to children. Technology is seen as a universal material, with which children can express themselves creatively, make their voices heard, create their own projects, and while doing all that, connect and develop "powerful ideas".

The proposed activities are very diverse, designed to fit in classrooms and schools of very different contexts. Some activities are "**plugged**" (using computers or digital devices) but others are "**unplugged**" (using very simple materials or even the children's own bodies and school spaces). Some of them are designed to be carried out with the whole class, while others are intended to be implemented with small groups of children, while the rest of the class works autonomously.

The activities in the following chapters propose a wide range of actions, such as storytelling, spreading seeds of curiosity, promoting children's active work, and encouraging children to keep a reflective journal. It is suggested that teachers combine presentations, demonstrations, and challenge children with "hard fun" activities, promoting children's autonomy and freedom. Teamwork is promoted, as well as individual work. Moreover, in this approach, feedback is very important, and children are encouraged to learn to give and receive feedback, and to reflect on it. All the proposed activities give special importance to characteristic Montessori elements, such as the stories and the journal.



## Who created the guide?

The MonTech guide was developed through a research-practice partnership.

The guide was co-designed by members of UdiGitalEdu from University of Girona (Spain) who have expertise in Creative Technologies and Maker Education [Jordi Freixenet, Eduard Muntaner-Perich, Maria Berrocal, Marta Peracaula, Meritxell Estebanell], and with teachers from Escola Montessori Girona (Spain) [Kamila Bertlik, Eduard Vilanova, Laia Rovira, Alexandra Lafuente] and Waterpark Montessori International (Ireland and Norway) [Sarah Kennedy-Berge, Aleksandra Zarosa, Nicole Hermann], both organisations experts in the Montessori Method. We also received feedback, advice, and review from Dr. Colin Isham (UK).

The guide is also co-designed and classroom-tested by a set of teachers from European multicultural primary schools from Bulgaria (Petya Tsvetkova, Ani Angelova, Milena Simeonova, Simeon Tchukanov, Petya Petrova, Vesela Ruseva), Romania (Delia Pirvu, Norica Cioaca, Cristina-Eugenia Codita, Simona Stefania Chirita, Antonela Silvia Dan, Laura Eliza Stancu, Mihnea Alexandru Stancu), Greece (Georgia Adriotou, Dimitra Volika, Aspasia Matthaiou, Efstathios Zachariadis, Fotini Eleftheriou, Vasiliki Apostolopoulou, Anastasios Kesidis) and Spain (Adrià Bernat Camacho, Carme Gutiérrez, Berta Francesch, Bibiana Núñez, Beatriz Pérez and Patrícia Gonzalez).

We also relied on the collaboration and ideas from Adele Bracci from University of Bologna (Italy), and students Berta Espona, Roger Feliu, Souhayla El Boughlami Boukkhada and Júlia Ruiz from University of Girona.

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Several other activities have been inspired from other sources. These are referenced accordingly in the activity description.

## Preliminary – what did the teachers say?

Before we started to think about what this guide would look like, we consulted with over 300 teachers from multicultural schools in Bulgaria, Greece, Romania, Spain and Turkey. We were interested in their concerns and needs with regard to teaching diverse student groups and use of technology. Teacher priorities were language and communication, behaviour, emotional well-being and integration more generally. Engaging parents and associated cultural barriers were also highlighted. We also asked teachers about their use of technology to understand starting points and where the project would be introducing innovations.

We have used the outcomes of the teacher consultation to design this guide, and highlight below how MonTech practice addresses each of the priorities explored in the consultation.

### Communication and language in the classroom

For many teachers, developing students' communication skills, especially when the language of the classroom is not their first language, is a particular challenge. In our guidance on how to run a session (page 15), we highlight the importance of small group interaction between teacher and students, with plenty of questions, focus on key concepts and invitation to solve problems. Working at a small group level, the teacher can target language use to where the students are in their language development. We also highlight the importance of children describing what they are doing, which for second language learners has the added benefit of providing an opportunity to develop oracy skills. Activities included in this guide specifically relevant to language development include:

- Grammar variables and Scratch as a language
- Activities relating to the concept of conditionals
- Activities with visual stimulus which reinforce language instructions
- Activities which encourage students to produce visual representations of concepts (e.g. loops, randomness and watercolours)
- Activities which encourage students to produce audio representations of concepts (e.g. synchronicity and parallelism: body percussion)

### Behaviour

The guide highlights the key features of the Montessori method which promote positive learning behaviour. We describe in detail, for example, the purpose and use of the design journal (page 16). This helps students be clear about what they are doing and why, and so focus more on activities and goals. How teachers provide feedback to engage and motivate students to learn is also critical for positive behaviour. On (page 18) you will find guidance and a demonstration of how to do this effectively.

## Student integration

The integration of students from different backgrounds is best served through activities which promote peer-to-peer collaboration and communication. MonTech provides many opportunities for this, through its advocacy of small group work, Scratch as a learning tool (chapter two), and collaborative interaction in many of the activities described in this guide.

## Emotional well-being

Interest in students' mental health has increased as a result of the disruption to their lives caused by the pandemic, but also their exposure to disturbing and aggressive behaviour online. For refugee children, there is the added trauma of their journey and the situations they are fleeing. The Montessori approach – particularly the guidance on giving feedback (page 18), and allowing students to take control of their own learning– provides a particular framework of care and predictability, where children can feel safe. Building positive relationships with peers is also an outcome of the many collaborative activities contained in this guide.

## Use of technologies

There is already widespread use of technologies in schools, electronic and otherwise. However, some are used more than others. The use of computers and interactive whiteboards are now part of standard classroom practice, along with traditional engagement with craft materials. Digital animations, computer games and courseware are also growing in popularity, but remain to be utilized by the majority of teachers. Less frequently applied technologies include coding, robotics and making and tinkering. Uptake of these technologies is particularly supported by MonTech, and activities promoting their use can be found in, for example:

- The use of Scratch (chapter two)
- Loops: discovering micro:bit
- Loops, randomness and art with Scratch
- Music and conductivity: electric guitar with micro:bit and Scratch

## How is this guide organised?

The guide consists of three chapters, and each one containing different types of activities from which to choose. Each chapter includes resources and activities to help students create self-directed projects in response to a specific prompt.

An introduction precedes the three chapters and establishes the methodology of the MonTech workshops. It provides practical pedagogical information about the proposed learning activities, what we call projects, such as their structure and principles, specifically: pupils' organisation, students' responsibilities, teachers' role, the importance of the journal, giving feedback and Scratch in this Guidance Book for teachers.

The first chapter is the “Story of Technology”. It is a story that will serve as a reference. The idea is that the teacher tells this story with passion and feeling, creating a suitable atmosphere to engage the children. There is a secondary follow-up story on the history of computing which can be used as a further lesson.

The second chapter is called “Fundamentals of Creative Computing” and is an introduction on how to use the Scratch environment following Montessori principles. These key concepts are used as a basis for cross-curricular activities.

The third chapter is called “Incorporating Technology across the Curriculum” and offers different examples, all with plugged and unplugged activities, balancing learning with and without screens. This includes activities that can be related with coding concepts (events, loops, conditionals, synchronism, parallelism, or variables) or applications in technology (sound & music, colours & light waves, communication, time, simple machines, circuits & electricity) that can be found in chapter three.

Our intention is to equip teachers with the skills to reinterpret, adapt, or inspire their own learning activities. We hope that you remix and reimagine these activities, as well as include activities you are excited about from other sources—whatever works best for you and your students!

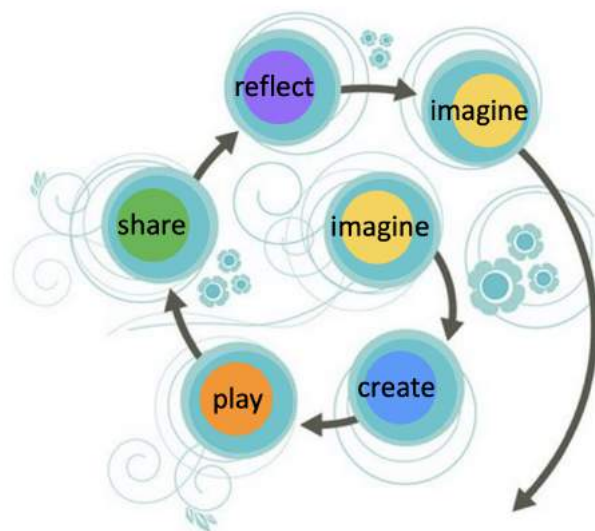
The examples of workshops presented in the guide have been tested and have worked well in schools with different cultural contexts in the partner countries.



# What kind of learning activities will you find in the guide?

Children 6-12 love projects when based on exciting stories, interesting facts and opportunities to research (Healy Walls, 2008)<sup>1</sup>.

This guide is mainly about projects. The activities in each module are designed to help students create projects that are unique and matter to them, while exploring a particular tech concept. This work is supported through the creative learning spiral with activities of exploring, creating, playing, sharing, and reflecting.



Spiral of creative thinking according to M. Resnick (2007)<sup>2</sup>

In this guide you will find a collection of activities (**imagine, create, share, play, reflect**) of all kinds, plugged and unplugged, and suggestions to work with the whole group or in small groups.

These terms are the ideas taken from Resnick (2017)<sup>3</sup> and “The Getting Unstuck Guide” (Brennan et al., 2021)<sup>4</sup> and are defined as follows:

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<sup>1</sup> Healy Walls (2008). At the Heart of Montessori II: Core Principles in Action

<sup>2</sup> <http://web.media.mit.edu/~mres/papers/CC2007-handout.pdf>

<sup>3</sup> Resnick, M. Lifelong Kindergarten: Cultivating Creativity through Projects, Passion, Peers, and Play (The MIT Press)

<sup>4</sup> Brennan, K., Haduong, P., Williamson, M. A., Peters, L., Smolevitz, S., & Yu, B. (2021). *Getting unstuck: An intermediate Scratch curriculum to support design studio culture in the classroom.*

## imagine

We propose to start the activities and workshops by imagining. This can be promoted in different ways. One that is closely linked to Montessori principles is to use a “*spark*” to ignite the children's imagination. This spark can be a story (in many of our workshops, short stories are an important part of the beginning of the activities), or a demonstration, a video, music, Scratch projects, etc. This spark is proposed by the teacher or educator right at the beginning of the activity with the idea of inspiring children and sparking their imagination.

Another possibility (following a spark or during an activity) is to directly ask the children to imagine what they are going to create/build during the workshop. For example, in an art and coding activity, they could start by imagining the artwork they would like to code.

Having these spaces to imagine, not only at the beginning of the activity, is very important. And it is also important to give space to “*re-imagine*”. That is, when they have iterated through all the phases of the activity, they can reimagine how to improve what they have created or reimagine new projects from what they have just made.

## create

After imagining, since we are promoting active learning, all the proposed activities containsome phase to create/build/construct, where children learn by doing, touching, experimenting through hands-on experiences. This part is directly connected to the philosophy of Constructionism, that is, the idea that children create knowledge in their minds while they are building something with their hands.

*Create* activities can help students develop their vision through planning, get started by remixing a project, and use strategies to make progress when they encounter challenges. These activities support student progress in a variety of collaborative configurations: from one-on-one support, to small group coaching, peer support, or moments of whole group instruction.

## play

Playing is much more than having fun. Quality playtime does not involve just interacting with an object or a toy but also designing, creating and exploring with it. Furthermore, its true essence relies on experimenting, taking risks, trying new things and testing the boundaries. But if the act of playing is valuable, even more is its intrinsic attitude or state of mind: *playfulness*, because curiosity, imagination and experimentation are considered the ingredients of creativity.

Therefore, let the children play with artefacts and projects they make themselves, but also with artefacts created by other teams. For example, if it is a workshop that includes Scratch, let them play with a curated collection of Scratch projects to get inspired and intrigued. Make them wonder how they work and explore them. Give them time to enjoy creating their own. Display classmates’ projects and motivate children to teach others how to play theirs.

## share

Sharing work and receiving feedback from peers are key practices, fueling the motivation students will draw on as they develop their projects. Feedback can serve as a learning source (see pag 19), a way to improve projects, or as affirmation of work done so far, as well as inspiration for what to do next with projects.

This sharing process can take place at many different scales. Children can share within their team, with other teams in their class, with other classes, and today thanks to the Internet, with the whole world (e.g. sharing a Scratch project online).

The guide includes a variety of structured protocols to help students share their work and offer each other constructive criticism, both synchronously (e.g., through paired face-to-face conversations) and asynchronously (e.g., through Scratch's online comments system).

## reflect

There is no learning without reflection. By reflecting on their project and their process, students can develop critical and reflective attitudes towards their own work. Students' projects do not necessarily have to be finished or flawless for students to draw connections between what they have made and what else they want to learn.

“The secret of good teaching is to regard the child’s intelligence as a fertile field in which seeds may be sown, to grow under the heat of flaming imagination. Our aim therefore is not merely to make the child understand, and still less to force him to memorise, but so to touch his imagination as to enthuse him to his inmost core. We do not want complacent pupils, but eager ones; we seek to sow life in the child rather than theories, to help him in his growth, mental and emotional as well as physical, and for that we must offer grand and lofty ideas to the human mind, which we find ever ready to receive them, demanding more and more.”<sup>5</sup>

## Workshops

In this guide, we refer to our activities as workshops. We like the word ‘*workshop*’, which is both a place where things are created and a gathering of people intensely engaged in a discussion or activity. This connects us with the ideas of the Maker Movement, and in our case, even more specifically with Maker Education.

In a workshop you learn through hands-on activities, collaboratively, through trial and error, and iterating from prototypes that are then refined and improved. In other words, it is project-based learning (PBL). The work within a workshop is also closely linked to Tinkering, another very interesting term from an educational point of view. Some of our activities have been inspired by projects from the Tinkering Studio in the Exploratorium (San Francisco).

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<sup>5</sup> Maria Montessori, *To Educate the Human Potential*, 1989, p. 11, Clio Press, Oxford

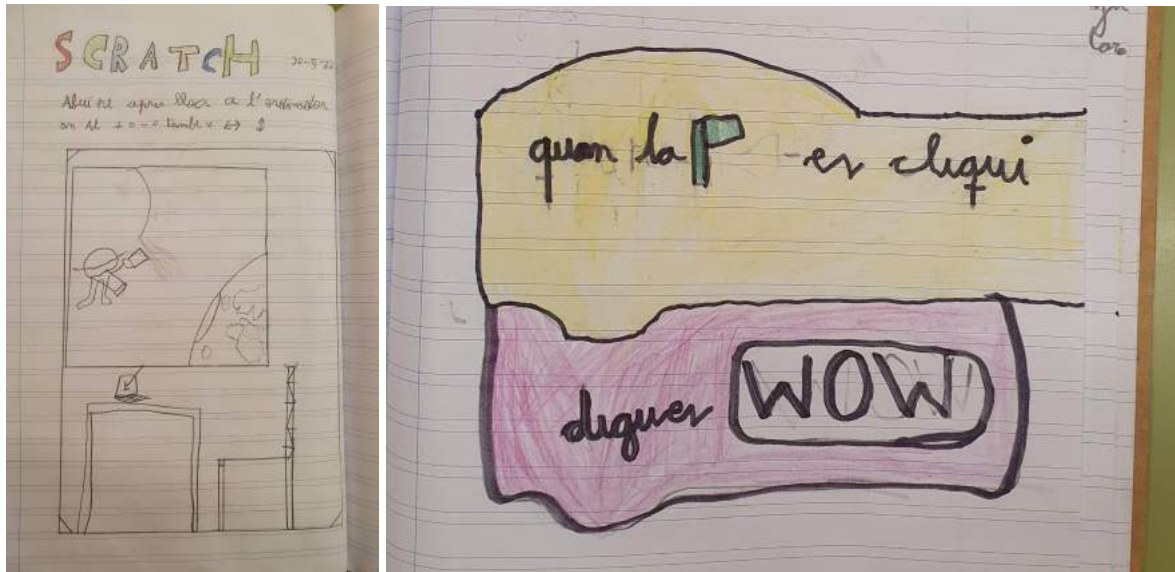
## Sessions

Based on the practice of the Montessori Method and on the feedback from teachers in multicultural schools (that it is particularly important for the teacher to be able to attend to children in small groups) we strongly recommend offering various activities (**imagine, create, play, share, reflect**) of all kinds, plugged and unplugged, and try to work for as long and as often as possible with small groups of children. This means that the teacher sometimes addresses the whole class, but spends most of the time working with a small group. In the Montessori approach the different types of sessions can be identified as: 1- story telling and exemplifying content to the whole group, 2- teacher presentations introducing learning material to a small group (instructional learning to guide the students through the first steps) and 3- autonomous work of students in small teams or individually (learning through discovery). In the case of learning through creative technologies, this could be an example of how to structure a session:

- **THE WHOLE CLASS:** The teacher starts the session by addressing the entire class. He or she tries to **spark** the children's interest with an inspiring story or anecdote, by presenting a project, or through an unplugged activity. In the Montessori approach, this would be equivalent to the time dedicated at the beginning of a session to tell a story such as the one of the great stories or its derivation. The teacher finishes this part preparing the students to keep working autonomously by suggesting a small variety of activities / options to choose from, so that children in teams of 2 or 3 can investigate and work independently. He or she allows the children to choose according to their preferences, giving time to the children to **imagine** (maybe seconds, maybe some minutes), and then letting them explore, **create**, and work independently. Instruction cards / hand-outs for the different activities can help students to work independently.
- **SMALL GROUPS:** While the children work independently in teams, call on a small group of children (4-6 children) to present a particular activity. Explain a key concept to the small group with a demonstration, asking lots of questions, and encouraging them to solve a problem. Challenge them to work independently in a follow-up activity. Spend 5-10 minutes with this small group. When finished, call on another group of children.
- **THE WHOLE CLASS:** Towards the end of the session, gather all children together again. Ask for feedback and reflections from each of the groups. What have you been working on? What have you discovered? Invite children to reflect and record activities in their journals.

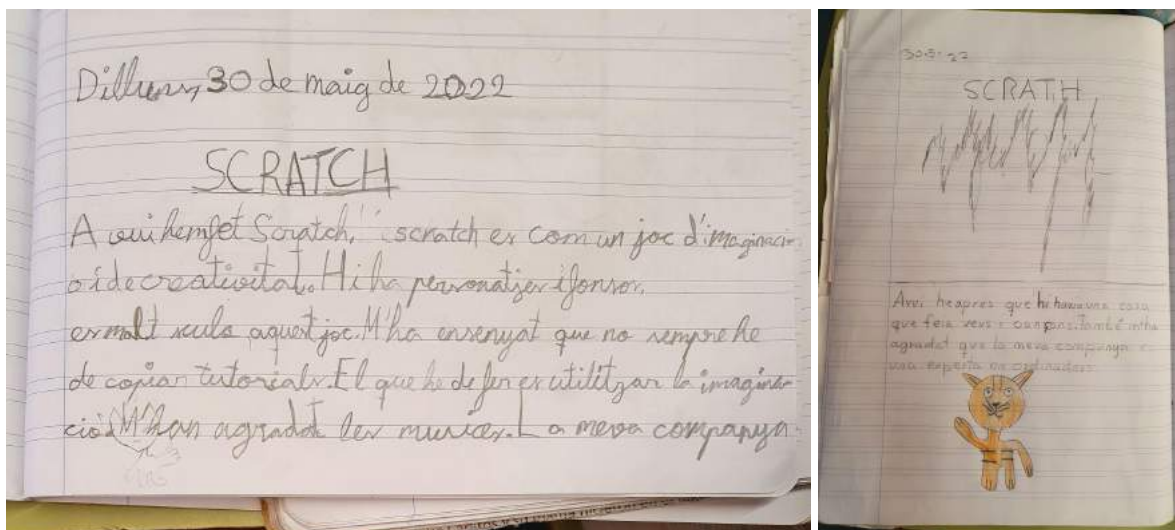
There are many ways to structure a MonTech activity, depending on how long and how often you see your students. Given variability from classroom to classroom, each activity allows space for you to choose how the activities should be organised. For example, you can plan for three 1-hour sessions on consecutive days, a full morning, or a theme project that spans a month. Remember to, as Maria Montessori said, follow the child.

## Special focus: Journal



In a Montessori classroom, special focus is placed on self-responsibility for learning, and therefore students are shown how to **plan and document** their learning and this becomes part of the daily routine. This occurs on many different levels, from creating a day plan for what they will work with and which lessons they will participate in, to keeping a logbook or a diary / journal of their daily lessons and work.

*A logbook is a tool used by the student for keeping track of their work, planning their independent work time, keeping track of long-term project work, and also as a tool for reflection.*



As students work, they are able to see their progression, ensure that they have completed work as needed, and continue to plan based on these reflections. It also is an accountability tool, which can be used in discussions with the teacher on the student's progress, work habits and other topics that might arise. The logbook is a very useful tool for long-term project work as it helps students to stay focused, stay on schedule, plan the next steps, and work toward a goal. It also gives a concrete basis for discussions and feedback as the student works on a project.

**Design journals** - In the guide you will find activities that will make reference to the design journal, and will propose students to go to the design journal (it can be a simple notebook) to plan, sketch, brainstorm, draw, give feedback and reflect. For example, students can write down what they liked about a project, draw characters before going to the Scratch graphic editor, or give feedback to a peer about their project.



The design journal will be a collection of student activity that shapes the learning experience and can be used as an essential design studio tool. Design journals support students in thinking about their progress throughout the learning activities, and they help them see, understand, and support that progress.



## Special focus: Feedback

In this guide, we refer to feedback as a practice that will help children learn. It is not just saying that they like or dislike something. It is about analysing, observing meticulously, and saying “in a certain way” how a drawing, a work, a presentation or a project, can be improved. That particular way of “saying things” matters.

The following video of Ron Berger of EL Education gives an excellent example of what feedback is, and how to implement it in the classroom (we strongly recommend watching it with your students):



<https://vimeo.com/38247060>



**Austin's Butterfly: Building Excellence in Student Work**

More from EL Education  
 Autoplay next video

Ron Berger (2014)<sup>6</sup> describes feedback as a practice for

- 1) Building a mindset of continuous improvement;
- 2) Instilling responsibility and ownership of learning;
- 3) Contributing to collaboration and a culture of safety.

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<sup>6</sup> Ron Berger, Leah Rugen, Libby Woodfin. (2014). Leaders of Their Own Learning: Transforming Schools Through Student-Engaged Assessment. EL Education

He proposes developing a positive culture for critique and descriptive feedback: an essential starting point is ensuring that the guidelines **be kind**, **be specific**, and **be helpful** are the backbone of the class.

So, how is feedback to be given?

- **Tone:** how words are used matters a great deal in giving effective feedback
  - Effective tone: be positive, be constructive when critical, make suggestions not prescriptions or mandates
  - Ineffective tone: finding fault, describing what is wrong but offering no suggestions, punishing or denigrating students for poor work
- **Clarity:** understandable and user-friendly
- **Quantity:** choose priority points
- **Focus:** feedback can focus on work or tasks, as well as communication and presentation skills, giving new ideas, examples or tips to help improve

In this way, it is going to be an objective of this guide:

- 1) for children to learn how to give and receive feedback (to make it effective it has to be kind, specific and helpful)
- 2) to realise how powerful feedback is, because it helps you to improve, it helps you to learn.

Feedback can also be built into activities, materials and programs, allowing children to correct their own mistakes and improve their work independently, without an adult's interference. Dr. Montessori called such feedback "Control of Error". The control of error becomes a point of interest in itself. It encourages concentration and promotes good self-esteem. Mistakes are seen as natural in the process of learning.

"If we are to thread the narrow path of truth and keep our hold upon reality, we have to agree that all of us can err; otherwise we should all be perfect. So it is best to cultivate a friendly feeling towards error, to treat it as a companion inseparable from our lives, as something having a purpose, which it truly has."<sup>7</sup>

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<sup>7</sup> Maria Montessori, *The Absorbent Mind*, Chapter: Mistakes and Their Correction, 1988, p. 225, Clio Press, Oxford



## Important messages to teachers

- ❖ It is important not to impose the same activity for the whole group. Children should be working on different things - we should try to offer a range of activities to children and respect their choices.
- ❖ Remember that results are not important. The important part is the journey, the process. Do not stress the need to finish, do not worry about diversions. Slow learning can be deep learning.
- ❖ Respect the child's concentration. Do not interrupt when you see children working independently, focusing on the task. Stand back and observe.
- ❖ Encourage children to show and tell what they are doing, to share the problems, to communicate with each other, to help and learn from each other.
- ❖ Do not answer questions directly, let the students discover for themselves. The answer to "How do I do this?" can become "What do you think this button does?"
- ❖ Do not touch keyboards, don't touch a single mouse unless you are asked. Let the students do everything. "Help me to do it by myself!" is a main Montessori motto.
- ❖ Give constructive feedback and encouragement to all the students, highlighting progress. Allow children to find and correct their own mistakes. Errors are so interesting!
- ❖ Encourage children's internal motivation by allowing them to work on what really interests them. Create an atmosphere of joyful learning experience.
- ❖ Encourage children to collaborate in pairs or in groups of 3 or 4 children, but respect if they choose to work alone.

## Pedagogical considerations

This guide is about technologies, but not in the strict sense of covering that area of the curriculum. We understand technologies as **a powerful and transversal tool** (like a pencil). In this view, computers are not here to replace books, cardboard, or brushes, but to **complement** them. We propose a set of activities to engage children in the process of learning, but foremost, what we want is for children to enjoy learning and to be conscious of it, to learn to listen, to empathise and to work in teams, to have original ideas and to carry them out, to be aware that they have a voice that others want to listen to. In short, this guide aims to help teachers to design creative learning experiences, and to use the tools of our world to create things.

Maria Montessori believed that music literacy was an element of culture that children ought to learn. She wanted us to teach all children to read music. Music performance should not be just for talented people and artists. Music belongs to us all and should be used as a creative medium (Healy Walls, 2008)<sup>8</sup>. Today, in the 21st century, we see clear parallels in the arguments that Maria Montessori defended at that time with regard to music, with today's technology and coding. This new language is not only designed for children who want to be engineers, but rather a skill that all children deserve to learn.

The guide we put forward does not intend to be a ground-rule to follow. Its purpose is to be **a collection of resources** that helps to work on some key concepts of children's learning. Even though some of these principles require the previous achievement of others, they may have been introduced in another situation, and pupils could have already acquired them. In this case, teachers should feel free to skip or alter these ideas as it is suitable for their students. Moreover, it is convenient to understand that it is unnecessary to proceed with the presentation order of the sequence extended hereunder.

The concepts included in the guide are coding concepts presented in chapter two (events, loops, conditionals, synchronism, parallelism, or variables) and applications in technology (sound & music, colours & light waves, communication, time, simple machines, circuits & electricity) that can be found in chapter three.

These have been chosen as likely to facilitate the comprehension of other related principles and can be a basis or starting point for further exploration.

The resulting collection gathers examples that illustrate how to focus on teaching with a methodology influenced by the Montessori Method and Creative Thinking boosting Technologies.

Although technologies are not required for some of the suggested lessons or activities, they are for others. Furthermore, the different tasks complement each other to help children internalise ideas from observable concrete situations to increasingly abstract ones.

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<sup>8</sup> Healy Walls (2008). At the Heart of Montessori II: Core Principles in Action



We recommend always observing the pupils and being prepared to present a concept based on their interest at the time and their skill level. This will take advantage of their **inner motivation**, their degree of receptivity is greater, and learning is more effective and significant. With this work, based on students' interest to solve problems or attain a goal that they have set themselves, grasping the principles will be better and, consequently, easier to apply in other contexts. As a result, learning will be more comprehensive and transferable.

In addition, teachers may create situations by asking questions or providing challenges. Conducting children to realise something they might have previously ignored awakens their craving for knowledge. At this moment, pupils will be more responsive, and it will be the ideal time to introduce the resources in the way explained in this Teacher's Guide or similarly.

Our aim is that the proposed activities trigger students' **imagination** and invites them to embrace their own creative projects. Therefore, teachers will have to consider to what extent the lesson plans present an achievable objective for their pupils. The activities should be adapted to the student group. This does not mean teachers always have to revolve around children's previous knowledge or what other adults have taught them before. Rather, **new challenges** should be seen as opportunities to walk on unexplored paths together without keeping to the known. It should not be strange or scary for students to see that teachers are not familiar with everything. In this way, they can venture into fresh experiences hand in hand, and other colleagues can give solutions to their doubts.

The proposed activities in this guide are not set in stone and do not have to be replicated identically. This guide aims to be an inspiring collection of examples adjustable to pupils' characteristics, classroom situations and teacher methodologies. It is intended to be a **starting point** for using creative technologies within the various areas in the curriculum. However, it is by no means comprehensive. We encourage practitioners to continue to add to this resource for their own classroom!

## Why is Scratch so important in this guide?

This guide is not only about Scratch, as it contains some other affordable creative computing tools (like **micro:bit**, **Makey-Makey**, **Edison robot**) and many unplugged activities, but Scratch will often be the reference and central element of the guide.

[Scratch](#) is a programming language and online community that makes it easy to create your own interactive stories, games, and animations—and share your creations online. As young people create and share Scratch projects, they learn to think creatively, reason systematically, and work collaboratively, while also learning essential mathematical and computational ideas. Young people around the world have shared more than 40 million projects on the Scratch website, with tens of thousands of new projects shared every day. Scratch was designed and developed at the **MIT Media Lab**, in a research group called Lifelong Kindergarten.



[Lifelong Kindergarten](#)

The tool is designed for children (although it is also used by many adults) and has a deep pedagogical grounding linked to **Constructionism**.

### Why is Scratch especially suitable for multicultural schools?

The advantages of Scratch as a tool are that it:

- is online and free, you don't need to install any special software to start creating.
- can be downloaded and used without internet connection.
- is multiplatform and works on computers as well as tablets and mobile phones.
- is available in many languages.
- allows intuitive learning through discovery and exploration.
- can be used to create digital stories, games, artistic projects, simulations, etc.
- allows the sharing and mixing of creations via the Internet.
- gives access to a huge community.
- is easy to start creating projects (low floor) while allowing advanced users to create complex projects (high ceiling) offers a wide range of activities and foci for learning (wide walls).
- allows the mixing of different media, digital and also traditional.
- has extensions for playing with music, giving voice to characters (recording or text-to-speech), and connecting the story on screen with the outside world (sensors, robots, etc.).



Scratch can be used in both primary and secondary education, and there is also a version called Scratch Jr that is ideal for early childhood education or for children who cannot read yet.

Because it is translated into multiple languages, it can be used in schools in different countries, and is especially useful in multicultural schools, where different teams may be programming their stories in different languages within the same classroom.

Although the main target of the tool is children, teachers and families can be co-participants and beneficiaries.

## Application across the curriculum

Scratch is not only designed as a tool to teach programming, but as a programming environment that can be used in a cross-curricular way. It doesn't matter if we are in a language class, a maths class, an art class or a science class. Scratch allows us to create stories, games, artistic projects, simulations and a long list of projects where the disciplines are mixed and interconnected.

When we use Scratch for Digital Storytelling, children are learning a language (writing the story script and dialogues), learning art (while drawing the storyboard, characters and backgrounds), technology (programming the animation and movements), global citizenship (because they interact with children from other countries), etc. In addition, they develop skills related to creative thinking, critical thinking, teamwork, curiosity, empathy, and more.

## Resources and technology requirements

All we need to use Scratch is a computer (or tablet) and an Internet connection. In the event that we do not have an Internet connection, instead of using the online version, we can use a downloadable version.

In order to do digital storytelling with Scratch, in addition to computers and an Internet connection, it is advisable (although not required) to have traditional materials such as pencils, markers, paper, cardboard, scissors, etc. In this way, we can create crafts and drawings that can later be photographed (or scanned) and inserted into Scratch as characters and/or backgrounds.

## Practical things

If this is your first experience with Scratch, you can feel confident because the Scratch team and the entire community of Scratch educators have developed educational materials that will help you along the way.



We strongly recommend the Scratch for Educators page (<https://scratch.mit.edu/educators>), where you will find resources, guides, ways to connect with other educators, and also information on how to get a teacher account.

This may be the first time that your students are being asked to use their own Scratch login, or to share a project and add it to a class studio.



The Getting Unstuck people have created how-to Scratch logistics pages ([https://docs.google.com/presentation/d/1XIQErSPXJH1xzVzLRTLbMgva9a9FNdDhK1n3sjitRZQ/edit#slide=id.ge43fef63bc\\_2\\_74](https://docs.google.com/presentation/d/1XIQErSPXJH1xzVzLRTLbMgva9a9FNdDhK1n3sjitRZQ/edit#slide=id.ge43fef63bc_2_74)) that may be helpful to you and your students: how to create a studio, how to share a project to a studio, how to fill in a Scratch project page, how to give credit, and how to give feedback. Additionally, here are some Scratch-related questions you might consider:

**Scratch Accounts:** What accounts will students use? Will they be student-created or teacher-created?

**Username:** How will you help students keep track of their usernames and passwords?

**Sharing Projects:** Have you created a studio (or studios) for the modules you'll be teaching? Have students added projects to a studio before?

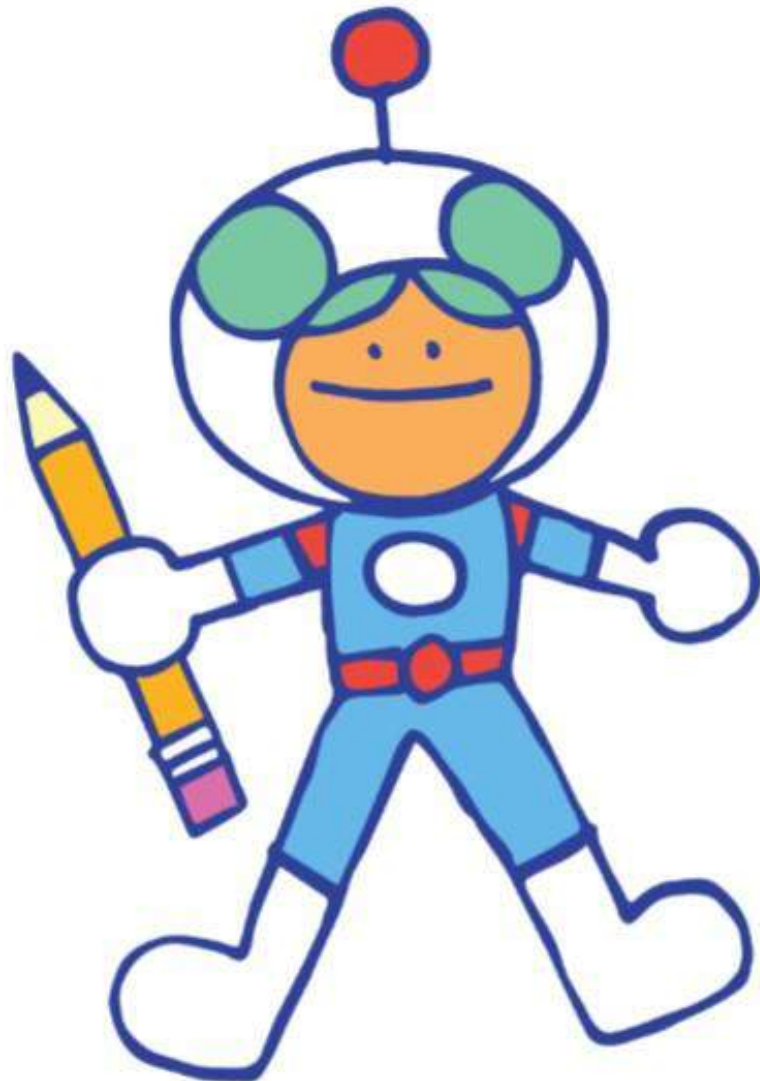
**Scratch Community:** How comfortable are students in completing their project pages (e.g., *Instructions, Notes and Credits*)? How familiar are students with searching the Scratch community for resources and inspiration?

**Digital Citizenship:** How comfortable are students in offering respectful feedback online? How comfortable are students in giving credit to sources that inspired them?





# Chapter 1: The Great Story of Technology



# Engaging Your Students Through Storytelling

Storytelling has been a part of the human experience since the very beginning and the tradition of oral communication should be kept alive in our classrooms. Storytelling in the classroom is a unique method of not only conveying information to students but as a way to create a dialogue about a certain topic and connecting the students to the learning in a way that activates the *spark*, the imagination. The storyteller creates a drama and engages the students in the experience.

Using storytelling as a method to present a new concept or topic is a tried-and-true tool for Montessori educators and emphasis is placed on the Great Lessons – a sequence of stories that present the full curriculum to the students. In this guide, we present several stories as tools to ignite the *spark*, to inspire the students' imagination, priming them for deeper learning experiences. Stories are highly effective in engaging the students, helping them to personally connect or identify with the curriculum. To that end, we include the following tips for using stories in the classroom:

- Make time for stories! They are a powerful instructive tool.
- Any story requires planning and preparation. If you use objects or pictures, make sure you have everything you need within reach. You should also consider creating a special atmosphere for the story – set the stage! You can decorate the room, use music, special lighting, etc.
- The teacher must become a dramatic actor – boring stories will not captivate the students' imagination!
- Connect to your students while you are telling a story. Make eye contact. Ask questions of the students and ask for their ideas where it fits. This way, you know you have their attention. Storytelling is the art of captivating active listeners.
- Do not put too many facts in the stories – you should include enough to activate them but leave room for questioning!
- Ask open-ended “curiosity questions”. We want to inspire curiosity in the students, so do not give them all the answers. There should be enough open questions in your stories that activate the “wonder” and allow them to explore later.
- When students ask questions, try to answer simply, but encourage them to explore on their own. “That is a really interesting question. Let’s research that together later and maybe we can find out more.”
- Most importantly, storytelling is a skill, and like all skills, requires practice! Make time to practice. Remember that the stories don’t have to be long, and you can always have notes on hand. With time and practice, you will feel more comfortable telling stories and it will be a fun and effective learning experience for you and your students.

The following section is generously shared with the MonTech project by Montessori Norway.



A timeline of technology for use in the Montessori classroom<sup>9</sup>

## Introduction to the Story

“This then is our task, to gather the highest discoveries that have been made in the sciences, to render them clear and fascinating, and offer them to childhood.”

(Maria Montessori, *Creative Development in the Child, Volume Two*, p. 263)

“The animals are at rest once their needs have been satisfied. In Man hunger and cold were sources of activity for the mind as well as the body. Once these had been satisfied the body was satisfied, not so the mind. To the mind they gave suggestions, inspirations, problems. And these are for the mind what cold and hunger are for the body. They give no peace until they are satisfied. Even when bodily hunger has been satisfied and warmth restored, the mind still continues to produce ideas. These gave Man no rest, until by bodily striving he had created a workable reality of what his mind has imagined.” (Mario Montessori, *The Human Tendencies and Montessori Education*, p. 37)

“The next time you glance down at your phone to check what time it is or where you are, the way you might have glanced at a watch or a map just two decades ago, think about the immense, layered network of human ingenuity that has been put in place to make that gesture possible. Embedded in your ability to tell the time is the understanding of how electrons circulate within cesium atoms; the knowledge of how to send microwave signals from satellites and how to measure the exact speed with which they travel; the ability to position satellites in reliable orbits above the earth, and of course the actual rocket science needed to get them off the ground; the ability to trigger steady vibrations in a block of silicon dioxide – not to mention all the advances in computation and microelectronics and network science necessary to process and represent that information on your phone. You don’t need to know any of these things to tell the time now, but that’s the way progress

<sup>9</sup> The timeline is pictured in this document. If you wish to know more about the timeline, please contact Montessori Norway: [post@montessorinorge.no](mailto:post@montessorinorge.no)

works: the more we build up these vast repositories of scientific and technological understanding, the more we conceal them. Your mind is silently assisted by all that knowledge each time you check your phone to see what time it is, but the knowledge itself is hidden from view.” (Steven Johnson, *How We Got to Now: Six Innovations that Made the Modern World*, p. 154-155)

Children today almost inevitably become frequent users of digital technology like mobile phones and computers, as well as the games and social platforms that these devices make possible. For Maria Montessori, it was important to be able to adapt to the era in which you live, but in a way that makes you able to do this without succumbing to it. One way she envisaged this was through giving children what she called a “cosmic education”, which is the term she used for a way of teaching and learning that takes as its starting point the bigger pictures, both geographic, including the Earth and the whole universe for that matter, as well as historic, as it’s so easily forgotten we’re a product of that history. How can we give children a somewhat complete picture of the technological development that runs as a common thread throughout the whole of human history? And for that matter, why is this such a central goal in our work? As Montessori teachers, these are central questions that have a meaning way beyond what we personally might think about the current technological development and its influence on children.

As already said, according to Maria Montessori, one of the most important tasks as teachers is to help the children understand themselves and the society they inhabit from a historical perspective. Not only does this create a stronger interest for many aspects of society, it could also potentially give us a different view of ourselves and our role in the big picture. This is of course a perspective one might take without going to Montessori’s ideas for support, but it’s interesting to see if any new old insights can be gleaned from Montessori herself.

“What is necessary is that the individual from the earliest years should be placed in relation with humanity. [...] The child will have the greater pleasure in all subjects, and find them easier to learn, if he is led to realise how these subjects first came to be studied and who studied them.” (Maria Montessori, *To Educate the Human Potential*, p.17)

“There is a need for a syllabus which can give an understanding of the conditions of man in modern society with a cosmic vision of history and the evolution of human life. What purpose would education serve in our days unless it helped man to have a knowledge of the environment to which he has to adapt himself.” (Maria Montessori, *The Formation of Man*, p. 11)

During the spring and summer of 2018, a small working group organised by Montessori Norway tried to arrive at some principles, guidelines and questions for discussions that can help us as Montessori teachers and schools reach a more nuanced stand on digital technology. This concerns things like smartphones and computers, but also the more general question of the role of technology and the opportunities it offers. The result of this work is a short set of guidelines that has as its foremost goal to offer some questions and arguments that will make it easier for us to think through these questions, while staying within and

making use of the Montessori framework.<sup>10</sup> One thing that appeared especially important to us was to offer these bigger historical vistas, where phenomena and events are placed into a bigger context, what Maria Montessori called “cosmic education”.

With this goal in mind, we have developed a timeline of the history of technology and an accompanying story.<sup>11</sup> The goal of this story and timeline is to make it easier for Montessori teachers to approach the history of technology in a way that aligns with the pedagogical principles we strive to follow and develop. The story overlaps with and develops further many of the themes we find in several of the existing big Montessori stories, and is intended as a continuation of these. We return to our own history, going all the way back to the first humans and the tools and discoveries they made. The story is centred around how we continually have been seeking new ways of meeting our fundamental needs, with ever new versions of old ideas and solutions, as well as the discoveries of completely new ones. The story also emphasises how these developments are connected and intertwined, containing the unimaginable masses of people who have worked untiringly for a very long time, only to then often discover something completely different from what they started out seeking. Finally, it also focuses on all the ways that technology influences us, often in unpredictable ways, sometimes slowly and unnoticeably, sometimes so quickly that we’re not even perceiving the changes until they have happened.

The story is not meant to convey a mass of historical facts but aims rather at telling the children about human ingenuity and the development of new tools and other technologies. The children will hear examples about how technology changes how we work, see and hear and remember, how we relate to other people and communicate, how we move around, how comfortable we live, how long we live, to mention just a few possible themes. Since all timelines and general presentations could be called a kind of an abstraction, a visual presentation such as this one is also an example of what Montessori called “materialised abstractions”. According to her, this term could be used for those things that as objects create an outer material support for the imagination of the child, i.e. an aid for imagining things that you wouldn’t be able to imagine without such support.

The goal of telling this kind of story, and this is hopefully something that surfaces in discussions with the children during and after the presentation, is to create a stronger awareness of how technology, from the fire to the wheel, the printing press to the telegraph and so on, changes the way we humans relate to each other, how we organise society and what we are capable of doing. It covers some of the same history as other stories, with a different focus, supporting the children in asking different questions. For Maria Montessori, technology was always something that could arouse our curiosity and amazement, a result of the great work of uncountable known and unknown people, a work that we today are in debt to as we enjoy the possibilities today’s technology offers us.

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<sup>10</sup> Resulting in the digital strategy “Montessori and the development of Technology”, with a story and timeline.

<sup>11</sup> The timeline is pictured in this document. If you wish to know more about the timeline please contact Montessori Norway: [post@montessorinorge.no](mailto:post@montessorinorge.no)



The story should be seen in relation to the many other stories and activities that are already in use, and should be seen as a supplement to these. The story of the coming of life and the early humans, the long black strip and the timeline of the hand, as well as man's fundamental needs and mutual dependence, are all presentations that outline themes that make part of this story. Just like all of these presentations, this story is meant to be used with children from around six to twelve years of age, and the length, focus and amount of detail can be adjusted according to need. Such stories do not need to have any definite follow-up work, but it can be useful to have some questions and themes on hand for further exploration after the presentation. Some such themes are briefly mentioned following the story in this document. There is also a list of books that have been used for the work with this timeline.

*"The most important inventions don't have an inventor."  
(Jürgen Kaube, Die Anfänge von allem, s.13)*

The timeline is a simple visualisation of a little part of a much bigger history, and many details have been left out to make it understandable. There is nothing about the place of origin for the different technologies, and no exact dates are given. This is mainly because human technologies are products of a certain person at a certain time only as an exception. Most technologies develop very slowly without us humans even being fully aware of much of this development, and geographical location and reasons for this geographical dissemination are mostly only available through indirect and uncertain methods, through archeological evidence.

The goal is to give the children a feeling for this development, and we do not really want to give them the impression that we know the details of this story any better than we actually do. It is also of course possible for those children who become extra interested to investigate some technologies or epochs more in detail, but even then they will often reach a point where the most updated science will yield nothing but informed guesses to their questions.

## The Story of Technology

Where do ideas actually come from? How are new things made? Have you ever had a good idea, maybe something you made because you suddenly had this cool idea floating around in your head? Where did this idea come from? Did it come from you, or maybe something you had seen?

It's very hard to know for sure how humans long ago arrived at their ideas, how they made the things they made. Maybe they looked at the animals and got inspiration from them? If you have seen a bird fly, maybe it's a bit less hard to imagine being able to fly yourself? But how do you do that, I mean, flying? It would take a lot of ideas for us to get there. And having observed a beaver fell a tree and build quite advanced dams, maybe a human thought: "Hmm, maybe I could invent a way to fell trees and make my house out

of the logs?” Oh yes, there are even monkeys who use stones as tools, to crack hard nuts, so that they can eat the delicious nuts inside. But sending humans to the moon, how in the world did we think of that?

What is at least certain, is that humans have made many inventions. Maybe it’s just like that, we humans like inventing things? And the world around us isn’t exactly easy to live in, is it? We would so much like to stay warm, dry, find food and water, and keep ourselves and the ones we love safe.

Scientists are not quite sure about when it happened, because there are no books or stories that are that old, but a very long time ago we humans made one of our first, but also maybe our most important, discovery: we discovered fire, and we learnt to control it. It’s hard to say just how we did this. Maybe we arrived somewhere where lightning had started a fire, or maybe we hit some special rocks together and sparks flew and ignited something? Even though it seems weird to us, this must have been really hard to discover. Many humans lived their whole life without fire, and many of them surely lived their whole life never managing to create the fire they once saw. Maybe some humans managed to use fire once, and never again?

But little by little we got better, and children learnt to make fire from their parents and grandparents and the other humans around them, and children must have played with fire since they were little, I’m sure of that. But we had no books and no teachers, and it surely happened that some groups of people died out and all their knowledge and skills were just forgotten like that. But humans around the world continued practising and exploring, and we made better stone axes and other tools that we used for hunting and making clothes, and we used tools to make more tools. Just think about what new things you can make if you can make a really good stone axe.

Humans travelled around looking for food, they dug in the soil for edible roots, they found berries and nuts, they caught fish and land animals. Some of them settled where the fishing was good, these were maybe the first humans that settled somewhere permanently. As you may know, humans first travelled out of Africa and slowly but surely spread across the globe, and we survived thanks to cooperation and inventiveness. We made warm clothes and lit fires, to be able to survive in colder climates. It seems that humans can adapt to almost anything, because if we arrive in initially uninhabitable areas, maybe looking for food and resources, we just struggle even harder to find a way to be able to live there, and make even more inventions.

As I’ve said already, we humans used our hands for work, we used our head for thinking out new ideas and solutions, and we used our heart, our cooperation and love to be able to live and thrive together, notwithstanding all the difficulties and hardships. We started cultivating the soil, we made ploughs and millstones, we figured out how to keep livestock, measure the earth and keep track of time and things. As time went on, our ploughs became better, we made tools out of iron and bronze, we invented more names and number systems to keep track of things and make our thinking even more powerful.



We also started exchanging goods, and somehow symbols of value, like money, were invented, and we could buy stuff from one another. Why would you spend all your time making a bad iron plough if your neighbour is a good blacksmith who can make a much better plough in much less time? Just think about what it means for people to be able to buy stuff and labour from one another – what kind of invention that is.

So, as you know, humans have done some quite amazing work throughout history, and there are no books that are thick enough to tell the whole story. But we can think with gratitude about all these men and women who had worked and worked, scratching their heads and struggling to make something, and finally succeeded. Maybe they invented something completely new, based on some crazy idea that popped up in their head, or maybe they just made some really smart improvements to some tools they already had. Maybe we've heard about them, or maybe they never got the honour they deserved for having done such incredibly difficult work? The world is so full of inventions and human inventiveness that you'll never be able to make a list that contains all of that.

(rolling out the timeline)

Here you see a little selection of things that humans have made during our history. Some of them we might have talked a lot about, like letters and numbers, and these are almost like superpowers that let us write down and tell other people about the discoveries we make. We have also talked about agriculture and food, about housing and light, clothing and music. In all of these areas, our needs and our curiosity pushed us toward making further inventions and discoveries.

Maybe you see something in the timeline that you know about already, that interests you, something that means something extra for you, or something you've never heard about. Behind every one of these technologies there are thousands of humans that have worked and thought and struggled to make things work, and failed again and again before some of them finally succeeded. Most of them we'll never hear anything about. Still, there are more than enough people we could learn more about, and if we look a bit closer, we'll discover that people are often much more interesting and ingenious than we might first think.

For every invention we make we reveal new opportunities, something that used to be impossible is suddenly possible. Once the sea was a dangerous place where only the bravest of the brave dared go, now we go out on the sea on beautiful summer days, and we send big ships with thousands of containers across all the big seas. Humans used to have to use the sun and the stars to know where they were, but then we invented the compass and drew maps and made lighthouses and satellites that can see where we are, and we can find our way even when it's dark and foggy. A hundred years ago it could take weeks for a letter to reach some other part of the globe, but today a message to a friend in Australia arrives just as quickly as a message to your neighbour. Humans living thousands of years ago would have thought we are wizards, and honestly, it's quite amazing the things we're able to do.

Can you imagine a world without mobile phones? How would such a world look? What about the world without the internet? Maybe a world without cars, what would we lose then? Maybe we'd be forced to invent something else instead? What if there were no books, and no internet either, how would we humans be able to learn much in that case? Once, humans weren't even able to write. Just think about that, once there was not a single human being who could speak. No one came and taught them anything, but we sat around, thinking and grunting, and little by little making up words and languages. Much later, we figured out how to write down these sounds we were making and still make sense of what a person had been thinking. And when we finally had all of that, it probably became easier to think up even more stuff. New thoughts appeared in our heads, and we kept on investigating and testing all kinds of crazy stuff. Some surely found all of this a bit scary, maybe they didn't like that all the silly things they said were written down and remembered for so long. But it also made it possible to remember so much useful stuff, and we started collecting knowledge in a new and systematic way. This made even more new ideas possible. So, which ideas do you think these humans had, and what problems were they trying to solve?

In the last few hundred years we've just become more and more humans here on Earth, and this is surely in a large degree thanks to all of these inventions we've talked about and that you see depicted here. How have these inventions changed the lives of humans in ways that make it possible for even more of us to live together? What new difficulties have we discovered that we are thinking about and working and struggling to solve today? Which inventions do you think we'll make? Which problems would you like to work on and try to solve?



## Sources and literature

Here are some books that have been used in the work with this timeline and story, as well as some books that might prove useful if you want to know more about the subject. For a good collection of nice stories about the history of technology, check out Steven Johnson's *How we*

*got to now*. This book also exists in a version adapted for young readers and have been made into a six part documentary series.

Michael J. Dorer, *The Deep Well of Time. The Transformative Power of Storytelling in the Classroom*, Parent Child Press 2016

George Dyson, *Turing's Cathedral. The Origins of the Digital Universe*, Vintage 2012

Yuval Noah Harari, *Sapiens. A Brief History of Humankind*, Harvill Secker, 2014

Steven Johnson, *How we got to now. Six innovations that made the modern world*, Penguin Books 2015 (finnes også i forenklet versjon for unge lesere, på engelsk)

Jürgen Kaube, *Die Anfänge von allem*, Rowohlt 2017

Kevin Kelly, *What technology wants*, Viking press 2010

Maria Montessori, *Creative Development in the Child, volume two*, Kalakshetra Press, 1998

Maria Montessori, *To Educate the Human Potential*, Montessori-Pierson Publishing Company, 2007

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Francis Sejersted, *Er det mulig å styre utviklingen? Teknologi og samfunn*, Pax Forlag 2002

Mario Valle, *La pedagogia Montessori e le nuove tecnologie. Un'integrazione possibile?*, Il leone verde 2017

- This story and the content for the timeline was written by Lars Sandåker, Montessori Guide, on behalf of Montessori Norway (National Montessori Association in Norway).
- The timeline is beautifully illustrated by Marianne Karlsen.



<https://mariannekarlsen.no/>

- The complete strategy document “Montessori and the development of technology” was written by Montessori Norway in collaboration with a working group consisting of Montessori guides from all levels; 0-18.

This story is a sub-story of the Story of Technology, developed in the context of the MonTech project. It is meant as a deeper look into a specific section of the timeline of technology and can be told with its own timeline of computing.

## The Story of Computing

Do you remember how we looked at how technology developed? We discussed a very important invention that helped with so much of the technology that developed over many thousand years. Numbers!

We don't know exactly when or where numbers were invented, but we know that about 5000 years ago they began to be used in Mesopotamia and Egypt. Since then, we humans have used numbers as a tool that has opened up a world of possibilities, allowing us to do an infinite number of different things. The need to make calculations using numbers made humans start to imagine systems and tools to help in that task.

Shortly after the discovery of numbers, Mesopotamians invented the abacus, the first mechanical counting device of all time. Its effectiveness has certainly passed the test of time, and it is still in use in many parts of the world, almost 5,000 years later.

For many centuries the abacus, with minor variations, was the only machine we had for counting and mathematical calculations, although we had gradually begun to invent devices for other types of calculations, such as counting time or astronomical calculations.

It was not until the beginning of the 16th century that **Leonardo Da Vinci** imagined a mechanical adding machine. That dream did not come true until the 17th century, when **Blaise Pascal** created a mechanical calculator (the Pascaline), capable of addition and subtraction. In parallel, in the same century, **Gottfried Wilhelm von Leibniz** created another mechanical device known as the Universal Calculator, which, apart from addition and subtraction, could also perform multiplication, division and square roots. These devices, incredible as it may seem, were entirely mechanical, and data was entered by changing the position of several gears, manually.

From this point on, inventions related to computing machines began to accelerate. A major leap was made by **Joseph-Marie Jacquard**, in the early 19th century, when he created a loom, still in use today, that could automatically reproduce weaving patterns by reading information encoded in patterns of holes punched in pasteboard cards. The cards



were punched strategically and placed in a certain sequence to create a particular weaving design. To change designs, it was necessary to prepare a new collection of cards.

The idea of punched cards greatly influenced **Charles Babbage**, who in 1816 conceived his Analytical Engine, which can be considered a true nineteenth-century prototype of the computer. Essentially, the Analytical Engine was a multi-purpose calculator with the ability to operate differently depending on the problem at hand, i.e., something very close to a general-purpose computer. The programming of this machine had to be performed by punched cards, and **Ada Lovelace**, a collaborator of Babbage who had participated in its design, described in her writings some algorithms to program the machine, being considered, thanks to this, as the first programmer in history.

The control of electricity made it possible to make another great leap forward, and from then on, calculating machines became electro-mechanical. **Alan Turing** was a brilliant English scientist, who among many other things formalised the concepts of algorithm and computation with his Turing Machine, an abstract machine that served as the theoretical basis for modern computers. Turing is also considered one of the fathers of Artificial Intelligence, and his participation in the cryptanalysis team at Bletchley Park was key to deciphering the encrypted messages of the German Enigma machine, shortening World War II and saving thousands of lives. That team built machines such as the Bombe and the Colossus, true predecessors of today's computers.

From this point on, the golden age of computing began, creating an acceleration in which we are still in the midst of. Among the great inventions made since then, we can highlight:

- IBM's Mark-I computer (1944). It had 760,000 wheels and 800 km of cable and was based on Babbage's analytical engine.
- The ENIAC computer (1946). It was a thousand times faster than its electro-mechanical predecessors and had the capacity to perform 5,000 arithmetic operations in one second. Nevertheless, the machine weighed 30 tons and covered a space of 450 m<sup>2</sup> (it filled an entire university basement).
- The EDVAC computer (1949). John von Neumann laid the foundations for the architecture of modern computers, and participated in the construction of this computer, which allowed something new and revolutionary: data and instructions to coexist in memory, thus allowing the computer to be programmed in a language.
- Fortran (1956). The oldest commercial programming language, designed at IBM.
- Personal computers: Altair 8800 (1975), Apple II (1977), IBM PC (1981).
- Internet (1969), HTML (1989) World Wide Web (1990).
- First laptop (1980), first smartphone (1992).
- Facebook (2004), first iPhone (2007).

# Chapter 2: Fundamentals of Creative Computing

<https://scratch.mit.edu/studios/31932136/>



<p align="center"><b>WORKSHOP 1:</b> <b>Kidbot - First Contact with Coding</b></p>	<p align="center"><b>Unplugged</b></p>	<p align="center">Ages 6-12</p>
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<p>In this activity, children are going to discover what a program is and the concept of a sequence of instructions, writing programs, and executing programs. A child will play the role of the robot.</p>	<p><b>Aim</b></p>	<p>Engage the children to think about robots, intelligence, and what is the language of robots</p>
	<p><b>Materials</b></p>	<p>Digital blackboard to project a YouTube video Paper and pencils</p>



## imagine (unplugged)

The teacher creates an atmosphere in the classroom (dimming the lights) and projects the following music video (Kraftwerk - The robots). The teacher asks the children to dance freely as if they were robots (move like robots). The teacher dances like one of them.



[https://youtu.be/D\\_8Pma1vHmw](https://youtu.be/D_8Pma1vHmw)



After some exercise, the teacher asks students to define what a robot is, and after listening to their responses, presents some instances and questions if children can name all the robots that participate in their daily life, from the time they wake up until they go to sleep.

This conversation can be extended by talking about intelligence, asking children if they think robots are intelligent, or if we can define intelligence. You can ask if a monkey is intelligent, and for what reason. The same with ants and mosquitoes, dolphins and elephants - what makes animals intelligent? Who is more intelligent, an elephant or a mosquito? Who is more intelligent, a child or an ant? Can a robot be intelligent? Let the children discuss and present their ideas and doubts.

The teacher can explain that a robot can do things automatically with precision and can have some intelligent behaviours. The teacher can give the example of the Roomba® robot.

Roomba® is able to discover a world by building a map of the room (or two rooms, or a floor) and detect when the batteries are low, return to the base to recharge the batteries, and it moves through its world, tries to go through all the places, discover all the spaces and vacuum at the same time, so it does its job accurately (cleaning).

Finally (it is important not to miss this step), the teacher asks the children what the language of robots is. How we can tell a robot to do something.

### create

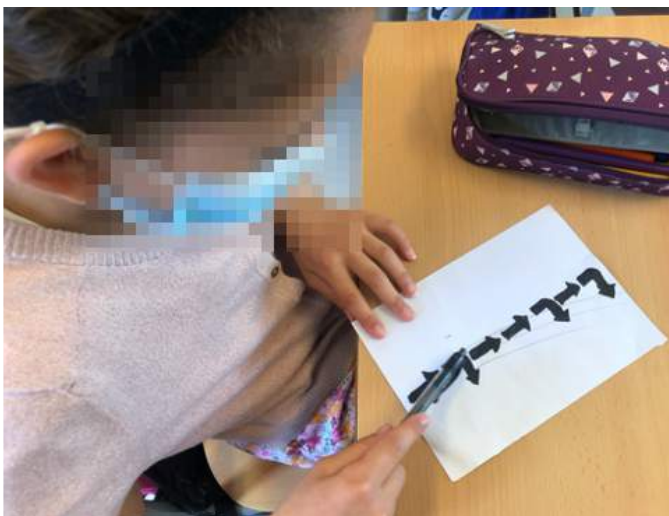
The teacher presents three instructions to the children, drawing arrows on the board. Each arrow is an instruction. The up arrow is the instruction that tells the robot to take a step forward. The right arrow tells the robot to turn right (you can explain that it turns 90 degrees, depending on the children's knowledge - it is simply a matter of showing the teacher that if this arrow reaches the robot, it turns right 90 degrees). The same with the left arrow.

Then the teacher explains that one child will play the role of the robot and between the two of them they will program it. This is done by writing one instruction after the other. This is writing a sequence of instructions.

The teacher gives a demonstration. He writes the sequence (drawing on the blackboard): "up arrow", "up arrow", "right arrow", "up arrow". It is a program of 4 instructions.

Then she asks for a volunteer to act as a robot, a "kidbot". She loads the program into the robot's hands and touches (as if pressing a button) its head gently. The kidbot moves one step forward (executes the first instruction: "up arrow"), one step forward (second instruction), turns right (third instruction), and one step forward (fourth instruction).

After this demonstration, the teacher divides the children into teams and asks them, to program the kidbot to make a square. The teacher can use a chair for the kidbot to complete a lap of the chair (see image below).



## play

### share

After this first challenge, children can do multiple things, like set up a circuit setting a second challenge, invent instructions (jump, grab with hands, talk, repeat, etc...), dress the kidbot with cardboard, or/and build a helmet. This activity can also be very interesting to introduce conditionals: *if* this condition happens *then* do this action. Suggest to a group of children to program their kidbot in a way that uses conditions.

You can also extend this activity to work on some important practices. For instance, children can also swap programs, and have the different kidbots in the class run programs that their classmates have made.



All these activities can be done in the classroom or in the playground (or in any other space).

## reflect

Before finishing this workshop, give children time to reflect on what they have been doing. You can ask questions to the whole class, or let the children write down what they think they have learned in the notebook. You can ask again the questions we posed at the beginning, about whether robots are intelligent.

A good way to reflect on the activity is to use the journal to individually test the programs or invent new ones. The student can draw a grid on a page and use a button or a token as a robot. Using instructions written in the same journal, the student can make the robot move around the grid.



<p style="text-align: center;"><b>WORKSHOP 2: Discovering Scratch</b></p>	<p style="text-align: center;"><b>Plugged / Unplugged</b></p>	<p style="text-align: center;"><b>Ages 6-12</b></p>
<p><b>Activity description:</b> This magical presentation and its follow-up activities <b>address pupils with little or no previous experience in coding</b> in order to <b>get started with Scratch</b>. With the materials provided, you will encourage students to <b>explore this powerful tool by themselves</b>: the interface parts, the characters (sprites), the scenarios (backdrops) and the instruction blocks and their categories. Meanwhile, they discover the different ways of <b>learning and working on a project</b>.</p> <div style="display: flex; align-items: flex-start;"> <div style="margin-right: 20px;">     </div> <div> <p>Overall, this activity aims to show <b>Scratch as a language</b> (programming language) that allows a <b>wide range of possibilities</b> for children to <b>express themselves and share their voices</b>. Strongly influenced by Montessori principles (<b>control of error</b>) and materials (<b>Montessori Grammar</b>) this lesson plan is inspired directly from open resources created by the <b>MIT Scratch team</b> (directly extracted from <a href="https://scratch.mit.edu/ideas">https://scratch.mit.edu/ideas</a>) and from the <b>Creative Computing Curriculum</b> designed at Harvard, which we suggest you examine for more ideas and variations to introduce Scratch to children: <a href="https://creativecomputing.gse.harvard.edu/guide/">https://creativecomputing.gse.harvard.edu/guide/</a></p> </div> </div>		

We recommend you bring this workshop to your lesson to **focus in on the computing age after narrating the *Great Story of Technology*** (Chapter 1).

You will find different kinds of activities according to the learning styles: instruction vs discovery. Be aware: tutorials are a very useful tool for pupils' learning, but we should not be tempted to use them as the only tool. In the Montessori approach, materials and how to use them are introduced to students through presentations, where the teachers demonstrate the use through examples. This gives a reference point for the students to start discovering by themselves, which leads to reflection, creation and sharing. Every student needs to do this on his/her own path, and some students need more guidance than others to start working independently, although all students must reach this point for significant and deep learning.

The analogy to the "Montessori presentations" when learning through creative technologies are the tutorials and demonstrations. They can be the starting point to propel the students to the discovery phase. Depending on their learning style, some students will feel more secure practising for a long time with demonstrations, tutorials and Scratch cards before reaching the discovery phase. For other students, a lengthy instructional time can be detrimental to maintaining their interest; they need to start learning by discovery just after having received some sparking clues on the activity.

On the other side, there will be children who prefer to discover, learning without tutorials or Scratch cards. But to start discovering, we recommend the activity "10 blocks challenge" (from the Creative Computing guide, pg. 30), because this activity invites them to discover

how a set of 10 instructions work ("only 10"). In a way, the teacher sets the stage for the child to experiment and discover. But instead of leaving the child alone in front of a vast of the sea, the teacher prepares the environment for the child to start discovering a smaller space. This runs parallel to the Montessori concept of *isolation*.

Although there are children who prefer instructions and others who prefer to discover on their own, our recommendation is that everyone tries everything, and that the teacher offers the different options, materials and activities, so that the children can choose which path to follow.

In the following section, we propose different ways (paths) to inspire children, to let them imagine, create, play, share and reflect. You may choose different activities **or create your own combination (to inspire children, to propose that they create from tutorials, or scratch cards, or learn to discover)**. Observing your class group, as well as individual children, you can find (or test) which options work best. For instance, you can start with a story about the Scratch instructions and interface, finish it with an unplugged demo (imagine - option A), and then switch to the computer for a plugged one (imagine - option B). Finally, give children missions to discover Scratch on the computer by themselves. As you will see, you can choose among different options, creating the combination that suits your children better.

## DISCOVERING SCRATCH

Pick a **start** based on the needs of your class age group:

<b>Imagine option A: story (recommended for 6-8)</b>
<b>Imagine option B: Scratch Demo (recommended for 6-12)</b>

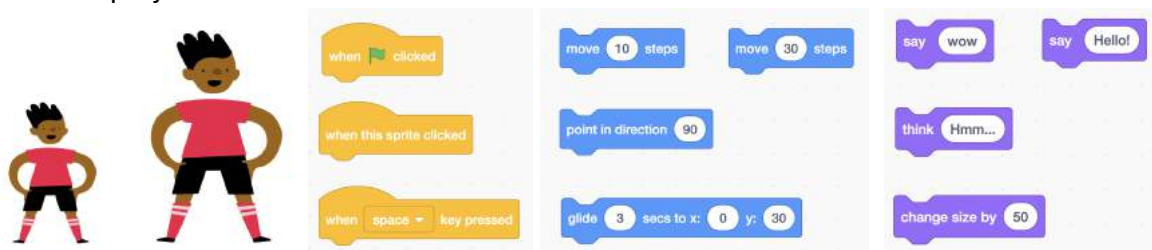
Choose between different **Follow-up activities** and/or combine them:

<b>Missions with Scratch cards</b>	<b>Scratch tutorials</b>	<b>10 blocks challenge</b>
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### imagine option A (unplugged)

#### Materials:

- Printed story characters in colour and large size (Ben and the instructions should measure about 20-25 cm, find them on the shared Drive), cut out and laminated
- Printed *Scratch interface* puzzle (paragraph 2)
- Computer with Scratch access
- A projector



The **teacher** tells the whole class a **short tale about instructions (unplugged)** using **one or two printed sprites** (at least Ben) and **a few instruction blocks** (2-3 for each category, from now on, families). Review the activity proposed materials. The following story could be an example as it **describes the Scratch interface**, presenting the **basic knowledge required for Scratch users to begin creating projects**.



*There is a world in which instructions and characters, called sprites, live. On one side of the world, live the instructions, and just on the other side live the sprites. In the middle there is a playground where they play and have fun together.*

*The instructions are very orderly. All the instructions are different. Each one does something different. But there are some instructions that are sisters because they do similar things. For example, the blue instructions belong to the blue family. Here we have three sisters who are very brave because they are very strong, they run and move with agility (showing them). All these blue instructions live in the same house. Just below this house, lives the purple family (showing them). The purple instructions are very smug and always take care of their appearance, and they also think and say things. A little further down lives the family of the yellow instructions. Here we have two sisters (showing them), who are characterized by the fact that they always sleep, but from time to time, when something happens, they wake up suddenly and then the action starts.*

*Just as in a football or basketball team, no one instruction is more important than the others. The instructions have different skills and when they do things together, they can be very powerful. They are all very important at one time or another.*

*In this world all the instructions are very friendly. Sometimes for fun they connect with each other, becoming a sequence of linked instructions known as a program. The order in which they are connected is very important, because one instruction always goes first and then the other. The one that goes first, makes this thing go first. And then the other one. A program is a sequence of connected instructions.*

*And always, always, the first instruction in the program is an instruction from the yellow*

family. When this instruction wakes up, then it wakes up all the instructions in its sequence.

This is Ben (showing them). He is a sprite. He lives here. All the programs that are in the playground belong to Ben. One program makes Ben do things. For example, this program (showing the program) makes Ben move 10 steps every time the green flag is waved, and then Ben says hello, and then Ben says, “wow”.

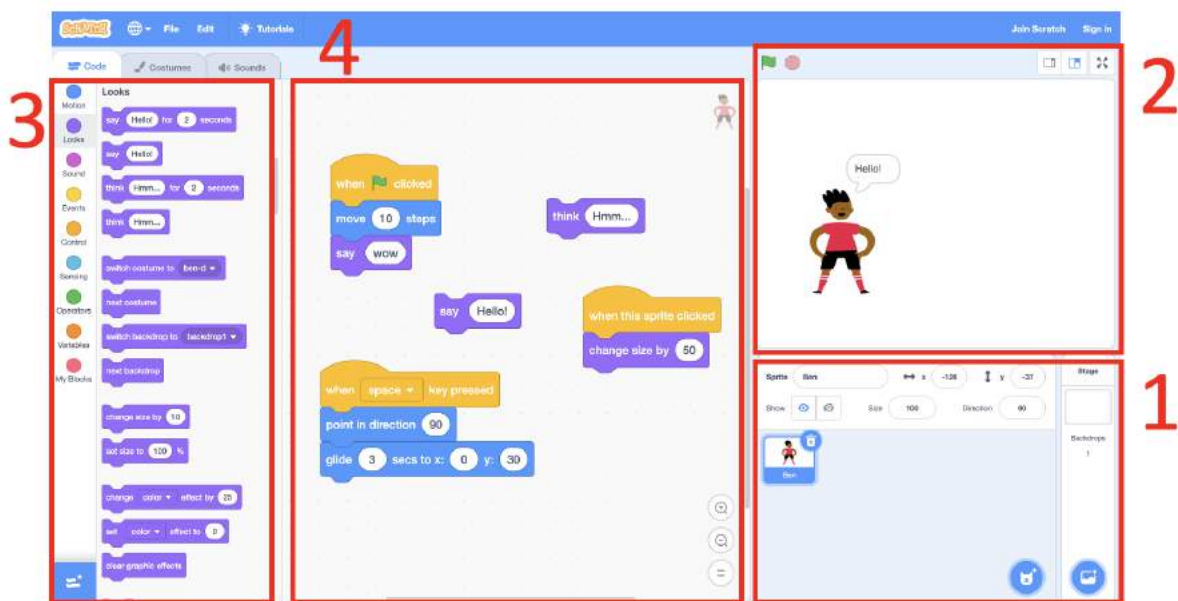
Let's look at another example: ...

And then the teacher can put together a sequence of 4 instructions, and interact with the children, asking them what they think this program does.

### imagine option B (plugged)

The teacher shows the Scratch interface. It's a show for the whole class. A window with Scratch connected to the internet needs to be projected on the whiteboard.

Start with a short, live demo explaining the different parts of the Scratch window, highlighting four main areas: 1) the area to define and create sprites and backgrounds; 2) the place where all action happens (where we can see sprites doing what programs says); 3) the place where the instructions are located; and 4) the area for programming the actions of all the sprites (the playground).



In relation to area (3), we show how when we click on the blue house (button) all the instructions of this family appear, and how when we click on each of the buttons (differentiated by colour), a set of instructions appears next to it.

We also show how we can drag an instruction to the scripting area and see what happens when clicking on the piece, for instance with the instruction “move 10 steps”.



Additionally, we can show a 1 minute video to introduce Scratch:  
<https://scratch.mit.edu/about>

Then it is time for children to discover things by themselves in an independent way. One of the options could be that the teacher gives missions to small teams that cover different ways of exploration, instruction and discovery. Let's put some magic and playfulness into this whole process. Here we propose the follow up activity Missions with Scratch cards.

<b>Follow-up Activity: Missions with Scratch Cards</b>	<b>Plugged</b>	<b>Ages 6-12</b>
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**Material needed:**

Mission envelopes, Scratch Cards, computer with access to Scratch.

**imagine**

The teacher has prepared envelopes with instructions for the teams (missions). In each envelope there will be instructions and opportunities to explore and discover. In every envelope there will be a mission and a set of Scratch cards (different for each mission). Scratch cards are materials prepared by MIT that offer a very interesting way of learning. On one side, there is a visual representation of what is going to happen in Scratch, and on the other side of the card, the Scratch instructions to do it are shown.

## create (plugged)

### play

During this activity the teacher-guide goes to every group encouraging participants to discover by trying things and click on instructions and see what happens. We also encourage participants to tell other participants what they have discovered.

In the mission they will have to explore, learn, and at the end reflect on the whole process in the design journal. It is important that the teacher tells them to keep track of time. The last ten minutes will be for the design journal, and they should share what they write.

**Recommendations:** It is very important that before handing out the envelopes the teacher tells the children that teamwork is very important in this mission, that they should take care of each other, that they should work with the laptop, but that everyone should have keyboard time, that it is not enough for one to work and the others to watch. Also, remind children that if they are going to use sound, they should connect headphones. Laying with music and sounds in Scratch is great fun, easy, and strongly recommended, but children should use headphones so as not to disturb the rest of the class.

Mission X:

Hello team \_\_\_\_!!! (invent a team name)

Welcome to the learning experience with Scratch!

You have in your hands a collection of Scratch cards. Your mission is to explore them. You will see that they are diverse, and there will be opportunities for each of you to take control of the keyboard. You must cooperate and learn from the cards. But we also recommend that you explore things. Let your curiosity guide you. There is no danger of breaking anything in the program. We encourage you to drag an instruction to the script area, click and see what happens. We encourage you to link two, three and more instructions and click on the group to see what happens.

Scratch cards (available in different languages):



Scratch cards:

<https://resources.scratch.mit.edu/www/cards/en/scratch-cards-all.pdf>

You can find Scratch cards in many different languages.

## reflect

### share

After the exploration, the teacher asks the students to share and reflect in their design journal on one of the following:

- 1) Draw or write in the design journal something that surprised them
- 2) Draw or write something they learned from/with a partner.

At the end, we ask some of them to share their reflections with the whole group. This is a class exercise, where we ask for the attention of the whole group. We also emphasise that the important thing is to learn to listen to each other.

Alternatively, if sharing with the whole class does not work, you can propose that they share what they have drawn/written in the journal in groups of two children from different teams.

<p><b>Follow-up Activity: Scratch Tutorials</b></p>	<p><b>Plugged</b></p>	<p>Ages 6-12</p>
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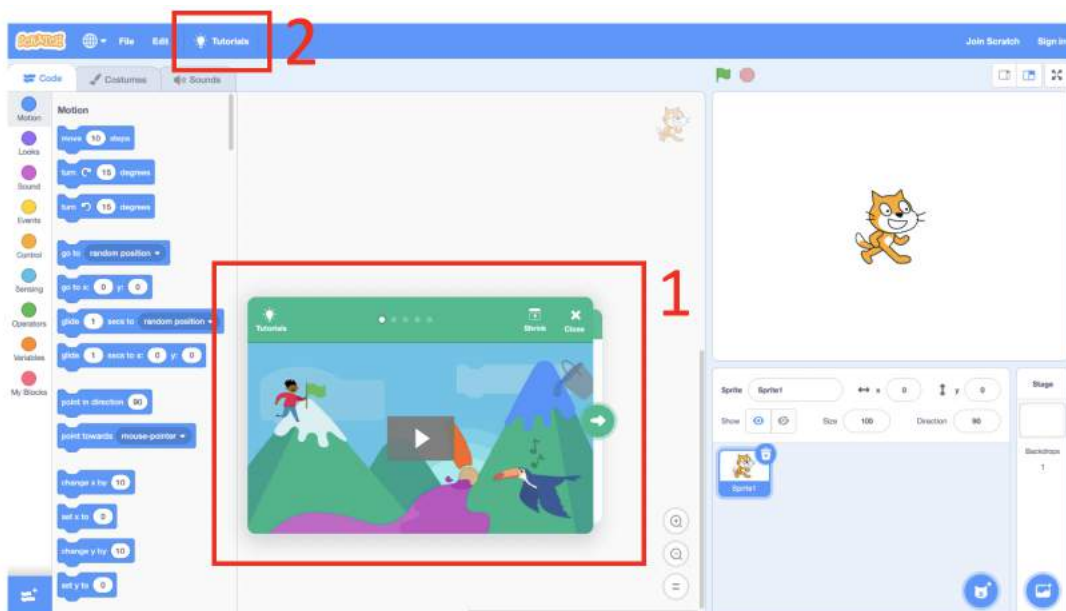
**Material needed:**

Computers with access to Scratch, Scratch tutorials and headphones. See <https://scratch.mit.edu/projects/editor/?tutorial=getStarted> for all tutorials.

**Imagine (plugged)**

The teacher shows how to explore a Scratch tutorial. This is a presentation preferably for a small group, but you can do it for the whole class.

When you start Scratch for the first time, a short tutorial appears (1). This is very interesting, because it appears in the middle of the screen, with small videos, and different steps, that easily, children can stop, advance, repeat, and at the same time, what is taught in the tutorial, children can try (just behind, they can choose a character, try the instructions, etc...). If you click on zone 2, some tutorials appear.



In this section, we propose that the teacher shows how a tutorial works, and for the next section (create plugged), we propose that the children independently explore a tutorial on their own.

### create (plugged)

Give time to the children, who are working in pairs, to explore a tutorial by themselves.

### share (plugged)

Swap pairs (one from each pair). Ask the children to each explain the project they developed in step 2.

### reflect

Each child writes two things in his/her design journal: a heart (one thing he/she likes about the project) and a star (one thing he/she could try in his/her project).

<b>Follow-up Activity: 10 Blocks Challenge</b>	<b>Plugged</b>	Ages 6-12
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#### Material needed:

Computers with access to Scratch and hand-out from Creative computing guide (see Appendix 4). Headphones are recommended.

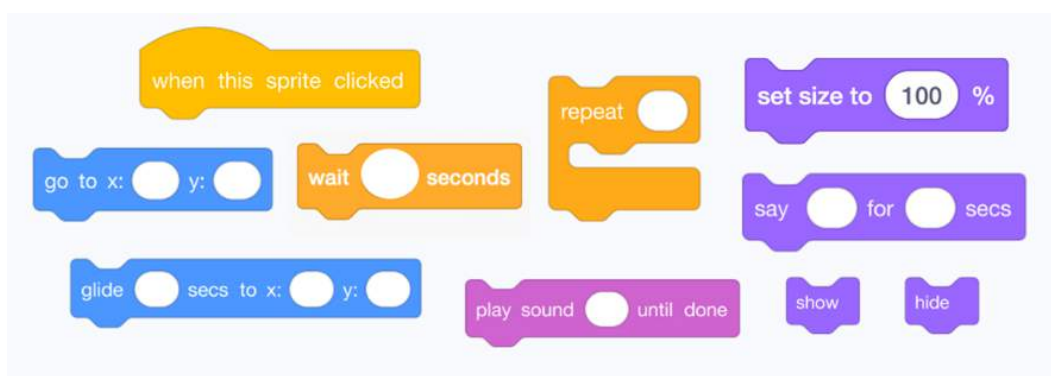


This is an activity designed by the Creative Computing Lab at the Harvard Graduate School of Education:

<https://creativecomputing.gse.harvard.edu/guide/index.html>

(HGSE 2022, [CC BY-NC-SA 4.0](https://creativecommons.org/licenses/by-nc-sa/4.0/)).

The original ten-block challenge of the Scratch studio allows children to explore freely within a structure to gain confidence. The idea is that in this activity, the children tinker with 10 blocks. But before we start, we are going to ask them to imagine which sprite they want to tinker with in their project.



### imagine

Students imagine the main character and the setting of their project. They can choose them from the Scratch Gallery or sketch them in their journal, take a photo and upload them.



## create

Depending on your children, you can either prepare a project that already has the 10 blocks in the coding area, or you can ask the children to find and drag the 10 blocks into the coding area themselves. Once the project is ready, the teacher asks the children to create a project with only one sprite, with the constraint of only being able to use 10 blocks in any way they want. Students may use each block as many times as they would like (they can duplicate them). But every block must be used at least once.

Give students time to create a project with only these 10 Scratch blocks: go to, glide, say, show, hide, set size to, play sound until done, when this sprite clicked, wait, and repeat. Remind students to use each block at least once in their project and encourage them to experiment with different sprites, costumes, or backdrops.

## play

### share

Children play with their projects. Then, they present them to the rest of their classmates or do “speed gaming”: pupils spend 2 minutes on a computer and move to the next one, and so on, trying their colleagues' creations.

As suggested in the “Creative computing guide”, take this opportunity to encourage different ideas and celebrate creativity by inviting a few students to present their projects in front of the class or by exploring other projects online in the 10 Blocks studio.

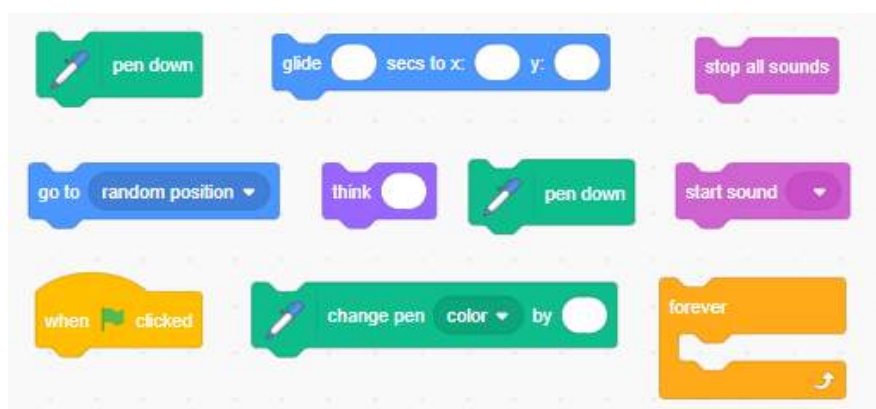
## reflect

Students write or draw in their journal something they have learned when overcoming the challenge or have enjoyed from their friends and the reason.

## create

If you want to iterate, the teacher can prepare another 10 blocks for the children to play with and discover.

The second ten-block challenge aims to introduce the pen extension, which might be interesting for art and numeracy projects such as exploring geometrical shapes or angles.



<b>WORKSHOP 3: Discovering Scratch with a Kidbot</b>	<b>Unplugged</b>	Ages 6-12
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<p>This is an unplugged activity designed to take the first steps in Scratch, following Montessori principles.</p> <p>We want the children to discover how instructions work, simply by playing.</p>	<b>Aim</b>	To introduce Scratch instructions to students of any age with little or no previous experience.
	<b>Materials</b>	Scratch interface printed (A4 size), transparent A4 envelope folder, hole punch machine, lanyard, coloured envelopes (same as Scratch instructions), printed scratch instructions (small/medium size), printed sprites (or class pupils photos).
	<b>Sequence</b>	Prerequisites: none
	<b>Related activities</b>	Workshop 1: Kidbot - First Contact with Coding

### imagine (unplugged)

#### play

A hands-on **material that represents the Scratch interface (unplugged)** with an explanation of its four main areas is facilitated to children organised in groups (2 to 3 children) so, when reading, **they can discover the different parts of Scratch by themselves.**

- 1) **Sprite pane:** the area to define and create sprites and backgrounds.
- 2) **Stage:** the space where all action happens (where we can see sprites doing what programs say).
- 3) **Block palette:** the place where the instructions are displayed.
- 4) **Code area:** the area for programming the actions of all the sprites (the playground).

If you do this activity after you have told the story, they connect the ideas of the tale with the different parts of the Scratch.



**create**  
**play**

Pupils create a script, combining the instructions blocks of the envelopes. Then, the idea is that one of the children does what the program says (like the kidbot).



**Recommendations:** As students become more fluent, the teacher introduces blocks and more complex instructions such as Events and Control. Pen extension blocks can also be introduced.

Children play, taking turns to act out the script.



### share

Pupils exchange scripts with other classmates and perform them. The teacher challenges them to make two sprites interact with each other, running two programs at the same time.

### reflect

Students write in their design journals how they have faced the challenge or its difficulties as well as the script that they had more fun with when acting it out.



<p><b>WORKSHOP 4: Discovering Scratch with a Fortune-teller</b></p>	<p><b>Unplugged</b></p>	<p>Ages 6-12</p>
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<p>This is an unplugged activity designed to take the first steps in Scratch, following Montessori principles.</p> <p>We want the children to discover how instructions work, simply by playing.</p>	<p><b>Aim</b></p>	<p>To introduce Scratch instructions to students of any age with little or no previous experience.</p>
	<p><b>Materials</b></p>	<p>Printed Scratch fortune-teller (See shared Drive) A4 paper, scissors and pencil colours or markers. Flashcard 1 with the activity description (see shared Drive).</p>
	<p><b>Sequence</b></p>	<p>Prerequisites: none</p>
	<p><b>Related activities</b></p>	<p>Chapter 1: The Great Story of Technology</p>





### create

The teacher puts up a challenge: can you build a fortune-teller from this template (see material needed - fortune-teller template)?

**Recommendations:** If there are some children in the class who know how to do it, let them teach others. Give them a finished fortune-teller to explore where the paper folds were done. Oversee that the work is accurate and that the paper folds are well done. Suggest pupils help each other so that all the fortune-tellers work well. Some children might find it useful to watch a YouTube video. For example, this one: “How To Make A Fortune Teller Out Of Paper” created by Helpful DIY. In this video, you can see how to make a fortune teller:



<https://youtu.be/TZauQZzXXc4>

### play

Children play with the fortune-teller in pairs: one student picks a number, gets a sprite, and acts out the program that is below it.

### imagine

Pupils think and devise their own fortune-teller, choose the characters (sprites) that will appear and the programs that will be underneath.

### create

Pupils build a new fortune-teller from paper, using scissors and colour pencils.

### share

Children play with their fortune-teller with different partners, so they can share their project.

### reflect

Students write in their journal something that they have learned or noticed about programs, or draw the steps that they followed to create their fortune-teller.

<b>WORKSHOP 5: Making Faces with Scratch</b>	<b>Plugged / Unplugged</b>	<b>Ages 6-12</b>
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<p>This activity is designed to take in the first steps Scratch playfully. It's one of the Tinkering Studio activities, and the way it is presented here is in line with Montessori principles.</p> <p>We want the children to discover this tool, especially to play with characters, costumes, as well as to discover different ways of learning and working on a project.</p>	<b>Aim</b>	To introduce Scratch to students of any age with little or no previous experience.
	<b>Materials</b>	A few computers (one per team). Camera/tablet/smartphone to take pictures. Everyday objects.
	<b>Sequence</b>	Prerequisites: none
	<b>Related activities</b>	Chapter 1: The Great Story of Technology, and Introduction to Loops.

## Making Faces



Make meaningful portraits by arranging everyday and symbolic objects into faces! By incorporating objects as metaphors (like a bar of soap for your most bubbly friend), you can capture and communicate meaningful characteristics in a playful and visual way.

Dreamed up by artist **Hanoch Piven**, this project supports looking at everyday objects in new ways, expressive visual storytelling, and iterating on ideas.

Share what you create and try out with us by using the hashtags **#TinkeringAtHome** **#FacesInThings**.



This is an activity designed by the Tinkering Studio:  
<https://www.exploratorium.edu/tinkering/projects/making-faces>  
 (© 2017 Tinkering Studio. Exploratorium).

## imagine

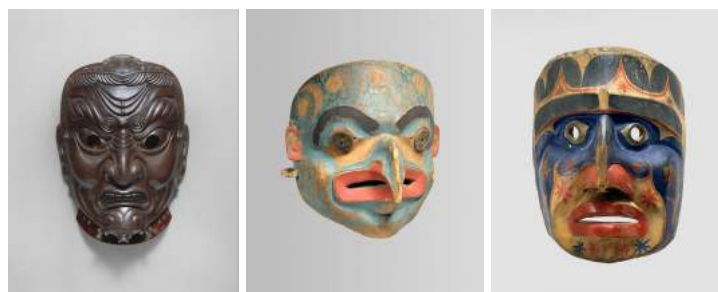
The main idea of this activity is to make meaningful portraits by arranging everyday objects into faces. By incorporating objects as metaphors, we can capture and communicate meaningful characteristics in a playful and visual way.

You can begin by asking students to start imagining and creating faces on the table, using materials they find around the classroom or have brought from home. You can use examples of some creations by Steph Muscat from the Tinkering Studio at The Exploratorium.



For inspiration, take a look at how artist Hanoch Piven (<http://www.pivenworld.com/art>) gets started with making faces out of jar lids, balloons, LEGO gears, rubber bands, and other loose parts and then check out tips for making your own faces.

This activity is an ideal way to bring the different cultures of the children into the classroom. A fun way to do this, and since we are creating faces, is to try to create mask-like faces from different countries. The teacher can bring masks from different cultures into the classroom, or ask the children to research them on the Internet, or even ask them to bring masks or other cultural items from home.



Metropolitan Museum of Art (Creative Commons CC0 1.0 Universal Public Domain Dedication).

As they imagine, design and begin creating, encourage children to use their journals to capture the evolution of their ideas.

### create (unplugged)

In groups, children can start creating designs that look like traditional masks but using everyday materials, or they can work directly with masks or photos of masks and modify them by adding other objects on top.

For materials, let the children gather things they might normally consider junk, like broken toys and old tools. Or let them go outside and collect leaves and other natural materials. Once they have gathered a stash of objects to explore and create with, they can start moving things around. They can use tables or do it on the floor.

When they are creating faces, and keeping in mind that later we want to create an animation in Scratch, children can take pictures of their creations with different expressions: winking an eye, sticking out their tongue, etc.

### create (plugged)

With Scratch, we can play to create short stop-motion films, using the pictures we have taken of faces displaying different expressions.

Take two pictures of the face you have created:

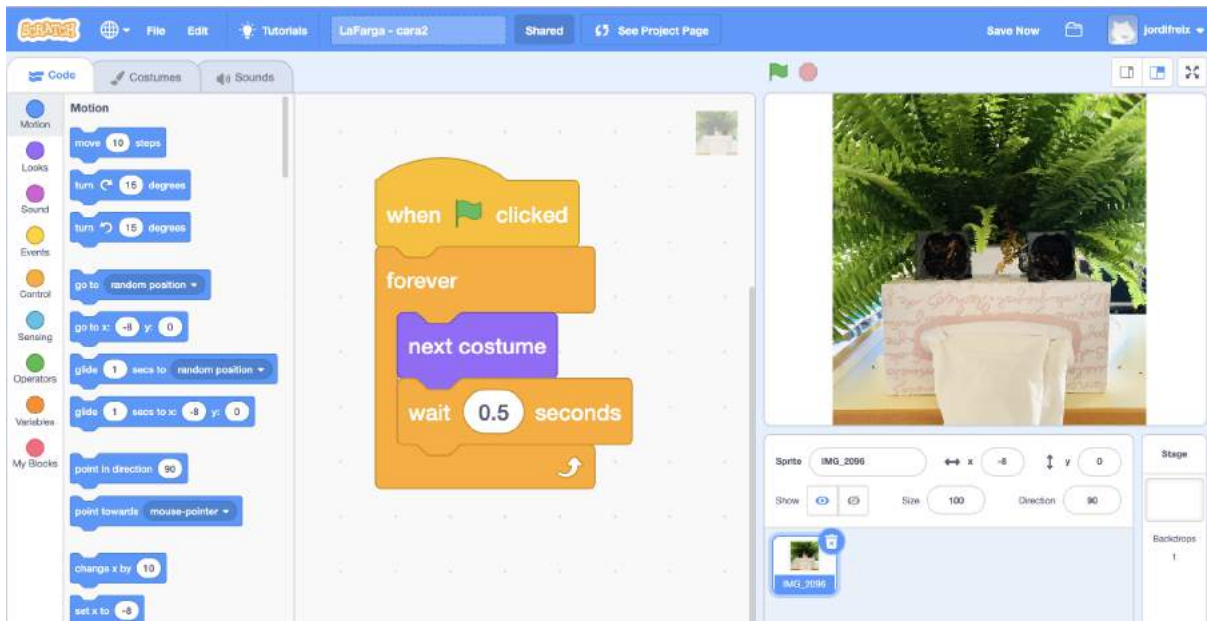


Upload the first one as a new sprite in Scratch. Import the second one as a new costume of that sprite (you can use the button for “new costume” located in costumes tab).



Open and play with the code of this example with the two previous photos:

<https://scratch.mit.edu/projects/609119751/>



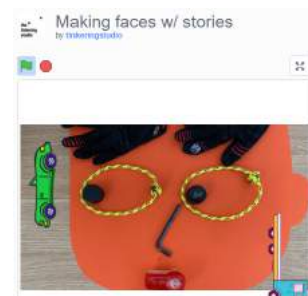
Then take a look at these other examples from Tinkering Studio. You can use them as sparks at the beginning of the activity or let the children explore them, play and remix.



<https://scratch.mit.edu/projects/573653511>



<https://scratch.mit.edu/projects/576452204>

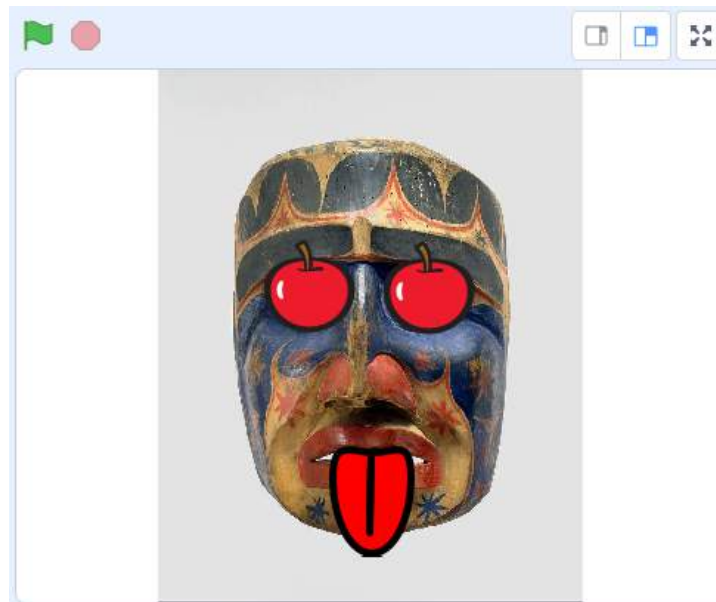




<https://scratch.mit.edu/projects/588240152>



Apart from creating faces with everyday materials, once we have introduced the photos into Scratch, we can also add other sprites from the galleries, or create our own drawings using the graphic editor. In this way, we will be combining real objects (the ones we have photographed, like the mask in the following example) with digital objects (other sprites or drawings made directly in Scratch, like the apples and tongue in the example).



#### share (plugged)

#### create (plugged)

Suggest that the children swap the project between teams. In this way, teams are encouraged to continue working in a project that was initially started by their peers. This is interesting because this exercise encourages them to understand what other participants have done, and to follow a story that someone else started.

#### reflect

Ask children to review the evolution of the ideas they captured in their journal and write the reasons (group discussions, teacher's feedback, research about masks, a picture, etc.) that drove them from one to the next.

<b>WORKSHOP 6: Scratch as a Language</b>	<b>Plugged/ Unplugged</b>	Ages 8-12
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<p><b>Activity description:</b></p> <p>This set of activities is strongly influenced by <b>Montessori Grammar</b> activities and principles such as <b>control of error</b>.</p> <p>They focus on building up the ability to create Scratch programming scripts, while reflecting on the instruction blocks' functions and use in parallelism with the parts of the speech of students' language.</p>	<b>Aim</b>	To reflect on coding as a language.
	<b>Sequence</b>	After Discovering Scratch
	<b>Material</b>	Computer with access to Scratch, headphones (optionally) and printed materials (see shared Drive)
	<b>Related activities</b>	Workshop 15: Grammar Variables



[https://drive.google.com/drive/folders/12hoELOnmUk-6SX5u\\_Xpxiw\\_swg\\_TFLx-k?usp=sharing](https://drive.google.com/drive/folders/12hoELOnmUk-6SX5u_Xpxiw_swg_TFLx-k?usp=sharing)



**Note:** Several of the following activities correspond to **Workshop 15: Using Grammar Variables**, which you can find in Chapter 3 of this guide. We recommend using both the Scratch activities and the grammar activities in parallel to help support the concepts being presented.

## imagine

**Spark:** Start discussing the concept of “**universal languages**” with your students.

**What do you think a universal language is?** *Expected answers (EA): A kind of expression that everyone understands. Could you mention some?* EA: Music, art, body language, emojis, numeracy, etc. **What do they have in common?** EA: Most of them are perceived by our sight, they are about feelings, etc. **How are they different?** EA: Some are objective, like numeracy, and others subjective such as music. **How do you think they all may overcome the language barrier?** EA: Because independent of our origin, we are humans and all feel the same emotions; because music and maths are in nature; because representations (like emojis) show a concept without using words/linguistic signs (that could only be understood with knowledge of their language). **Just for you to give it a thought, could programming be considered a universal language?** Please notice that there is no right or wrong answer. This discussion aims to imagine universal languages to present Scratch as a potential one.

**Imagine:** Before beginning your demonstration, explain to children they will **analyse Scratch as a language**. Subsequently, **activate students' previous knowledge of the speech parts** and the **functions of the different categories of the coding palette** (connecting previous sessions ideas).

**Do you remember the parts of the speech?** EA: nouns, adjectives, verbs, adverbs, conjunctions, etc. **Well done! So, as you have experienced when exploring Scratch, there are different types of coding blocks. Who remembers the blue ones' responsibility?** EA: movement/actions. **Excellent! Can you think of some examples?** EA: glide to X and Y position, rotate, go to a random position, etc.

You could keep on covering all the colour buttons. However, at this stage, we recommend you **focus on: Actions, Looks, Sounds, Events and Control instructions**.

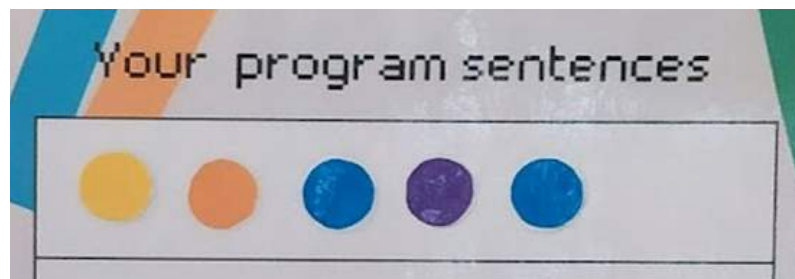
### Teacher material demonstration:

- 1) **Initiate your demonstration by showing all the materials:** the Scratch Program Blocks flashcard (as visual support), Your Program sentences (as a creating area), a computer with Scratch open, the dice and the coloured envelopes containing the buttons of each instruction blocks category.
- 2) Once everything is displayed on a flat surface, **throw the dice**.
- 3) **Get a button from the envelope of the same colour that came up**, for instance, blue, and **place it on one strip of the “Your sentence” flashcard**.
- 4) **Repeat** the two last steps **until you get 5 to 8 buttons**.

- 5) Looking at your buttons, **think aloud** about the **Scratch blocks** you know of **each category** and their **possible combinations**.
- 6) **Rearrange the coloured buttons following your reasoning**.
- 7) Then, go to Scratch on the computer, select the coding blocks you had in mind and put them following Your sentence strip sequence.
- 8) Finally, **run your program to check your sentence**.

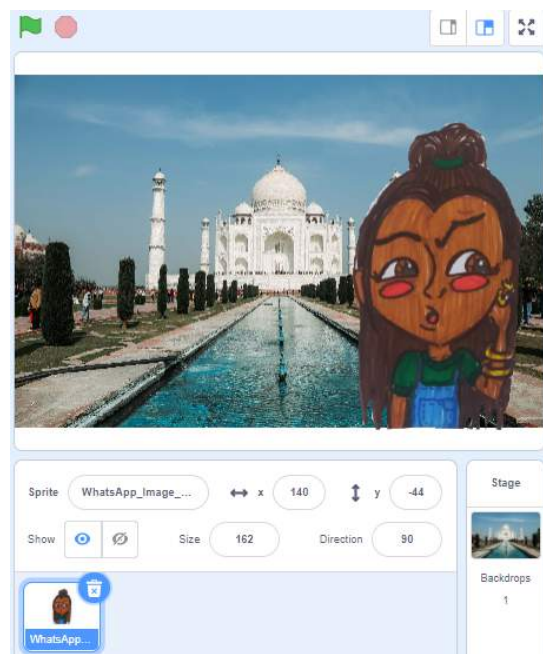
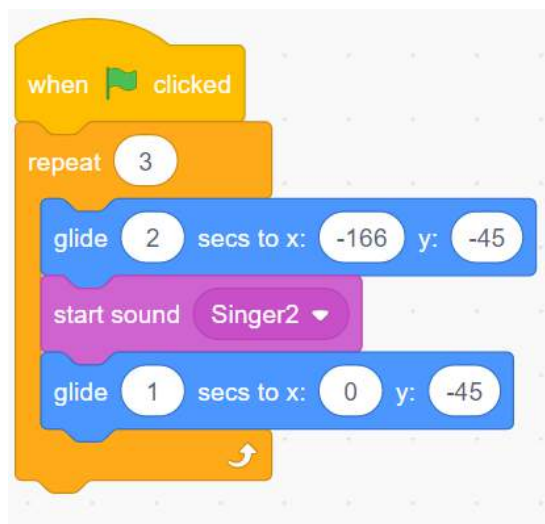
### create

Students take turns to **throw the dice**, and **get a button of the colour of their result**. When they get 5 to 8 buttons, they **rearrange them to create a sentence**.



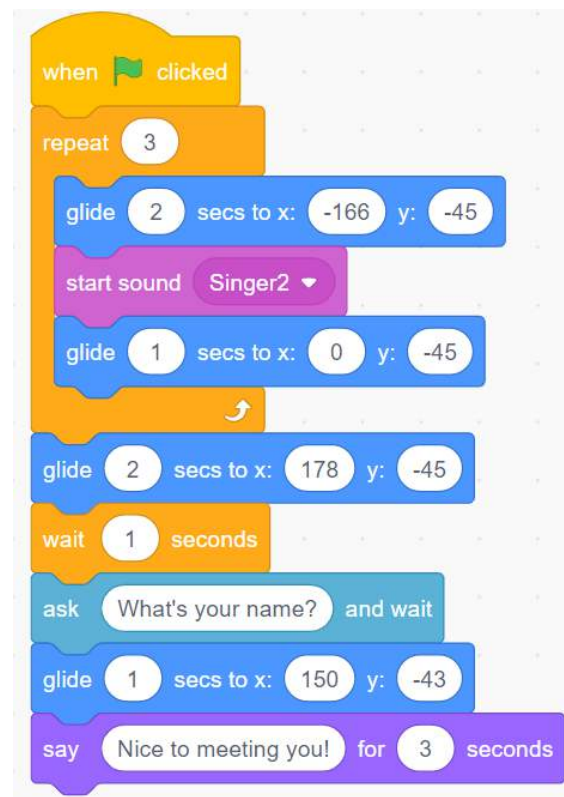
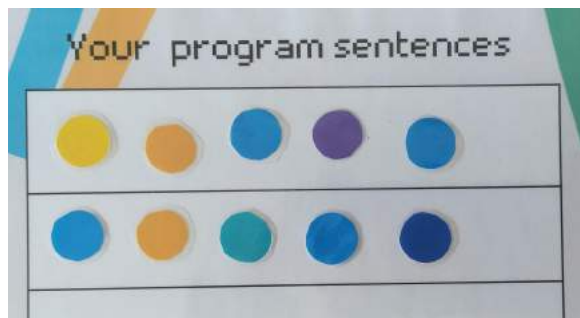
### play (plugged)

Using Scratch on the computer, children **choose an instruction block for each button and create a script**. When they run their program, they might notice possible incongruences and come across some coding rules.



## Share (plugged)

Children **share** their sentences **with classmates from another group** and **combine them to create a collaborative story**. Together, they agree on a sprite (character) and a background (setting).



## reflect

Pupils are encouraged to write in their design journal their **discoveries**. For instance, event blocks need to go first in order to start the program.

<b>Follow-up Activity: Scratch as a Language I</b>	<b>Plugged</b>	<b>Ages 6-12</b>
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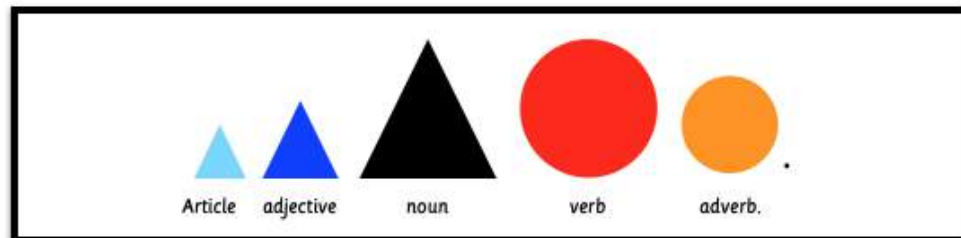
**Material needed:** computer with access to Scratch, headphones (optionally) and Scratch sentences stripes (see in the shared Google Drive folder).



[https://drive.google.com/drive/folders/1qaV\\_q7-GN1WeZBG9hOHITjMh\\_wfxnolC?usp=sharing](https://drive.google.com/drive/folders/1qaV_q7-GN1WeZBG9hOHITjMh_wfxnolC?usp=sharing)

## imagine

Linking it with **Grammar Variable Workshops (pg. 120)**, ask students to **write a sentence** that follows a determined structure. For example: Art. + Adj. + Noun+ Verb + Adv. Next, suggest they write on **different pieces of paper a random adjective, noun, verb and adverb**; before sitting with their words and sentences in a circle. If you have not worked yet on **Workshop 15: Grammar variables**, we recommend you skip this introduction.



**Crazy words (game adaptation):** Children pass their sentence to the child on their right, and one of the words to the child on their left (speech part agreement). Then, they read aloud the sentence they got, replacing the original word with the one they received. **Did they have to modify other sentence words to make sense/ be correct?** Then, they start again, passing another part of the speech. And so on, until they have used their four words.

**As a class, how many sentences were you able to create with the same sentence structure?**

### Teacher material demonstration:

- 1) **Start your demonstration by showing all the materials:** the Scratch sentences in their envelope and Scratch ready to use on a computer.
- 2) Choose a **sprite** and a **backdrop** in Scratch.
- 3) Randomly, **pick a sentence strip** from the sentence envelope.
- 4) **Seek an instruction block for each coloured button.**
- 5) **Arrange them to create a script** that makes sense to you.
- 6) Run your program to **check your sentence.**
- 7) Repeat two more times, choosing different coding blocks in order to create three divergent scripts (same sprite or another one).

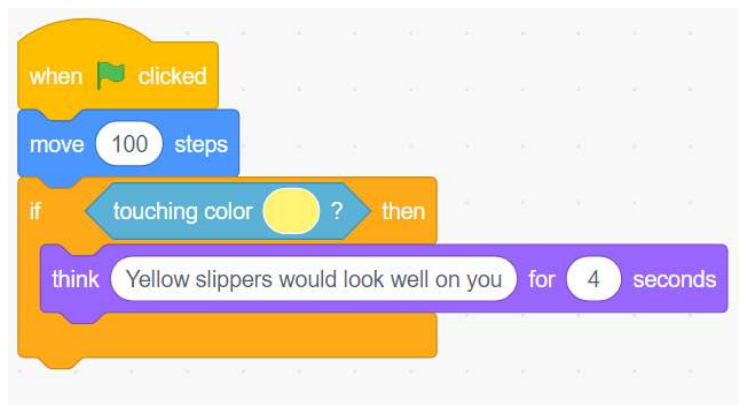
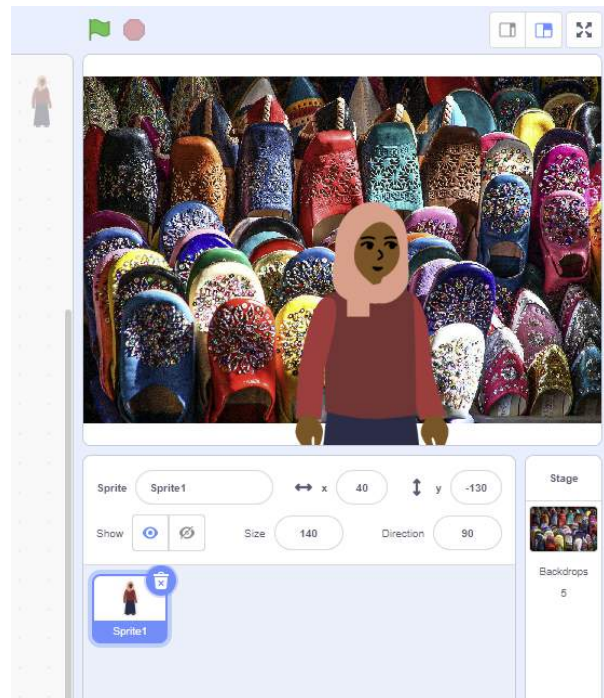
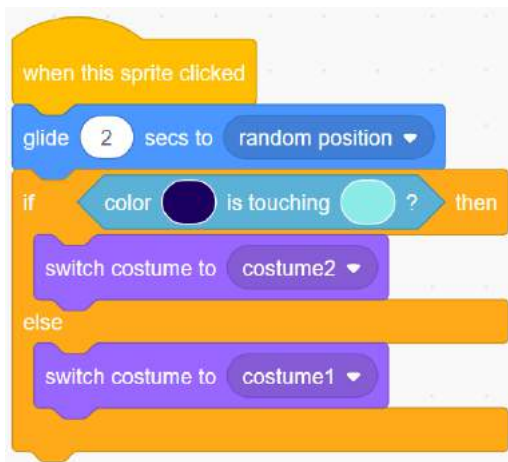
## create (plugged)

Children **pick a sentence randomly** and **choose the instruction blocks for each button creating the script in Scratch.** As in the previous activity, when they run their program, they might notice possible incongruences and come across some coding rules.



## play (unplugged)

Pupils play to create three scripts using the same sentence structure.



## share

Children show their programs and challenge their friends to create a different script with their sentence structure.

## reflect

Students can write about the most challenging sentence structure, why they found it difficult and how they worked it out in their journals.

<p><b>Follow-up Activity: Scratch as a Language II</b></p>	<p><b>Unplugged / Plugged</b></p>	<p>Ages 6-12</p>
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**Material needed:** Computer with access to Scratch, headphones (optionally), coding blocks, flashcards *and eight sided dice*.



<https://drive.google.com/drive/folders/1ECDs7lFesvMgRQxLRK696b8LsM2a06nn?usp=sharing>

### imagine

Start recapping the **previous follow-up activities**, and the **Grammar Variable Workshop** run in parallel.

*“We discussed **universal languages** and have been working on Scratch as a coding language since then. We have been learning about the **speech parts** and the **Scratch Coding Blocks** while **building sentences** and **creating different sentences using the same structure**. In this process, we have noticed and **discovered some rules**. Who can think of one?”*

#### Teacher material demonstration:

- 1) **Begin your demonstration by showing all the materials:** A computer with access to Scratch, headphones (optionally), coding-blocks flashcards and eight-sided dice.
- 2) Decide which **cards** you are playing with and **place them in stacks**. We recommend you introduce later variables and operators cards.
- 3) Explain that it is a game, and the first player to put together a complete sentence (with at least five cards) wins.
- 4) **Throw the dice** and **get a card of the same colour**.
- 5) Pretend you **wait until your turn again** and throw the dice to get another card.
- 6) **Think aloud** about the **coding sentence possibilities**, reflecting on the **coding rules**. For example, I got a control block that says *if (something) then (something)*. Therefore, I will need one **sensing block for sure** and a **motion, looks or sound**.
- 7) Keep on the two last steps until you get a sentence. Note: **you do not have to use all your cards in the sentence**.
- 8) When you announce that you got a sentence, **create the script in Scratch** and run it to **check it**.

### create

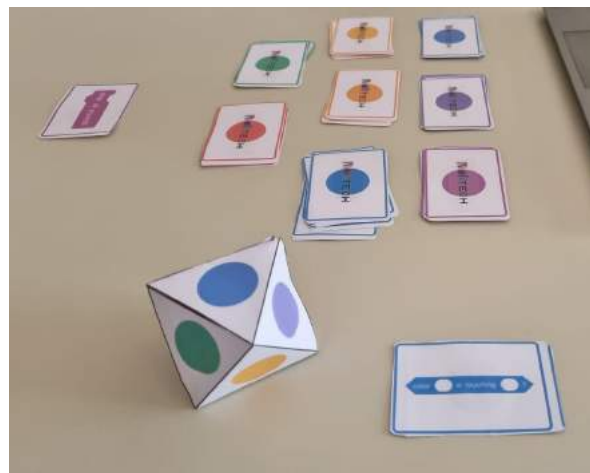
### play

Children place cards in stacks with the symbols face up. They start playing turns clockwise.

The first one (child 1) throws the dice and takes a card from the pile with the same colour. For example, sounds: stop all sounds.

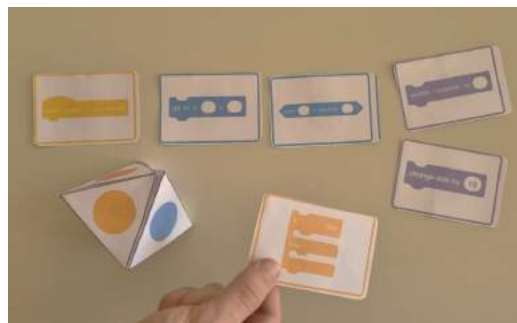


The next player (child 2) rolls the dice and collects a coding-block card. For instance, he/she gets a sensing block: colour x is touching y?



As they collect the cards, pupils try to arrange the coding blocks into a program/sentence that makes sense. However, they do not need to use all their cards. Following the previous examples:

- If child 1 wants to use “stop all sounds”, he/she will need another sound card that produces a sound.
- If child 2 wants to use “colour x is touching y?” in a sentence, she/he will need a control card. For instance: if (sensing block) then, A, else, B.



If they have the computer next to them, they can check the possible script sentence combinations in Scratch as they go, reinforcing their learning.

The first player to build a complete sentence that makes sense when created the script in Scratch, wins the game.

share

reflect

Pupils can draw a **Venn Diagram** in their design journal. In one circle, they write down the characteristics of **their language**. In the other, the ones of **the Scratch language** and, in their intersection, the things they have in common. Then, draw their conclusions.



Additionally, they could **debate** with their classmates the following question to conclude the Scratch as a language set of activities: **Could programming be considered a universal language? Why?**

<b>WORKSHOP 7: Loops - Discovering Micro:bit</b>	<b>Plugged</b>	Ages 8-12
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<p>In programming, loops are elements that repeat a portion of code a set number of times until the desired process is complete. Repetitive tasks are very common in coding, and loops are essential to save time.</p>	<b>Aim</b>	Discover what loops are and how they can be useful to solve problems
	<b>Materials</b>	micro:bit, computers, Internet connection, alligator clips
	<b>Sequence</b>	After Discovering Scratch activities
	<b>Related activities</b>	Workshop 8: Loops - Create a Dance Routine, Follow-up: Dance Party

### Imagine

Before we get started with the micro:bit and children begin to create their projects, begin by telling a story to understand the concept of a loop.



*Loops and Making Horseshoes*, a computational fairy tale by Jeremy Kubica (2011):  
<http://computationaltales.blogspot.com/2011/03/loops-and-making-horseshoe.html>

*Drex's new apprentice, Simon, was not working out. In fact, Drex never had a worse apprentice in his thirty-five years as a blacksmith. Simon could barely lift the hammer, let alone swing it with sufficient force to shape metal. However, worse than that, Simon also lacked the necessary intelligence to carry out even simple tasks. Had it not been for his diminutive size, Drex might have thought that Simon was actually an ogre.*

*Drex found himself constantly repeating instructions:*

*"Now, hit the metal again."*

*"And again."*

*"And again..."*

*Drex's patience was wearing very thin. Drex hated repeating himself.*

*Finally, Drex decided to try an experiment. "Simon, hit the metal twice." he commanded.*

*Clank. Clank. Simon complied.*

*"Now turn it over and hit it three times." Drex commanded.*

*Simon flipped the deformed looking horseshoe with the tongs, and he hit it once. Then he paused. He looked back at Drex. Simon looked confused.*

*Drex sighed loudly. Was that really too much for Simon to handle? The boy was hopeless.*

*"It is a loop!" proclaimed Drex loudly. He knew that Simon would not understand, but at least shouting made Drex feel better. "A simple, simple loop."*

*"A loop?" asked Simon.*

*"Yes. Haven't you ever heard of a loop?"*

*Simon shook his head sadly.*

*Drex realized that they had hit the core of the problem. How could Simon function as a reasonable blacksmith without understanding loops? Then again, Drex had no idea how Simon could function as a human without understanding loops.*

*"A loop is defined by two things: something to do and a way to know when to stop doing it. You keep doing that one thing over and over until you stop." explained Drex calmly.*

*Simon stared back blankly.*

*"Think about a one mile race." Drex suggested. "You run around the track, until you have gone a mile. That is four laps, right? So, running is the thing you do and having run a full mile is the criteria for stopping. The track even looks like a loop."*

*"I run until someone tells me to stop." declared Simon loudly.*

*"Of course you do." muttered Drex.*

*"In this case," continued Drex, "I want you to keep hammering that horseshoe until it is flat. As soon as it is flat, you can stop. WHILE the horseshoe is not flat, hit it with the hammer."*

*"Okay." agreed Simon happily. He promptly set about hitting the horseshoe over and over again until it was flat. Then he stopped. By the end Simon was breathing heavily from the*

*effort, but the horseshoe was completely flat.*

*Drex was stunned. How had Simon understood that?*

*“Good. Now go get the coals hot.” Drex commanded.*

*Simon looked confused again.*

*Drex sighed. “It is another loop. Pump the bellows 10 times. FOR each number that you count from 1 to 10, give the bellows a pump.”*

*“Okay.” Simon again got to work, pumping the bellows exactly ten times. He counted loudly each time.*

*“ONE... TWO... THREE... FOUR... FIVE... SIX... SEVEN... EIGHT... NINE... TEN”*

*Over the course of a week, Drex determined that Simon would repeat tasks if they were well specified in a loop. He would tell Simon exactly what task to repeat and exactly how long to repeat it. Sometimes he would simply tell Simon to count up to a certain number. Other times he would phrase it like a WHILE loop, telling Simon to continue doing something until a goal had been met.*

*Simon responded amazingly well to these structured commands. The blacksmith's shop was filled with the noise of Simon cheerfully counting and hammering. “One... bang... two... bang...”*

*Eventually, Drex was even able to move onto nested loops, issuing instructions such as “WHILE the sword is not thin enough: Turn it over and FOR each number from 1 to 5, hit it with the hammer.” And Simon would happily go about banging the sword into shape while turning it over after every five hits.*

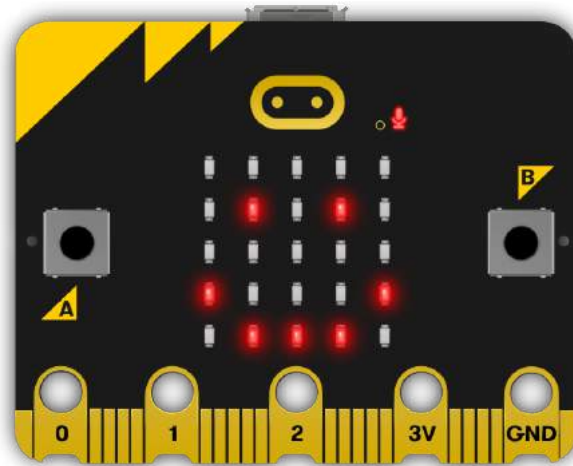
## Create

The **micro:bit** is a programmable electronic board with a very affordable cost. It was designed through the BBC's "*Make it digital!*" campaign, with the aim of promoting computer and engineering vocations among children and young people, and at the same time stimulating creative thinking and maker learning. For this reason, this card has, in a short time, become very popular in the world of educational technology, educational robotics and the maker movement.

The micro:bit is small, incorporates sensors and actuators, is very simple to program, and uses open source software. All this has led to the fact that apart from its more educational aspect, it is also used by makers of all kinds, creators and artists from different disciplines.



The easiest way to program the micro:bit is to use the **MakeCode** environment, a visual programming language. There is the possibility to program with MakeCode online (<https://makecode.microbit.org/>) and/or download the offline version (<https://makecode.microbit.org/offline>).



micro:bit V2



To set up, check the getting started section in the micro:bit official website: <https://microbit.org/get-started/first-steps/set-up/>



You can also watch this video about transferring a MakeCode program to the micro:bit: <https://youtu.be/-FZ8yTnoozY>

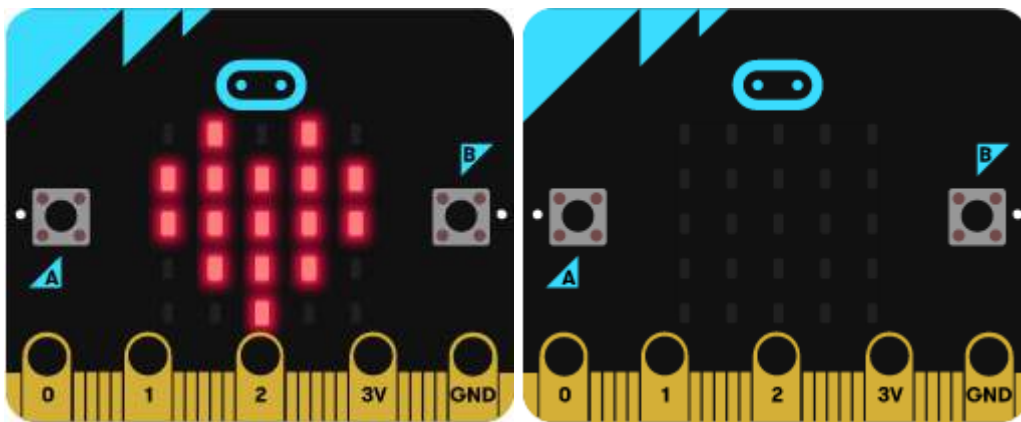
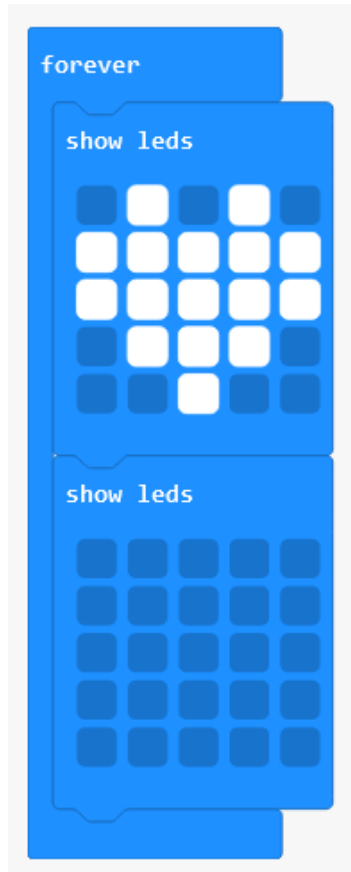
It is so easy that this set-up can be done directly by the children, through this first proposed activity.

### Flashing Heart with micro:bit

As a first activity with micro:bit, we can ask the children, divided into teams, to visit the MakeCode website, and start by creating a very simple loop: a forever loop.

The activity consists of making a flashing heart appear on the LED array of the micro:bit.

The code required is as simple as the following. We simply repeat forever showing the heart and hiding it, thus creating the flashing effect on the LED array.






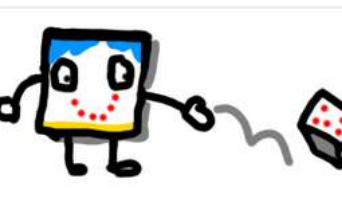


Code in MakeCode and the desired effect in the micro:bit.

Once they have copied this piece of code, children can download it to the micro:bit, and they will immediately see the effect of the flashing heart.

### play

When the children have tested the first example, it is the perfect time to let them explore and play, trying out other programming blocks in MakeCode and discovering features and functions of the micro:bit on their own.

If you feel they need a little help or guidance, another option is to let them try the basic tutorials on the micro:bit website.

 <p><b>Flashing Heart</b> Make an animated flashing heart.</p>	 <p><b>Name Tag</b> Scroll your name on the screen.</p>	 <p><b>Smiley Buttons</b> Show different smiley images by pressing the buttons.</p>
 <p><b>Dice</b> Shake the dice and see what number comes up!</p>	 <p><b>Love Meter</b> Is the micro:bit is feeling the love, see how much!</p>	 <p><b>Micro Chat</b> Build your own social network made of micro:bits.</p>



micro:bit - Basic tutorials: <https://makecode.microbit.org/tutorials>

### Reflect

Now is the time to reflect and let the children write down in their journals what they have been doing, and to draw and design new experiments.

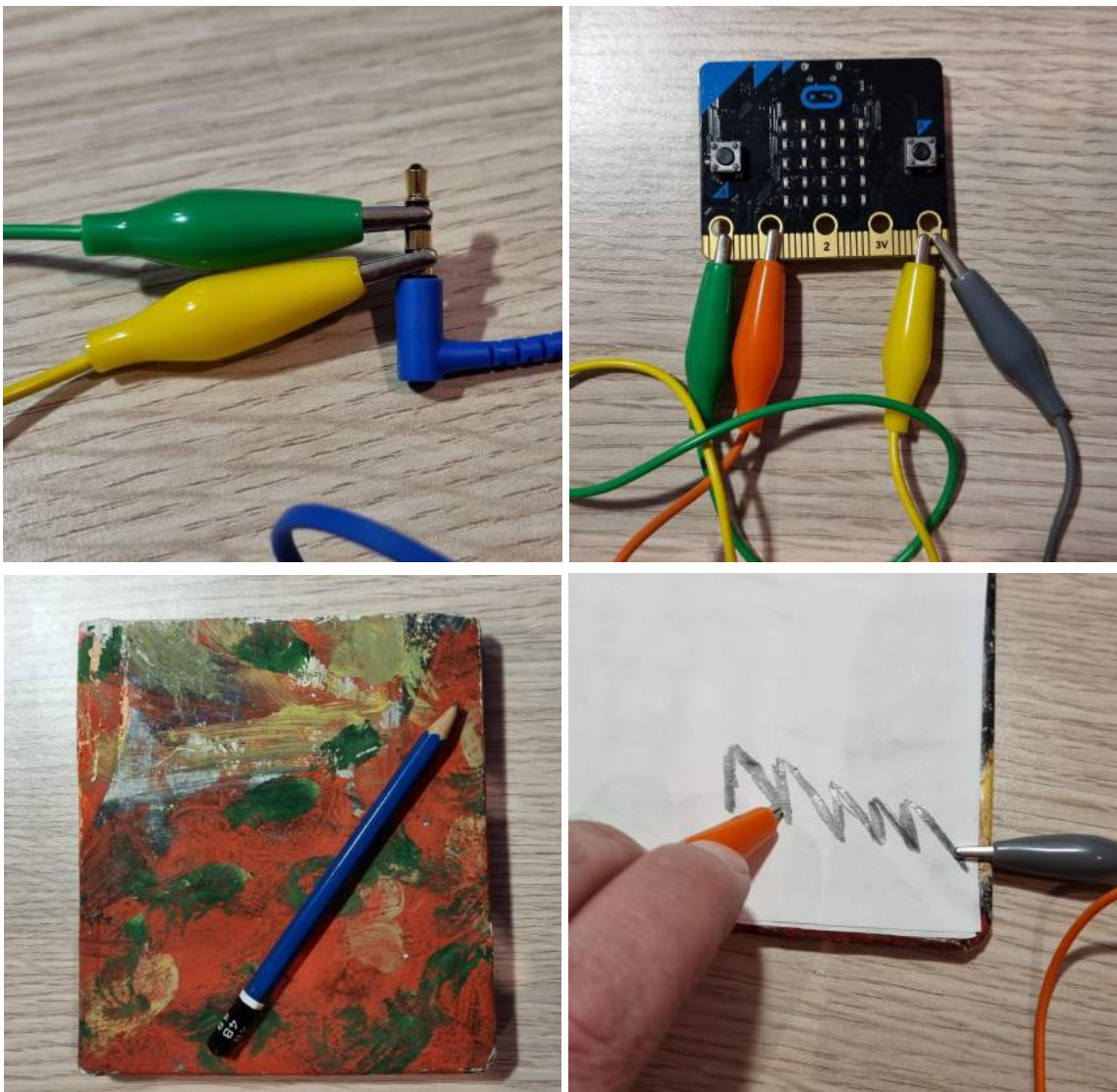
But this is not all we can do with the journals if we have a micro:bit! You can also try this final activity.

## Using the pencil graphite as a resistor in our journal

Graphite is the drawing bit of the pencil, and it conducts electricity but has quite high resistance. In this experiment, a pencil line or drawing is used as a simple variable resistor. Depending on the weight, thickness and length of the line we draw, we will get different resistance values. We will measure this change in resistance as a number and use this number to control the tone played.

We need: the micro:bit, headphones, 4 alligator clips, a journal and a pencil.

In the following photos, you can see the set-up:



When you have everything ready, try the following code (pictured below) on the micro:bit, move the orange clip over the picture or line (touching it) and see what happens. You should hear sounds in the headphones. And the tone should change depending on the area of the line or drawing you are touching. Here the code is a bit more complicated, but try to get the children to guess what is happening. Although they may have difficulty understanding it all, they will certainly be able to deduce things by reading the conditionals.

```
forever
  set sound to analog read pin P1
  set sound to sound x 4
  if sound < 300 then
    play tone sound for 100
  if sound > 300 then
    play tone 0 for 0
```

<b>WORKSHOP 8: Loops - Create a Dance Routine</b>	<b>Plugged / Unplugged</b>	<b>All Ages</b>
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Can loops be found in other types of “programs”? Choreography can be a way of exploring loops and patterns.	<b>Aim</b>	To reinforce the concept of creating a set sequence that repeats
	<b>Materials</b>	Dance Step cards (see shared Drive)
	<b>Sequence</b>	After Discovering Scratch
	<b>Related activities</b>	Follow-up activity: Dance Party with Scratch, Workshop 7: Loops - discovering micro:bit

### imagine

Remind students about loops and how we can create a sequence that can be repeated for a set number of times.

Present the Dance Step cards. Show the different steps, trying out with the students. Show how we can put together a dance sequence using the cards.

We can take advantage of this opportunity to learn types of dances from around the world like Dabke. Dabke is a dance genre of the Levant (Syria, Lebanon, Jordan, Palestine and parts of Israel, Iraq, Turkey, Yemen and Saudi Arabia).



DABKE CARDS:

EXAMPLE OF DABKE DANCE :

<https://www.youtube.com/watch?v=HYxQMbsmPaw>

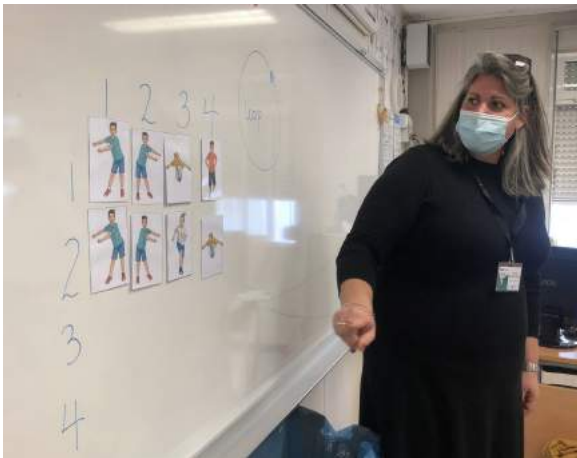
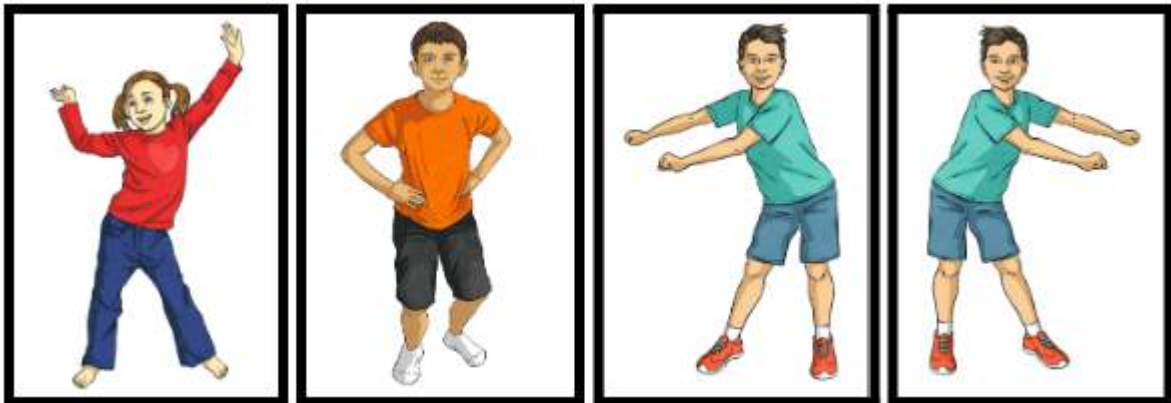
### create

In small groups, allow the students to build a sequence of four dance steps. Now practice that sequence together until the students have learned the steps. This sequence can be done by drawing, by printing the example ones or taking photos of the students and putting off the backgrounds as the example of Dabke cards.



Program to remove the background:  
<https://www.remove.bg/>

Next, tell the students that we want to put this in a loop that will repeat four times. Together as a group, count in 4 beats and begin to perform the dance - all four steps, repeated four times.



## play

Encourage the students to use the cards to create their own sequence using as many dance steps as they like, and then repeat the loop for a set number of times (of their choice). Allow them time to experiment and find moves that fit well together.



## share

After they have created a dance, they can perform for the rest of the group.



## reflect

In their design journals, ask the students to reflect on the dance activity. Prompt questions could include:

- Were there some dance moves that fit together better than others?
- Was it easy to keep the dance routine together when repeating the loop? Did the repeating loop help to remember the dance moves?
- Do you think all dances are loops? Why or why not?

<b>Follow-up Activity: Dance Party</b>	<b>Plugged</b>	<b>Ages 6-12</b>
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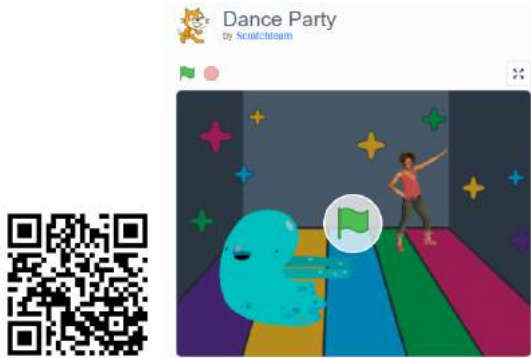


As a follow up activity you can ask children to make sprites dance in Scratch. This activity is inspired by the activities proposed in Scratch conference, and materials that work for a previous Scratch version <https://resources.scratch.mit.edu/www/guides/en/DanceGuide.pdf>

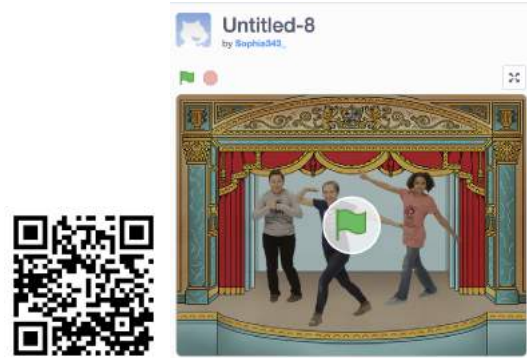
### imagine

Start by linking to the previous activity. Show a YouTube video with children dancing so that the different steps are repeated. Depending on the age and background of the children, show a video of children dancing an African dance, or a traditional Moroccan dance, or in case of teenagers you can go to a Tik-tok from a youth star that you think is appropriate. You should try to showcase dances from around the world. This is a good opportunity to bring the culture of children coming from migrant, minority or refugee families into the classroom. In any case, be careful that the video you choose is inclusive, as you are showing examples, not a repetition of stereotypes from Western culture. Include diverse characters, of all colours, of all shapes, from all parts of the world!

Also show a Scratch project. It's simply playing with different costumes and the loop of repeating in sequence, whether it's two, three or 25 times. Just for a couple of minutes, show some inspirational projects in Scratch, where children can see some examples of dancing sprites. Here are some examples:



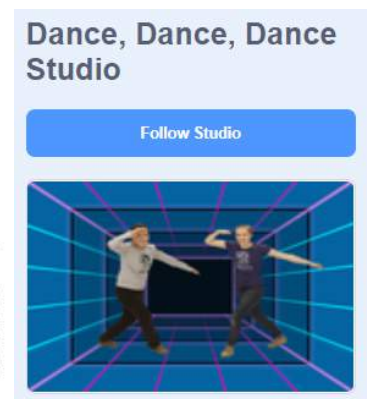
<https://scratch.mit.edu/projects/10128067/>



<https://scratch.mit.edu/projects/588135512/>



<https://scratch.mit.edu/projects/340824565/>



Or you can also explore the studio:  
<https://scratch.mit.edu/studios/1065372/>

## create

Start with a guided demo (10 minutes), then pupils can repeat at the same time you are doing the demo. For instance, we can make Ben dance.

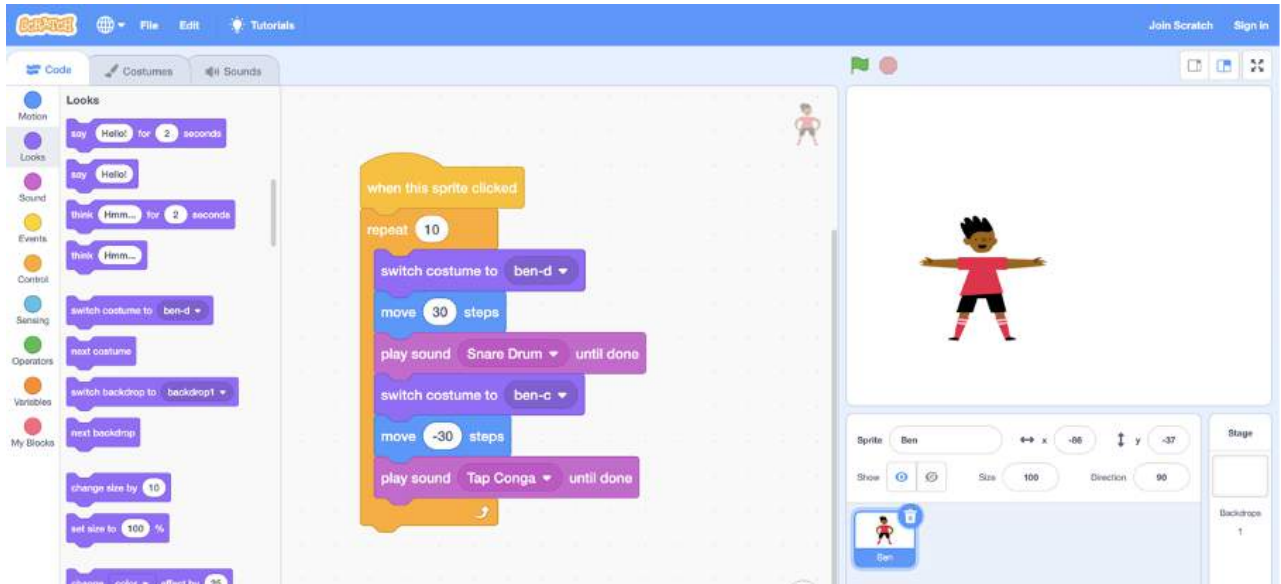
Start by dragging out the “move 10 steps” block from the “Motion” blocks to the scripting area. Every time you click on the block, Ben moves a distance of 10. You can change the number to make Ben move a greater or smaller distance.

From the “Sound” tag, choose the sound “Snare Drum” from the gallery. Repeat the same process and add “Tap conga”. Then drag out the “start sound Snare Drum until done” block. Click on the block to hear its sound. Drag and snap the “start sound Snare Drum until done” block below the “move” block. When you click on this stack of two blocks, Ben will move and then play the drum sound.

Copy this stack of blocks (by right-clicking the stack and selecting “duplicate”) and snap the copy to the already-placed blocks.

Change the second “move” block to -10 steps, so Ben moves backward. Change the sound block to the “Tap conga” sound. Every time the stack of four blocks is clicked, Ben does a little dance forward and back.

Go to the “Control” blocks palette and grab the “repeat” block. Wrap the “repeat” block around the other blocks in the scripting area. Note there is the number 10. Now, when you click on the stack, Ben dances forward and back 10 times. Here, the word “loop” can be introduced to participants. (They get their first “computational thinking” concept). Finally, drag the “when this Sprite clicked” block and snap it to the top of the stack. Click on Ben (instead of the blocks stack) to make Ben dance. Additionally, like in the next figure, you can add the block “switch costume”.



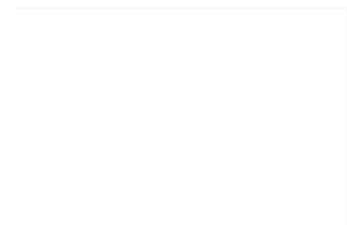
**create [unguided session]**

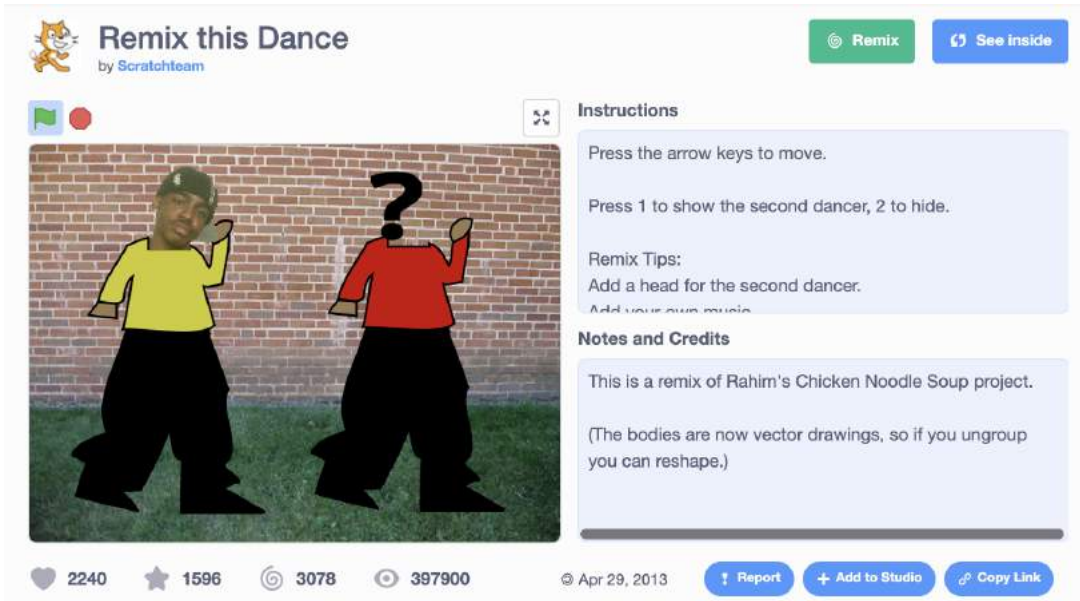
Ask the children to do a party dance project, exploring costumes, sequences and loops. Let them explore the sprites of the gallery related to dance. Allow participants to explore and discover by themselves.

When children come to you, you can just give them some ideas, like add more dancers (sprites), change backdrops, add colours and effects. Also, you can ask them to take photos of themselves doing different dance moves, import these photos as costumes into Scratch and use the “Eraser” tool of the graphic editor to remove the background.



You can also propose to remix this dance:  
<https://scratch.mit.edu/projects/10015792/>





Propose children to explore this project and to change the head of the second dancer, add your own music, change the clothes, or whatever they can imagine.

**share [unguided session]**

Help the participants add their projects to a shared studio in Scratch. Give them a link to the studio. Then they can click 'Add Projects' at the bottom of the page. Ask for volunteers to show their project to the group. Everyone can dance along!

Give them time to write in their design journal what they liked about this activity, which of their classmates' projects they liked best and why.

Advanced materials: Need for advanced projects on dance parties. Here are a couple:



<https://scratch.mit.edu/projects/2502892/>



<https://scratch.mit.edu/projects/75349150/>

<b>WORKSHOP 9: Synchronicity and Parallelism - Body Percussion</b>	<b>Plugged / Unplugged</b>	<b>All Ages</b>
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<p>The words <i>synchronicity</i> and <i>parallelism</i> define the situations where two or more similar events happen simultaneously without a cause-effect relation.</p>	<b>Objectives</b>	Introduce the concepts of synchronicity and parallelism and identify them in daily life situations.
	<b>Vocabulary</b>	At the same time Simultaneously Melody Musical instruments Parallel
	<b>Materials</b>	Music player devices, speakers, screen, computer, Scratch and optionally: Watercolours, hard paper and Body Percussion Flashcards (see shared Drive)
	<b>Prerequisites</b>	Workshop 2: Discovering Scratch, Workshop 7 and 8 about Loops

### imagine

The teacher plays a **song**, without showing the video (Le Vals d'Amelie) and asks children to **identify the melodies of the instruments** that are involved. Children represent them freely on blank paper using different watercolours for each musical instrument.



Le Vals d'Amélie: <https://www.youtube.com/watch?v=Xw7gZi6h-KU>,

After a short discussion, the teacher shows the **video of the song** to the children and formulates some questions: *How many instruments have you guessed? How many melodies have you identified? What colour did you choose for the violins? Were they (the melodies) played at the same time? What do we call it in music when two or more melodies are simultaneous? **And in other contexts?***

Briefly, pupils act out different situations of daily life, which are pupils' ideas or teacher's suggestions if needed, where two actions or events happen at the same time.



The teacher plays a **body percussion version of the same song**, without showing the video (Le Vals d'Amélie: <https://www.youtube.com/watch?v=t8ziPncyeeU>).

*What do you think has changed? What is different from the previous one? What is the new instrument?* Once the pupils have shared their ideas, the teacher plays the video to check their answers.

The teacher guides the children to conclude that the new instrument is **our body**. Also, the teacher asks them reflect on the fact that the video format allows one person to play different **rhythms synchronically**.

Finally, in order to provide some examples, the teacher leads a **body percussion warm-up**. We recommend starting simple and finishing by organising the pupils in groups and giving them different rhythms to experiment with synchronicity. An example activity: "Walk the line" caterpillar group activity - playing together in "orchestra".



[https://drive.google.com/file/d/0B8HN9oCT-nX0TEFqYXNH3FZRUE/view?resourcekey=0-V\\_P7f1hwzqF\\_ADXTXBvITQ](https://drive.google.com/file/d/0B8HN9oCT-nX0TEFqYXNH3FZRUE/view?resourcekey=0-V_P7f1hwzqF_ADXTXBvITQ)

\*see this resource in the online appendix

### create (unplugged)

During the **challenge** to create their **body percussion choreography using synchronicity**, children in groups choose a song and work on different rhythm music sentences during an extended period. When the given time is over, they share their creations with the rest of the class.

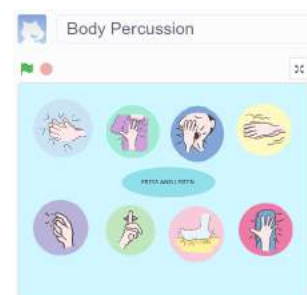
### create (plugged)

In the same groups, children **create a video** with Scratch to teach other pupils their body percussion choreography. Some possible results examples:



See this scratch project to practice body percussion.

<https://scratch.mit.edu/projects/709577856>





<https://www.youtube.com/watch?v=VldOnhk-jwo>



<https://www.youtube.com/watch?v=Jn1fOoZTIXM>



<https://www.youtube.com/watch?v=uzXpvlLRMog>

**play**

**share**

Students play with another group Scratch project and learn their Body Percussion choreography. Finally, they perform it in front of their classmates.

**reflect**

Pupils write down in their design journal about: *How would you describe synchronicity with your own words? Write about a situation you enjoy where synchronicity is part of it.*

<b>WORKSHOP 10: Introduction to Conditionals</b>	<b>Unplugged</b>	Ages 8-12
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<p>In coding, <i>conditionals</i> are statements that only run under certain conditions.</p> <p>In this activity, we will see that we actually use conditionals all the time in our daily lives.</p>	<b>Aim</b>	Learn the concept of conditional and practice it through examples and fun games.
	<b>Materials</b>	<p>Any <i>Choose Your Own Adventure</i> story.</p> <p>Decks of playing cards.</p>
	<b>Sequence</b>	Prerequisites: Instructions and sequences
	<b>Related activities</b>	Workshop 11: Play with conditionals and Scratch- Plugged

### imagine

A good way to begin exploring the concept of **conditional** is to tell children a *Choose Your Own Adventure* story. In a CYOA story, the plot of the story can follow different paths, depending on the choices the readers make. Likewise, conditionals allow a program to fork and follow different paths, depending on whether a condition is evaluated as true or false.

You can choose any CYOA story, or you can invent one. As you tell this introduction story to the class, you can emphasize with your voice the phrases that are conditional statements: *if the princess gets on the boat, **then** a magician suddenly appears.*

Here is an example of a CYOA planner, which is very useful when creating our own stories:

Start the Story: <b>Babu and Preetha in Bangalore</b>			
<p>One day, Babu was at home, but he was really bored. He thought to himself, “where would I like to go?” So he rang up his friend Preetha and asked her where they should go. She said that they should go to:</p> <p>Where would you like to go?  <b>Option 1: The cinema</b>  <b>Option 2: The shopping mall</b></p>			
<p><b>Option 1</b></p> <p><b>“If Babu and Preetha go to the cinema”</b></p>		<p><b>Option 2</b></p> <p><b>“If Babu and Preetha go to the shopping mall”</b></p>	
<p>When they got to the cinema, they saw that it was shut. They couldn’t believe it! So they walked around for a while before they decided to go to the:</p> <p>Where would you like to go?  <b>Option 1a: Lalbagh Gardens for a walk</b>  <b>Option 1b: Brigade Road to meet more friends</b></p>		<p>At the mall, they had a lot of fun because there was a live concert and a lot of people singing and dancing. Once they had finished shopping, they wanted some food. They decided to go and get food from:</p> <p>Where would you like to go?  <b>Option 2a: Indian restaurant</b>  <b>Option 2b: Western restaurant</b></p>	
<p><b>Option 1a</b></p> <p><b>“If Babu and Preetha go to Lalbagh Garden for a walk”</b></p>	<p><b>Option 1b</b></p> <p><b>“If Babu and Preetha go to Brigade Road”</b></p>	<p><b>Option 2a</b></p> <p><b>“If Babu and Preetha go to an Indian restaurant”</b></p>	<p><b>Option 2b</b></p> <p><b>“If Babu and Preetha go to a western restaurant”</b></p>
<p>In the park, they visited the oldest tree in Bangalore and had a great time watching monkeys stealing food from tourists.</p>	<p>On Brigade Road, they went up and down the street several times, and at the end they met some friends, and together they went to Karthika's house to play computer games.</p>	<p>In the restaurant, the waiter got the dishes wrong several times, but thanks to this, they tasted food they had never eaten before.</p>	<p>At the restaurant, they each ordered their favourite hamburger, but since they were eating on a courtyard, and it started to rain, they had to run for shelter.</p>



This CYOA planner is based on an idea from: [www.mrspriestleyict.com](http://www.mrspriestleyict.com)

Another good way to start is by reflecting on the decisions we make every day, all the time, and that determine our actions: *if it is cold, I will wear a jacket. If not, I will come to school in a T-shirt.*

### play

After these initial reflections, a good way to learn the concept of conditionals is through a game. We propose one where we use playing cards, but you can imagine many others. Another fun way to explore conditionals is through the kid-bot activity (see workshop 1, pag 43):

*if you stand on a yellow square, then turn left.*

### Activity: conditionals with cards

Practice IF and ELSE conditionals with playing cards.



First establish some rules by using conditional statements. Here are some examples:

- If I pick a red card everyone clap, else, everyone say “aww”.
- If I pick a black card and the number is bigger than 7, I get 1 point.

See the activity *Conditionals with Cards* from Code.org for more ideas:



<https://code.org/curriculum/course2/12/Teacher.pdf>

Let the children invent their own rules and play with the cards.

### Reflect

Reflect with the children about conditionals. Ask them to think about their favourite video games. Encourage them to write in their design journal: Do they earn more points for some actions than others? Of course, the answer is yes, and that is because computers are using conditionals to determine how many points they give you.



<b>WORKSHOP 11: Let's play with Conditionals and Scratch</b>	<b>Plugged</b>	<b>Ages 8-12</b>
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In coding, <i>conditionals</i> are statements that only run under certain conditions.	<b>Aim</b>	Learn the concept of conditional and practice it through examples and a <i>Choose Your Own Adventure</i> story coded with Scratch.
In this activity, we will see how to use conditional instructions in Scratch.	<b>Materials</b>	A few computers (one per team).
	<b>Sequence</b>	Prerequisites: Instructions and sequences
	<b>Related activities</b>	Workshop 10: Introduction to conditionals

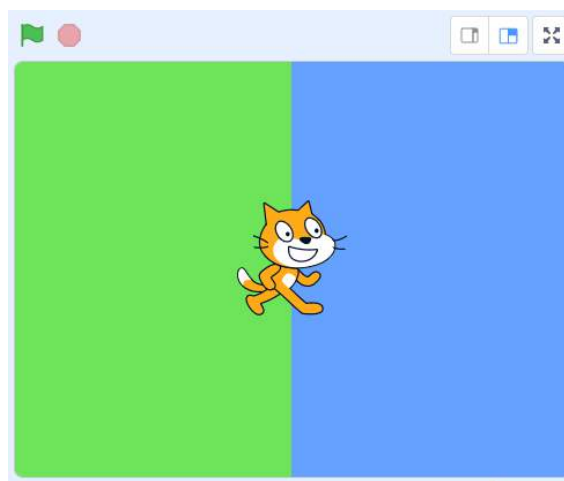
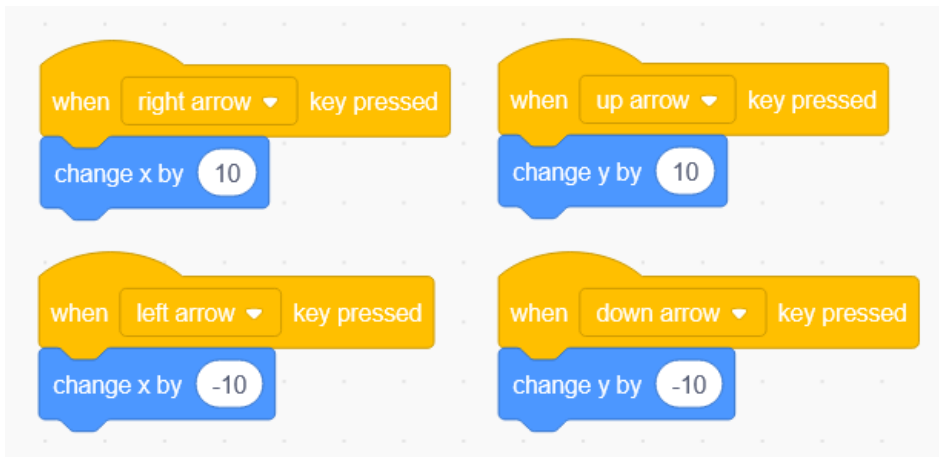
### imagine

A good way to start is to show the whole class a simple example of how to use conditionals in Scratch. For younger children, we can also use Scratch Junior.



Scratch Junior (ScratchJr):  
<https://www.scratchjr.org/>

In this example, we can make the sprite move with the arrow keys. We will have to create a backdrop painted with multiple colours. In this lesson, we have divided the backdrop into two parts, one blue and one green.

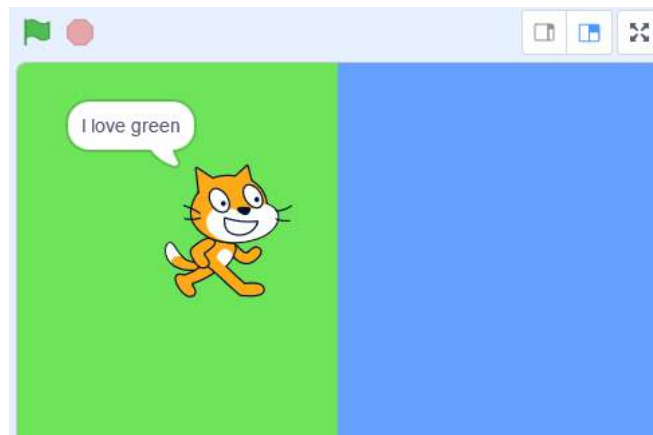


Once we have the stage painted in different colours and the character can move using the arrow keys, it is time to show how to program the conditionals. We can use this simple program:



Notice that we are using an "If-else" instruction from the Control menu (orange). We also use a "touching colour X" instruction, which is a sensor (menu sensing) that returns a "true" or "false" value depending on whether or not the sprite is over the specified colour.

With this script, every time we press the space key, our character says what colour it is on. So we can move the character with the arrow keys and when we wish, press space to see if it works.



The example could be further complicated by adding more colours and creating more complex structures with nested if-else statements.





We can find the program here:  
<https://scratch.mit.edu/projects/709575949>



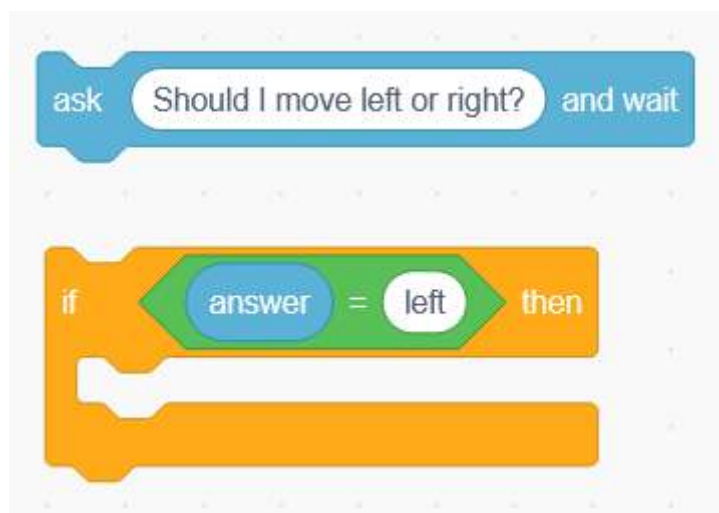
## create

### Activity: Choose your own adventure with Scratch

After this demonstration with the whole class, the idea is to divide the class into teams of two or three children, and have each team create an interactive story, where the sprites ask questions to the user, and depending on the answer they do some actions or others.

Depending on the Scratch level of the children, there are different ways to proceed.

If they have previously created a story using Scratch, you can simply show them these instructions, and see if they are able to create an interactive story using conditionals.

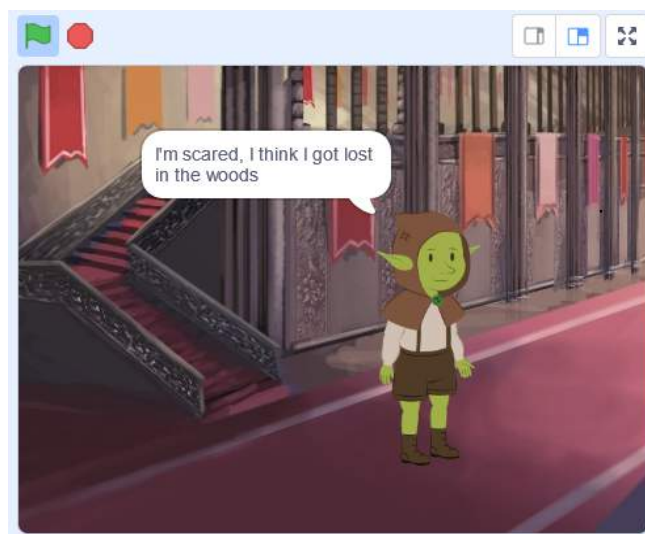
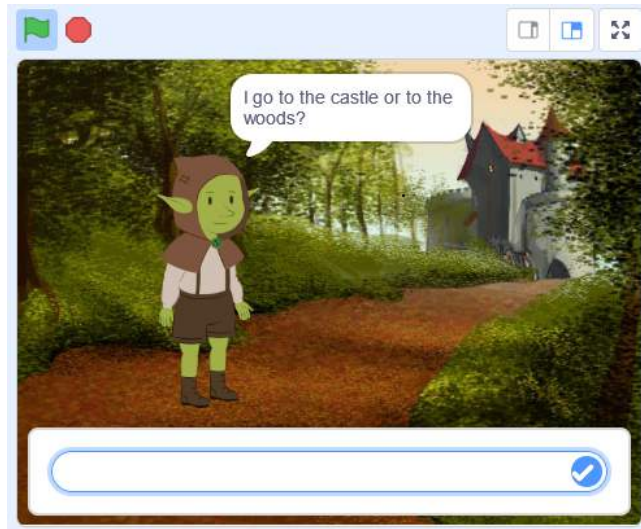


If they have never created a story with Scratch before, it is important that they first become familiar with moving characters, making them talk, and changing scenes. In the Scratch tutorials (top menu) there are several tutorials related to creating stories. A good way to learn is to have the teams follow these tutorials independently.



When they already know how to create simple stories, it's time to show them an example like the one we share below, and then let them experiment and explore for themselves.

```
when clicked
  switch backdrop to start
  ask "I go to the castle or to the woods?" and wait
  if answer = castle then
    switch backdrop to Castle
    say "Wow, this castle is amazing, let's explore it" for 2 seconds
  else
    switch backdrop to Woods
    say "I'm scared, I think I got lost in the woods" for 2 seconds
```



You can find the project here:

<https://scratch.mit.edu/projects/650412065>

### share

Give the children time to show and share their stories with the rest of the class.

### reflect

Ask the children to write a reflection in their design journal: Choose one story and give positive feedback or new ideas to continue the storyline.

<b>WORKSHOP 12: Introduction to Variables</b>	<b>Unplugged</b>	Ages 6-7 on
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<p>A <i>variable</i> is a name for information. The name represents what information the variable contains. Values can be assigned to variables. Think of variables as containers that hold information.</p> <p>To introduce the concept of variables, the students see that in an algorithm (a sequence of instructions) they can obtain a different result without having to write all the instructions again. It can also be used to work on the concept of abstract and concrete.</p>	<b>Aim</b>	Develop algorithmic thinking. Learn how to optimize plugged and unplugged programs. Develop abstract conceptualization.
	<b>Materials</b>	A set of coloured boxes representing variables, each with small variable value labels in matching colours  Strips with instructions for introduction  Paper and colour pencils
	<b>Sequence</b>	Workshop 2: Discovering Scratch Workshop 8: Loops Workshop 11: Conditionals
	<b>Related activities</b>	Workshop 13: Build a Monster Using Variables and Workshop 14: Let's play with Scratch and Variables Workshop 15: Grammar Variables

### imagine (unplugged)

Ask the children: Do you remember when we worked with Scratch and we played with setting up instructions in the program and how we could change the sequence of the instructions to make the program do different things?

Today, we want to look at how to create instructions in a way that will help us change what the program looks like or what it does, depending on how we feel.

Do you remember when we worked with grammar and we discovered the way changing the adjective in a phrase can change how something looks?

The *pink* cat drank the milk.

The *brown* cat drank the milk.

The only thing we changed in the sentence was the **adjective**, but it made a big difference to the picture in our heads of how the cat looked.

Today we're going to look at something called **variables**. Variables can change the colour of something, but they can also change many other things.

Let's have a look at what I have here. I have **code pieces**, which we will use to build a set of instructions. I also have some boxes, but we're going to keep these to the side to begin with.

### Activity

First, let's build a set of instructions. Let's imagine that we want to program a robot or a sprite, or even explain to a friend, how to draw a house. For this, we need to give them instructions in a clear sequence so that anyone following the instructions will manage to draw a house.

So, our first set of instructions might look like this:

*(Lay out the strips in sequence and follow each instruction as you read with the children.)*

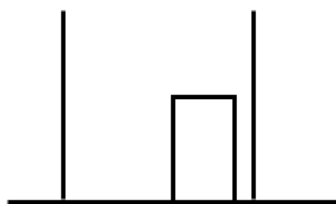
Draw the ground with a horizontal line



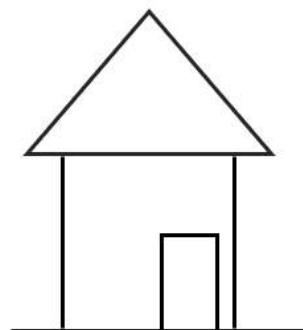
Draw the walls with two vertical lines above the ground



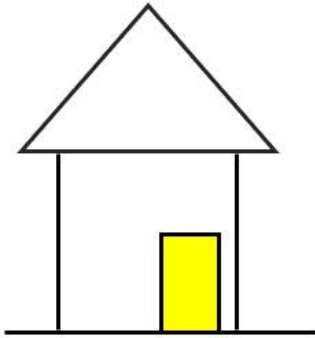
Draw the door with a rectangle on top of the floor between the two walls



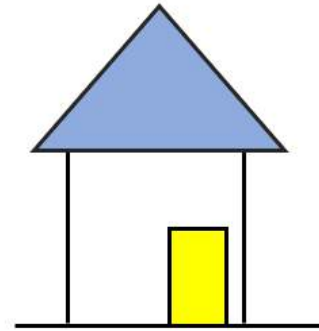
Draw the roof with a triangle standing on the two walls



Paint the door with the YELLOW colour pencil



Paint the roof with the BLUE colour pencil



Now, let's say I want the robot or my friend to change the colour of the roof. I have to repeat the set of instructions. But this time I have to change the last instruction to say "green".

Draw the ground with a horizontal line

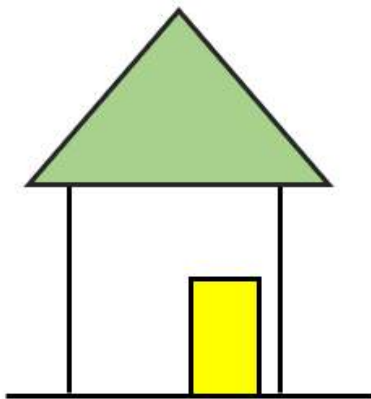
Draw the walls with two vertical lines above the ground

Draw the door with a rectangle on top of the floor between the two walls

Draw the roof with a triangle standing on the two walls

Paint the door with the YELLOW colour pencil

Paint the roof with the GREEN colour pencil



But what if I want the robot to draw a whole Village of colourful houses? Let's have it draw a house with a purple roof. What do you think I need to change now?

Draw the ground with a horizontal line

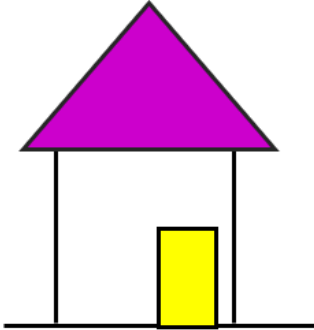
Draw the walls with two vertical lines above the ground

Draw the door with a rectangle on top of the floor between the two walls

Draw the roof with a triangle standing on the two walls

Paint the door with the YELLOW colour pencil

Paint the roof with the PURPLE colour pencil



So we have now written three programs that the robot can follow. And by doing this many different times, we could get a full village of different roof coloured houses by changing the one word in the instructions.

BUT - this could take a very long time if we needed to keep writing this every time!

NOW we can take a look at these boxes I have here. Do you see how one of them says "ROOF COLOUR" on it? Have a look inside the box, what do you see? (*labels with a variety of colours*).

In programming, we can use something called a **variable** to help us make changes to the way the program looks without having to change the whole set of instructions.

Let's take a look at our house-drawing program again. Instead of changing the roof colour every time, we can now add a variable. I'm going to call this variable ROOF COLOUR, just like the lid of the box.

Draw the ground with a horizontal line

Draw the walls with two vertical lines above the ground

Draw the door with a rectangle on top of the floor between the two walls

Draw the roof with a triangle standing on the two walls

Paint the door with the YELLOW colour pencil

Paint the roof with the ROOF COLOUR colour pencil

So, by using a variable, we only have to write one set of instructions, and we can just change the variable. In this case, we're going to change the roof colour (we could change also the



door colour). We can select any of the labels from inside the ROOF COLOUR box and place it in the instructions where we see ROOF COLOUR.

We can also say that for that case the variable ROOF COLOUR is equal to purple and write the instructions in the following way

ROOF COLOUR = PURPLE

Draw the ground with a horizontal line

Draw the walls with two vertical lines above the ground

Draw the door with a rectangle on top of the floor between the two walls

Draw the roof with a triangle standing on the two walls

Paint the door with the YELLOW colour pencil

Paint the roof with the ROOF COLOUR colour pencil

purple

What if we want our village to have not only coloured roofs but also coloured doors?  
Would we need to write two programs with a variable each?

Not at all! We can put more than one variable in the same program. In this case we could have a variable for the door colour and a variable for the roof colour. So a program that draws a house with a red roof and a green door would look like this:

ROOF COLOUR = RED

DOOR COLOUR = GREEN

Draw the ground with a horizontal line

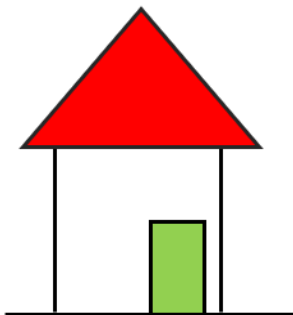
Draw the walls with two vertical lines above the ground

Draw the door with a rectangle on top of the floor between the two walls

Draw the roof with a triangle standing on the two walls

Paint the door with the DOOR COLOUR colour pencil

Paint the roof with the ROOF COLOUR colour pencil

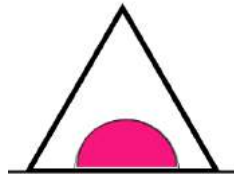


To introduce other cultures into the class, after this example, we can ask children about how houses are around the world. Challenge them to create a sequence of instructions to draw them:



**IGLOO**

A house constructed with packed snow blocks typical of Inuit hunters in the Arctic and Alaska because of the cheap cost of the materials and their usefulness for the winter time.



**TIPI**

A tipi is a conical tent made of animal skins or fur stretched over wooden poles. It is associated with tribes of Native Americans.



**JAIMA:**

A shelter used by nomadic people of north Africa. It is built like a tent, using canvas supported on poles and held in place by ropes.

**Create (unplugged) [unguided]**

**Play**

Children can now gather in pairs or small groups and start creating their coloured villages using this procedure: they build the drawing program placing the strips of the instructions in the order that makes it possible to build the house. Every time they want to draw a different house they get the colours they want for the roof and for the door from the ROOF COLOUR and DOOR COLOUR boxes, and they place it in the variable instruction. They proceed to draw the house using the instructions.

**Share [guided]**

**Reflect**

In the whole group or in smaller groups, reflect and share about the colourful villages they built. The teacher can ask what would happen if we wanted more elaborate houses. We want the program to draw more elements in it: a window (of a round shape, square shape), a chimney, etc. Not only colours can be introduced as variables, but also geometrical shapes and all kinds of things. Students can draw new ideas in their design journals.



*This activity is inspired in the "Envelope Variables" proposal in <https://curriculum.code.org/csf-18/coursef/14/>*



<b>WORKSHOP 13: Build a Monster Using Variables</b>	<b>Unplugged</b>	Ages 6-7 on
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<p>Think about variable things in real life. For example, when cooking a recipe, the number of guests. Think about the concept of “abstract” and “concrete”.</p>	<b>Aim</b>	Creative application of variables
	<b>Materials</b>	<p>Sets of monster body parts that include: bodies in a variety of colours, eyes, arms, legs.</p> <p>Multiple sets of Monster Program instructions</p> <p>Variable boxes with CB (COLOUR BODY), NUMBER EYES, NUMBER ARMS, NUMBER LEGS</p>
	<b>Sequence</b>	Discovering Scratch, Loops, and Conditionals
	<b>Related activities</b>	Workshop 12: Introduction to variables and Workshop 14: Let's play with variables and Scratch

### imagine (unplugged)

We are going to explain to the students that we are now going to use variables to be creative. Explain the contents of the box such as this one, with monster body parts.



Now explain how we will use the instructions to build a monster:

- We first choose a colour body.
- Then we attach some eyes to the body.
- Then we add some arms to the body,
- and then we will add some legs to the body.

The colour of the monster and how many eyes, arms and legs will depend on the **value** we select for each **variable**.

Introduce the set of instructions for programming a monster:

Pick up a body of colour CB

Attach (NUMBER EYES) to the body

Attach (NUMBER ARMS) to the body

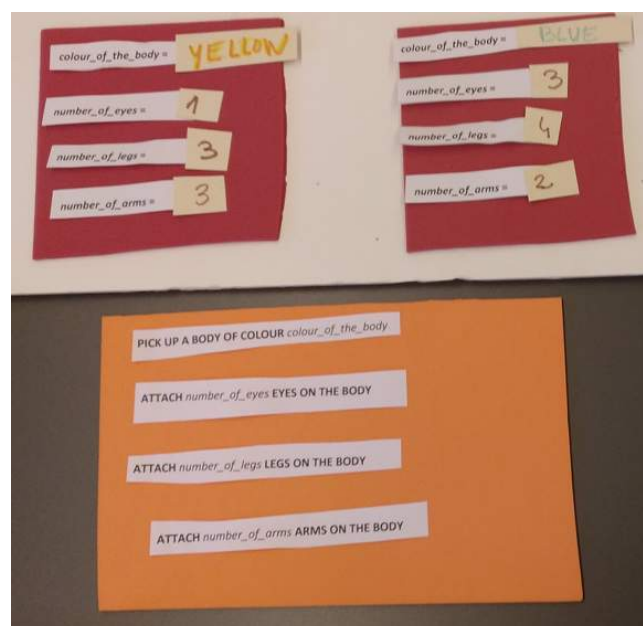
Attach (NUMBER LEGS) to the body

Demonstrate how to find the values for each variable in the correct box. Build an example monster.

**create (unplugged)**

**play**

The students can now use the set of instructions with the variable boxes to create their own monster. They can do this in pairs or small groups. First, one or two students puts together the instructions and then the partner (or partners) build the monster.



An example of the instructions to build two “variable monsters”, and a view of the whole set-up (example):



**share**

**reflect**

All together can reflect and share about the variable monster built. The teacher can ask how we could build monsters with still more variables (for example shape of the head), and for how long could we keep introducing variables. In their design journal, depending on the age of the children, ask the children to reflect on the concept of general and specific - general: “a monster”, specific: “a blue monster, with 3 eyes, 4 legs, etc”.... How much can you change something by only changing a single variable? What if you changed 2? 3? Etc.

In their journal, the children may also draw their monster and write the set of instructions they used, including the variables they chose for their creation.



This activity is inspired in the “Envelope Variables” proposal in <https://curriculum.code.org/csf-18/coursef/14/>

<b>WORKSHOP 14: Let's play with Scratch and Variables</b>	<b>Plugged</b>	Ages 8-12
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<p>In coding, a <i>variable</i> is a storage of values (text or numbers) that can be modified through the program.</p> <p>In this activity, we will see how we can use variables in Scratch.</p>	<b>Aim</b>	Apply and practice the concept of <i>variable</i> through several examples coded with Scratch.
	<b>Materials</b>	A few computers (one per team) and internet access to the Scratch platform ( <a href="https://scratch.mit.edu/">https://scratch.mit.edu/</a> )
	<b>Sequence</b>	Prerequisites: Discovering Scratch workshops, Workshop 12: Introduction to Variables and Workshop 13: Build a Monster Using Variables, activities about conditionals are also recommended
	<b>Related activities</b>	Workshop 13: Build a Monster Using Variables

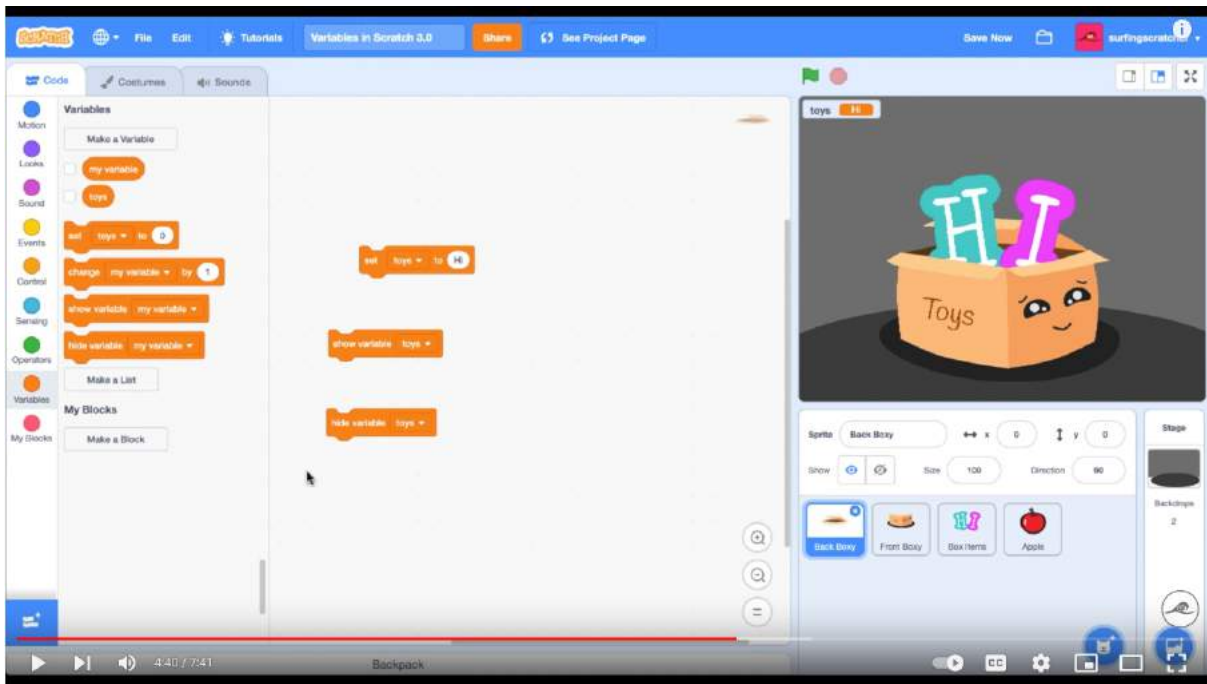
This workshop requires some previous practice with Scratch. It is not intended as a starter activity. The activity will also work better if the unplugged activities on variables have been previously completed. For some parts of the workshop, knowledge of conditionals is also important.

### imagine

At the beginning, we can use this 7-minute video as a spark for the children to see some examples of using variables in Scratch and understand its concept. It is a small tutorial, but the idea is not that through it they will understand everything, and that they will be able to program variables. It is only a possible starting point before getting down to work with the following examples. It is totally optional, and there are many other similar videos on YouTube.

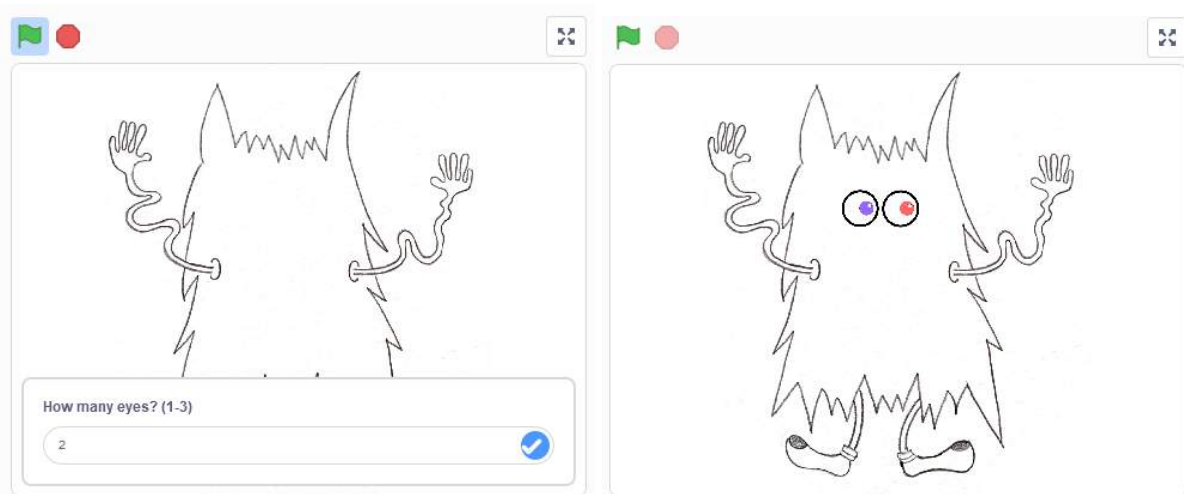


<https://youtu.be/wS1QETPfgGE>



## play create

Let's start with a very simple example that continues the "Build a monster using variables" activity by putting the monster inside Scratch and playing with changing its number of eyes using a variable.



The project incorporates the monster's body using a backdrop. Apart from this, there is a single sprite (the eyes) that asks the user how many eyes. The user has to enter a value between 1 and 3, and depending on the answer the sprite's costume is changed to have 1, 2 or 3 eyes.

This example uses the "ask" and "answer" blocks. *Answer* is a variable that Scratch already gives us, we don't have to create it. And it stores the answers that the user enters (texts or numbers) when answering the question generated by the "ask" block.

So what our program has to do is to start hiding the sprite (so that there are no eyes), ask the user how many eyes he/she wants, and then, by means of conditionals, check if the answer is 1, 2 or 3. If the answer is 1 we will change the costume putting the one with only one eye, and so on. Finally, it is necessary to show the sprite to see the result.

```
when clicked clicked
hide
ask How many eyes? (1-3) and wait
if answer = 1 then
  switch costume to 1
if answer = 2 then
  switch costume to 2
if answer = 3 then
  switch costume to 3
show
```

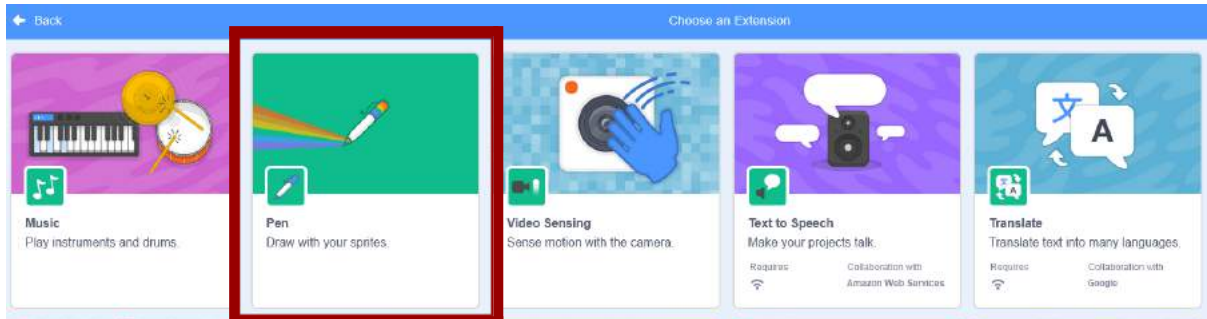
The variable "answer" keeps the number of eyes chosen by the user.

This script can, in fact, be optimized because since in the example the names of the different costumes are the numbers 1, 2 and 3, then we can choose the costume by simply putting the variable "answer" inside the "switch costume to" block. This piece of code does exactly the same that the previous one:

```
when clicked clicked
hide
ask How many eyes? (1-3) and wait
switch costume to answer
show
```



After playing and practicing with the previous example, we can complicate it a bit by adding another variable: number of mouths. In the example below, we will use some instructions from the “Pen” menu (to access this menu, we need to add the Scratch extension with the same name “Pen”). The extensions are added with the blue button in the lower left corner of the interface.

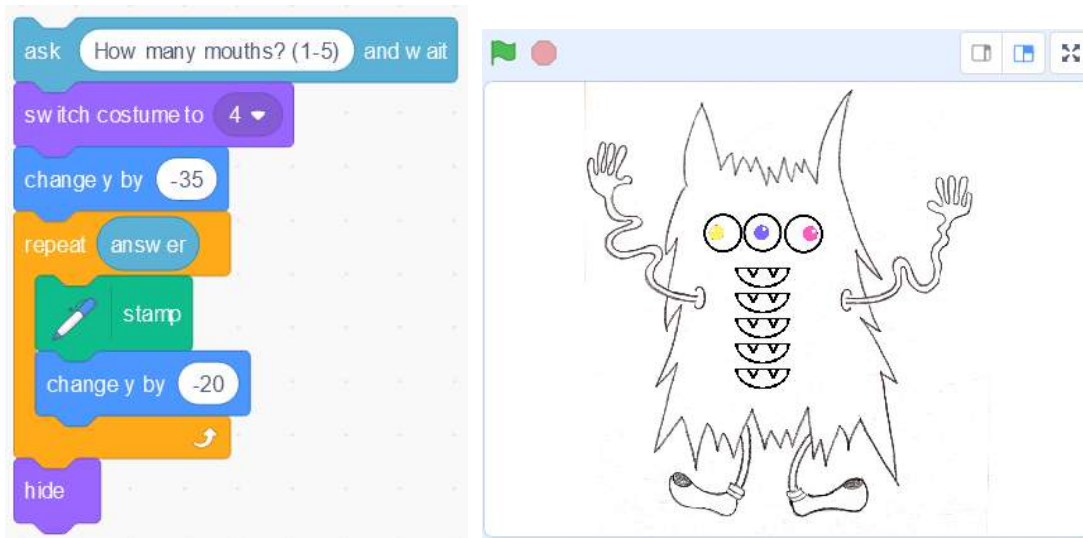


The program is very similar to the previous one, but this time we start erasing all and placing the sprite just at the point (x,y) where the eyes will go. We do it this way because in this program we are going to move the sprite, and we will be stamping it. So every time we run the program, we have to place the sprite in the initial point. The other difference is that when the user has already answered the name of the eyes, and we have changed the costume, we have to use the "stamp" block.

```

when green flag clicked
  hide
  erase all
  go to x: -20 y: 60
  ask "How many eyes? (1-3)" and wait
  if answer = 1 then
    switch costume to 1
  if answer = 2 then
    switch costume to 2
  if answer = 3 then
    switch costume to 3
  show
  stamp
  
```

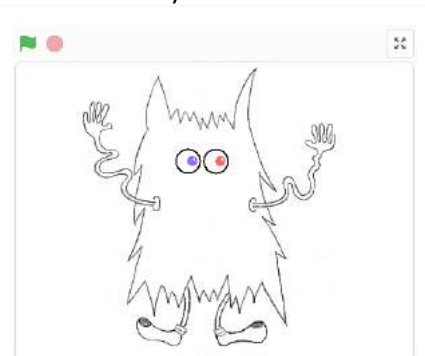
We can continue the program with this other piece of code, where when we know the number of mouths the user wants, we use a loop to stamp them. Inside the loop, we decrease the Y of the sprite so that the mouths go descending. It is also important to mention that previously, with the Scratch graphic editor, we have created the costume number 4, which is the drawing of the mouth.



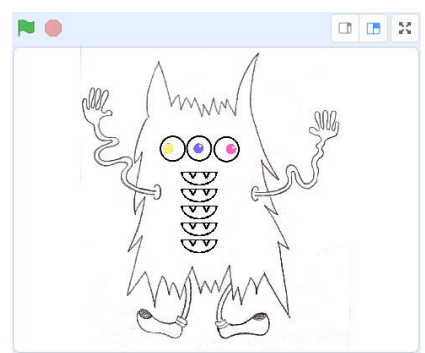
You can play with the code of both versions (only eyes & eyes and mouth) here:



<https://scratch.mit.edu/projects/710159905>



<https://scratch.mit.edu/projects/709482662>

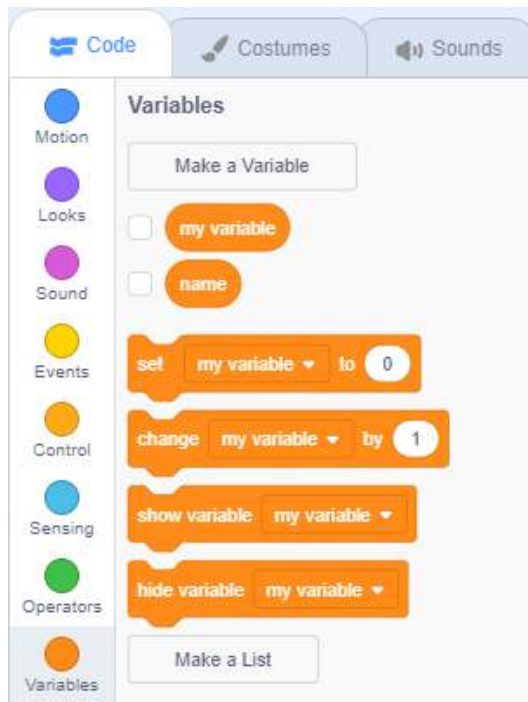


Another way to continue working with variables and Scratch could be to show the whole class an example of a program where we want the user to choose a nickname in the story or

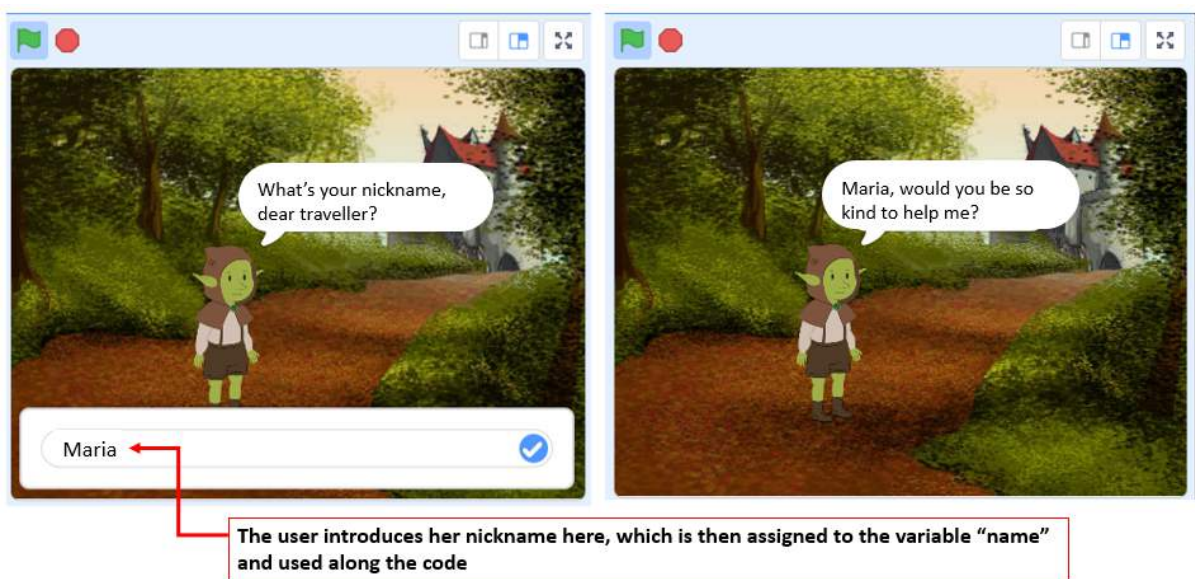


as a player. We store the name in a variable, so we can keep using it in different parts of the program without having to enter the name in all the places of the code where it appears.

Here, unlike in the previous example, we are going to create the variable ourselves. A variable with any name can be created by clicking at the variables box in the instructions family window:



As an example of the use of variables, we can take the Activity “Choose your own adventure with Scratch” (page #), and modify it, so the user can choose a nickname and the sprite addresses to it.



In this case, we have created the variable "name" in the orange "family of instructions" and introduced it in the program in this way:

```
when clicked
  switch backdrop to Start
  ask Whats your name, dear traveller? and wait
  set name to answer
  say join name , would you be so kind to help me? for 4 seconds
  ask Shall I go to the castle or to the woods? and wait
  if answer = castle then
    switch backdrop to Castle 3
    say join Wow! This castle is amazing, name for 4 seconds
  else
    switch backdrop to Jungle
    say join name , I am scared! I think I got lost in the woods! for 4 seconds
```

Note that when we want to join the saved answer with a sentence, we can use the "join" block of the "operators" menu (green). And the sentence that results from joining the variable with the text that we have chosen can then be put inside the block "say" so that the sprite says the whole statement and appears on the screen during the seconds that we choose.

**play**  
**create**

After showing the example, the children can work in pairs on a computer and check this:

	<a href="https://scratch.mit.edu/projects/636011398">https://scratch.mit.edu/projects/636011398</a>	
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They can explore the program, remix it, and write their own program where they have to use variables to keep the names of the users.

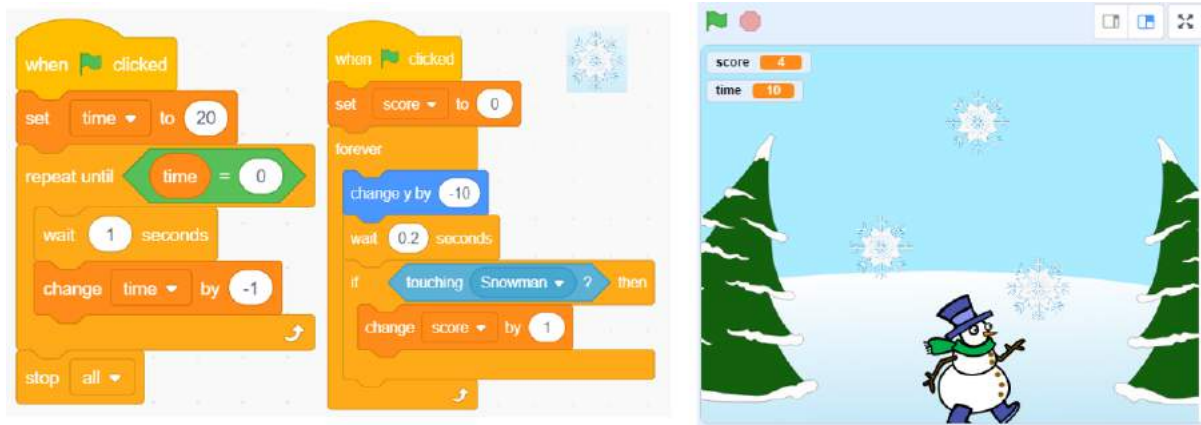
If the students have enough experience with Scratch and find the previous examples easy, the following examples can be very interesting to continue working with variables and get used to them. If not, they can continue learning by playing with the previous examples and making small variations of them.

### imagine

Another example of the use of variables is to keep track of countable items, such as score or time.

In this example, two variables have been defined:

- The variable **time**: at the beginning of the game it has been set up to 20 and when the game starts 1 is subtracted from it every second. When it reaches 0 the game stops.
- The variable **score**: At the beginning of the game is set to 0. The score goes up 1 point every time a snowflake is touched by the snowman (which is programmed to move to the left and to the right with the arrow keys).



You can run this scratch program and look inside in this link:  
<https://scratch.mit.edu/projects/636028655>

### play

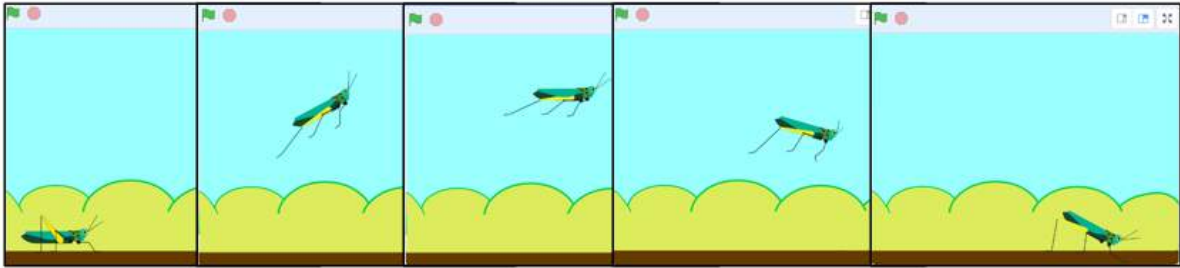
### create

Children can explore the program, re-mix it, and write their own program where they have to use variables to keep track of time or a score.

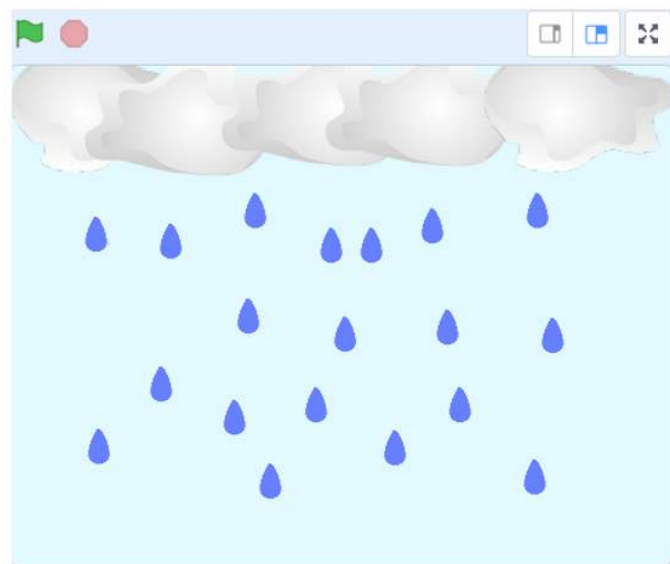
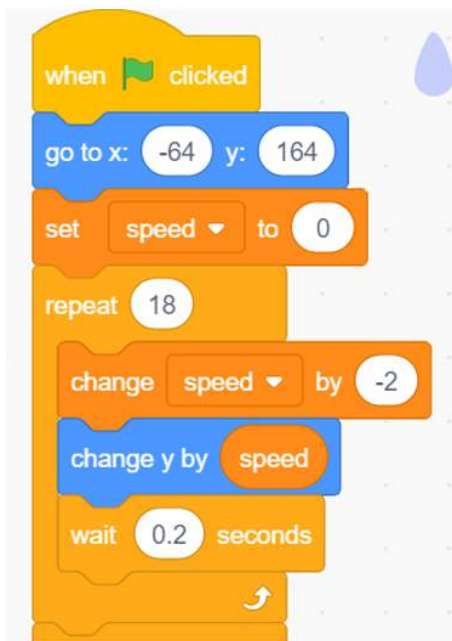
### imagine

In these last examples, a variable **speed** is used in an animation to change the vertical speed of the sprite (the grasshopper, the rain drops...) and, therefore, simulate a gravity effect (moving faster as it approaches the ground).

You can run these scratch programs and look inside at these links:



Jumping grasshopper: <https://scratch.mit.edu/projects/636037081>



Rainy day: <https://scratch.mit.edu/projects/636033872>

## play

## create

The children can work in pairs on a computer and choose either they want to explore and play the rainy day program or the grasshopper program.

They can explore the program, remix it, and write their own program where they have to use variables to speed up or slow down sprites.

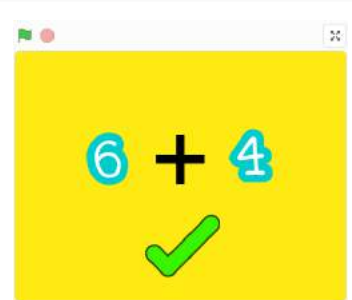
## share

## reflect

Children can share all together their discoveries and their creations, and reflect about what they have learned and how they want to keep going on. Show your project to a classmate. Ask them to say one thing they like about your project. Ask them to say one thing you could try in your project. Write all these ideas in your design journal.



<https://scratch.mit.edu/projects/709482561>



<https://scratch.mit.edu/projects/709491507>



# Chapter 3: Incorporating Technology Across the Curriculum



<b>WORKSHOP 15: Grammar Variables</b>	<b>Unplugged</b>	<b>Ages 6-9</b>
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<p>Each part of speech in grammar has a particular role in our language. When we change these, we can see how the meaning changes.</p> <p>Variables change the values in coding. By changing the value of a variable, we change the way the program runs.</p>	<b>Objectives</b>	Understand how changing values changes the product
	<b>Vocabulary</b>	Parts of speech, variable
	<b>Materials</b>	<ul style="list-style-type: none"> <li>• Story of Kingdom of Speech (see shared Drive)</li> <li>• Packets of word cards for each part of speech (see shared Drive)</li> <li>• Sentence pattern cards (see shared Drive)</li> </ul>
	<b>Prerequisites</b>	Introduction to variables Montessori Grammar (Parsing) Boxes (See Appendix 1)
	<b>Related activities</b>	Workshop 6: Scratch as a language and its follow-up activities



## imagine

Have you ever thought about the power of words? Have you considered how changing a single word in a sentence can make a completely different meaning? Language is very powerful, and selecting the right word is important if we want others to know exactly what we are thinking or what we mean.

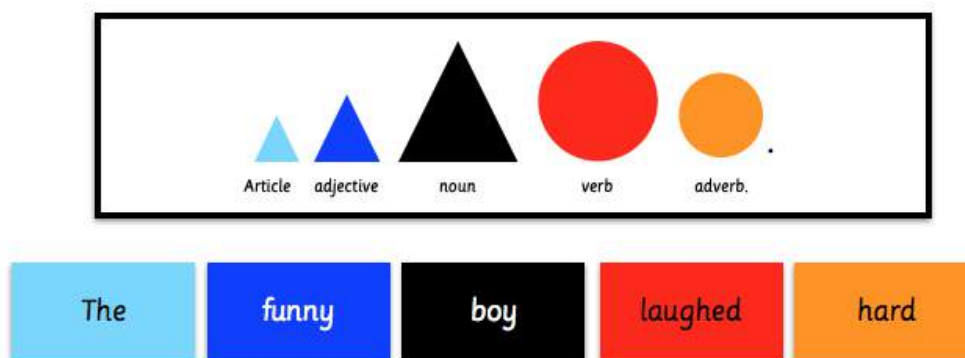
**Tell the story of the Kingdom of Speech** (see shared Drive). This will help to illustrate the power of words, the function of the different parts of speech in our language, and bring alive a “boring” lesson in grammar.

## create

(Relate to the Montessori parsing boxes, if relevant. See Appendix 1 for presentation.) Present the children with the symbols of each part of speech, reviewing the role each part of speech has in the sentence or in our language.

Lay out a sentence with the sentence card and build a sentence with the individual word cards. Now switch out one card (for example, a noun) with a different card (a new noun). Discuss what happens to the sentence.

Present the parts of speech packets, explaining how they relate to the parts of speech symbols (colours). Show the sentence strips with symbols and names of the parts of speech. Use the strips to create a sentence by finding a word from each coloured packet.



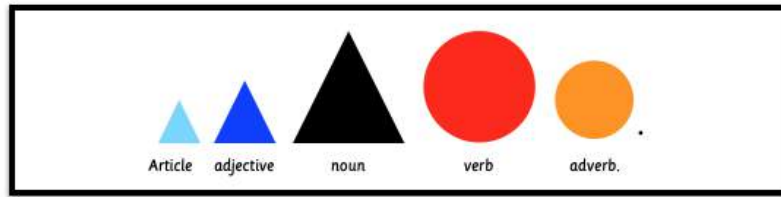
Explain that we can now change each of these parts of speech by replacing the word card with another word card from the corresponding packet.

## play

Experiment with creating new sentences by changing one or more parts of speech. Allow students to find how many variations they can make using a single sentence strip.

Alternatively, students can create a sentence, writing it down on a paper (without colours or symbols) and ask a friend to guess which sentence strip was used.

Relate to work with variables.



The	funny	boy	laughed	hard
The	funny	clown	laughed	hard
A	silly	clown	fell	hard

**reflect**

In their design journal, encourage the students to reflect on the power of language. How does changing one word in a sentence affect the meaning? How can you be creative with language? Why do you think it is important to consider which words you use?

Draw a sequence of grammar symbols. How many sentences can you make using the symbols and making variations of a part of speech?

<p><b>Follow-up Activity: Create a Sentence - dice game</b></p>	<p><b>Plugged</b></p>	<p>Ages 6-12</p>
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See *shared Drive* for the document with the game die and printable cards. The template for the dice can also be found in Appendix 3 of this guide.

## play

Place all the cards in 9 stacks, with the symbols face up.



The goal is to be the first to create a complete sentence that makes sense. The players take turns, clockwise.

Throw the die and take a card from the pile with the same symbol. Read the word on the card and place it in front of you, with the word showing so the other players can read it.

The next player continues, rolling the die and collecting a word card.

As you collect the words, try to arrange the words into a sentence that makes sense. You may have multiple cards of the same part of speech, and these can be moved around in the sentence, but you do not have to use all the cards in the sentence.

- If you roll “Free Choice”, you may choose a card from any of the 9 piles.
- If you roll “Trade to the left”, you can trade one card with the player on your left. The one who rolled the die can decide which card he wishes to give the other player AND which card he wants from the other player.
- If you roll “Trade to the right”, you can trade one card with the player on your right. See the rule above.

The first player to put together a complete sentence wins the game.

## reflect

In their design journal, students answer:

- 1) Which parts of speech were most important for you when you were building your sentence? (Children will realize that they need a subject and a verb for a complete sentence, and usually, these will be the cards most traded for.)
- 2) How does trading out a word affect the sentence?



<b>WORKSHOP 16: Art with Scratch - Randomness and Loops</b>	<b>Plugged</b>	Ages 8-12
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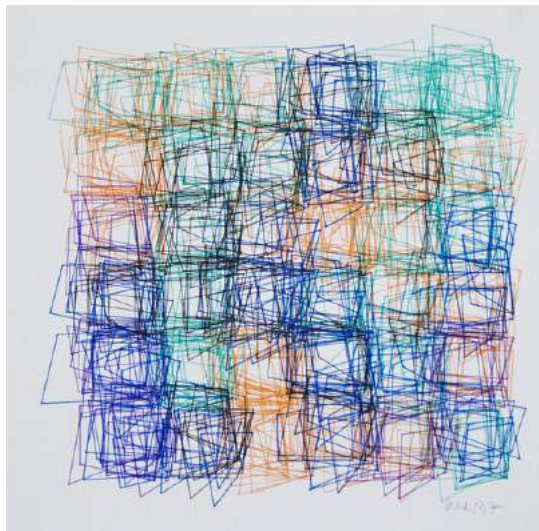
<p>In programming, loops are elements that repeat a portion of code a set number of times until the desired process is complete. Repetitive tasks are very common in coding, and loops are essential to save time.</p> <p>The use of randomness is an essential characteristic of computer art. In this activity, we will explore some ways of using randomness in digital visual art.</p>	<b>Aim</b>	Discover what loops are and how we can play with randomness.
	<b>Materials</b>	computers, Internet connection
	<b>Sequence</b>	After Discovering Scratch, intro to loops
	<b>Related activities</b>	Workshops 10 and 11 about conditionals and Workshops 7 and 8 about Loops

### imagine



A good way to start imagining is to let children explore how randomness is linked to art. One possible way is to show them works by **Vera Molnár**, a pioneering of computer art, with a work strongly related to the concept of randomness:

[https://en.wikipedia.org/wiki/Vera\\_Moln%C3%A1r](https://en.wikipedia.org/wiki/Vera_Moln%C3%A1r)



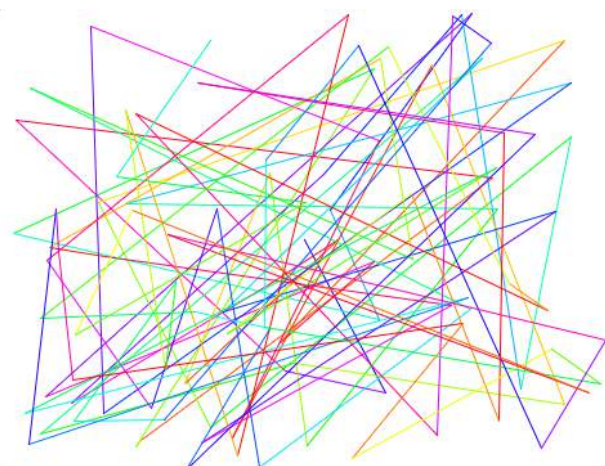
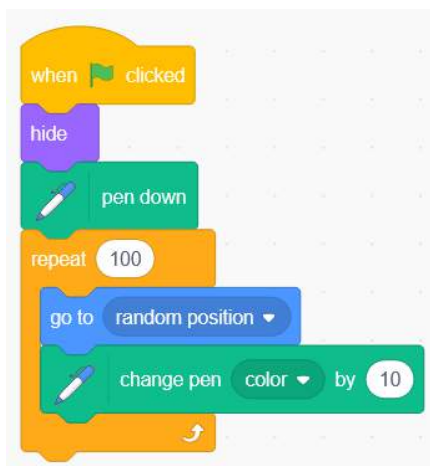
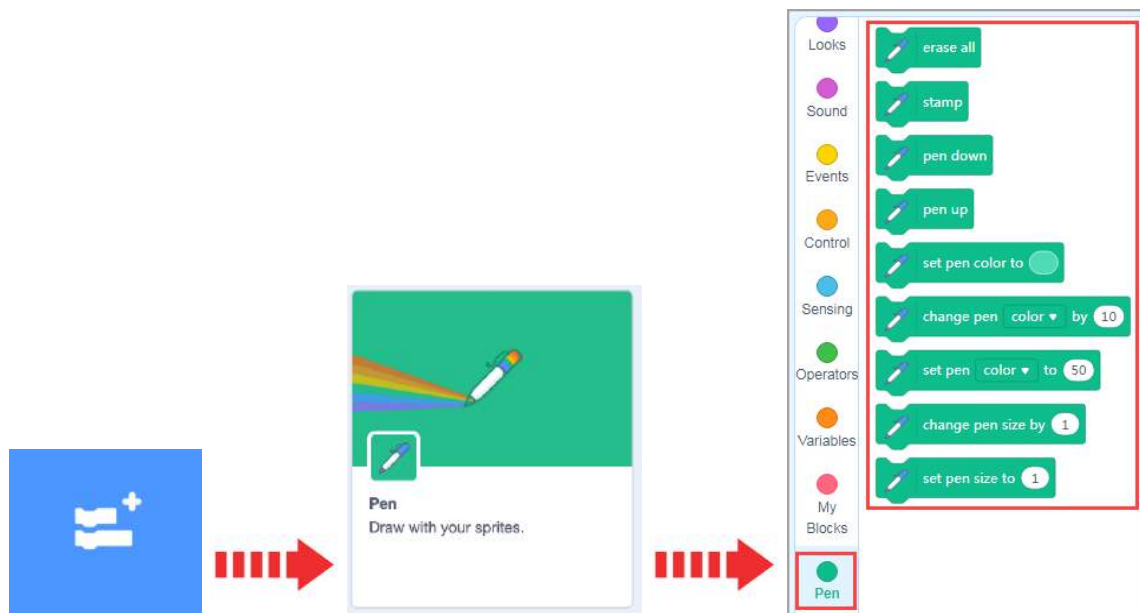
Children can start by searching for her works on the Internet, and then, in their journals, try to discover and reproduce the processes followed by Vera Molnár.

Once they have looked at some of the artist's work, and imagined some drawings in their journals, it's time to move on to the action with Scratch.

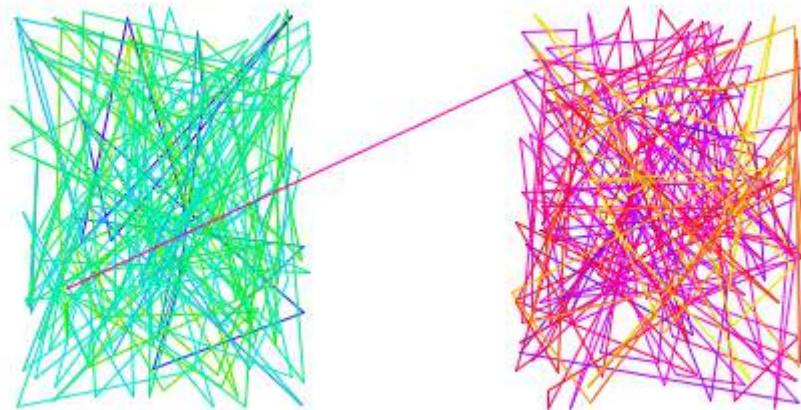
## create

## play

Using the "pen extension", the "pen down" and "pen up" instructions, some loops, movement instructions, and other instructions that children can add, very simple programs can be created that draw amazing random shapes and lines on the stage. Here are some examples.



```
when clicked
hide
go to x: -100 y: 0
erase all
pen down
set pen color to blue
repeat 200
  go to x: pick random -200 to -50 y: pick random -100 to 100
  change pen color by pick random -5 to 5
set pen color to magenta
repeat 200
  go to x: pick random 50 to 200 y: pick random -100 to 100
  change pen color by pick random -5 to 5
```

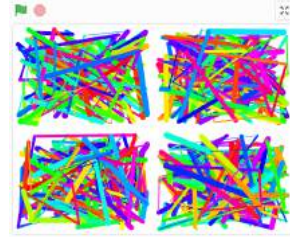


Let children freely explore the Pen extension instructions, but make sure they add some loops and some random elements to their programs. The randomness may be associated with the positions where the sprite is directed, or the colours of the pen, or the thickness of the lines, etc.

The pieces of code we have shared are just examples. They can be used as starting points and as inspiration to generate new projects and artistic creations. You can find a project to remix here:



<https://scratch.mit.edu/projects/638054696/>



A good place to learn about the possibilities of this extension is this Scratch wiki:



[https://en.scratch-wiki.info/wiki/Pen\\_Extension](https://en.scratch-wiki.info/wiki/Pen_Extension)

### share

Once the children have created and played with the “pen extension” and the concept of randomness, a nice and simple activity to do is to create a virtual art gallery. In Scratch, the projects we have shared can be placed in studios where people can find them.

Check this Scratch Wiki where you can learn how to create studios and put projects in them:



<https://en.scratch-wiki.info/wiki/Studio>

And you can check a Scratch studio with projects about loops and randomness in art, made by European teachers and educators during the MonTech training the trainers event:





<https://scratch.mit.edu/studios/31032630/>

### reflect

After the children have shared their Scratch art projects, it is a good time to reflect on what they have learned.

A good question to ignite these reflections might be: How do you think it is easier to create loops and randomness when drawing? Using the computer and Scratch, or using traditional media (pencils, paintbrushes, etc.)?

As they answer and think about it, they can use their journals to try to make a small drawing using some loops and randomness in their process. They can also draw again some of Vera Molnár's designs, but this time trying to understand the "algorithm" that lies behind them.

<b>Follow-up activity: Colours, Loops, Randomness and Watercolours</b>	<b>Plugged</b>	<b>Ages 6-12</b>
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Using the same idea from the previous activity, we can again use Scratch to play with art, loops and randomness. This time, instead of drawing lines with the pen extension, we will stamp the sprite on the stage. The sprite that we will stamp will now not be one of the default ones in Scratch. Instead, we will create it by drawing a spot or stain with watercolours in our journal, taking a picture of it, and uploading it to Scratch.

### imagine

The children can start by imagining some shape or form and capturing it in their notebook using watercolours (if they do not have watercolours, they can use any other type of paint, or crayons, markers, etc.). In our example, we are going to use this blue circular spot made with watercolour.



## Create

### play

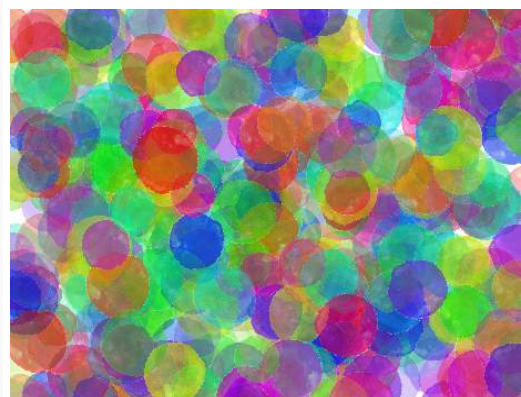
After they finish their shapes, they can take a photo of them and upload them in Scratch as “sprites”.

When you create these new sprites, you will have to erase the background of the form (that is, the blank page of the journal). This can be done from the Scratch graphic editor, with the "eraser" tool and a bit of patience, or it can also be done before uploading the photo, using an automatic background removal system like this one:



<https://www.remove.bg/>

Let the children experiment with creating programs that stamp their sprite, using loops and randomization. The "set X effect to" blocks are ideal for making shapes change colour, change transparency, add effects, and so on. Here you have a piece of code that you can use as a starting point, and begin creating and remixing:





<https://scratch.mit.edu/projects/709609254>



If you don't want to use the watercolours, you could also use the same exact script with any of the default Scratch sprites. Here an example of what happens if we use the Scratch cat:



<https://scratch.mit.edu/projects/709604820/editor>



**share**

**reflect**

After the children have shared their projects in the gallery, it is a good time to reflect on what they have learned and to invite everyone to show their projects.

A good question to spark these reflections might be: Which is the difference between drawing with the computer and with traditional art tools? Do you prefer using the computer and Scratch, or traditional media (pencils, paintbrushes, etc.)?

Children can also reflect on it in their journals, or write in natural language an algorithm that generates a drawing, and produce that drawing as if they were a robot (kidbot) that interprets the code.

<p><b>Follow-up activity: Movement in Art</b></p>	<p><b>Plugged</b></p>	<p>Ages 6-12</p>
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Both kinetic and optical art are artistic trends based on the aesthetics of movement. In both cases, the works that are part of them have movement or seem to have it.

The main difference between the two (although sometimes the border is blurred) is that in kinetic art the movement is usually sculptural (in a three-dimensional space) and optical art (Op Art) usually focuses on pictorial representation in two dimensions.

In this activity, we will explore how to make Op Art with Scratch.

### imagine

A good way to start is to let children freely explore the artwork of **Bridget Riley**, a pioneer of Op Art, who has spent decades creating abstract forms designed to explore the potential of optical effects.

If the children are too young, instead of letting them explore on the Internet, you can show some of Riley's most significant works (if you can have them printed in large size, the bigger, the better).

And obviously, if there is a museum nearby with Riley's work, this would always be the best option to start with.



Bridget Riley (Wikipedia)  
[https://en.wikipedia.org/wiki/Bridget\\_Riley](https://en.wikipedia.org/wiki/Bridget_Riley)



### Create

#### play

With Scratch, we can create optical or kinetic artwork in many different ways, from very simple to very complex projects.

We propose that the children start with a very simple project. The idea is that they download Bridget Riley's "*Uneasy center*" artwork from the Internet, put it inside Scratch as a sprite, and simply make it turn, using a 'Forever' loop and the 'Turn' instruction. The optical effect is beautiful.





*Uneasy center* (1963), Bridget Riley.

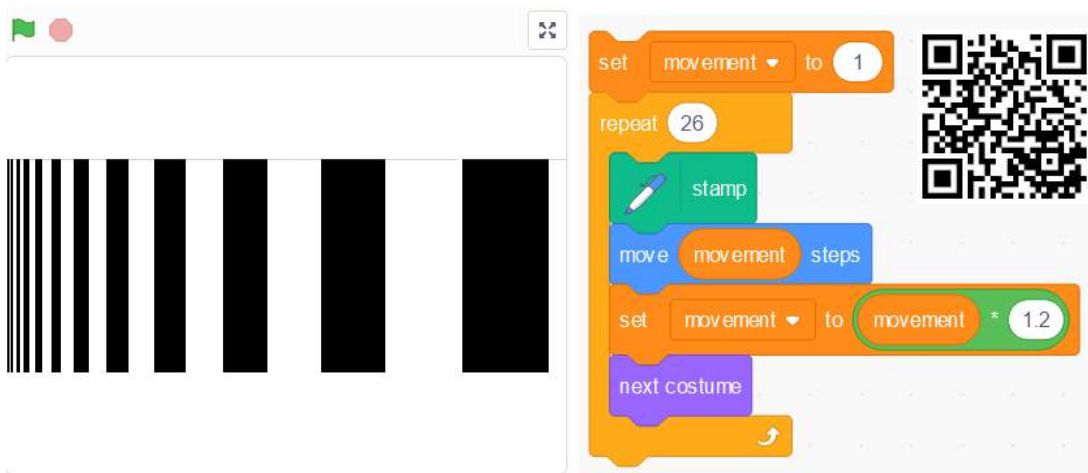
Scratch project:

<https://scratch.mit.edu/projects/709787827/>



Another fun option, although a bit more elaborate, is to print this spiral (or let the children draw a similar one) and attach it to a small motor to trigger the movement. We can also generate the movement with a stick and our hands.

If the children have already done the introductory workshops on variables, a simple Op Art activity that we can do with Scratch is the following. We need a sprite that is a black rectangle (we can create it with the Scratch graphic editor). To that sprite, we add a costume that is the same rectangle but painted white. And now, if we move this sprite, we change the costume, and we stamp it (the instruction 'stamp' is in the 'pen extension'), we can create beautiful effects like the following one.



### reflect

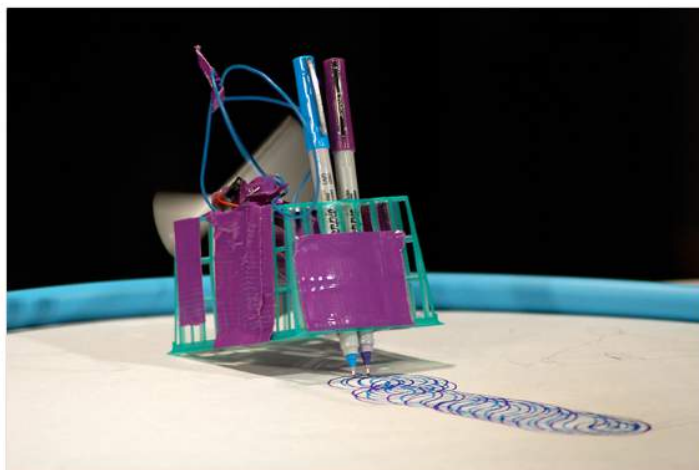
Ask children to write in their journal a reflection about how they got this effect in their artwork. Make sure the children realize that in the example we use a variable 'movement' that increases with each iteration of the loop. The rectangles are overlapped leaving each time more space between them, in this way the optical effect is achieved.

<b>WORKSHOP 17: Scribbling Machines</b>	<b>Unplugged</b>	Ages 6-12
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<p>This is one of the classic activities of the Tinkering Studio. Its structure and development are very much in tune with the Montessori approach.</p> <p>Children creating a scribbling machines can also play with variables: the length and weight of the eccentric motors, methods of drawing, materials used for the base, the speed of the motors, etc.</p>	<b>Aim</b>	<p>New use for everyday objects.</p> <p>This is a playful and inventive way of using harvested motors and switches from discarded toys and electronics.</p>
	<b>Materials</b>	<p>1.5-3.0 Volts DC motors (you can find motors in all sorts of toys and common household objects), batteries, markers, masking tape, and everyday objects (like paper cups, caps, etc.).</p>
	<b>Sequence</b>	<p>Prerequisites: none</p>
	<b>Related activities</b>	<p>Workshop 14: Let's play with Scratch and Variables Workshop 16: Art with Scratch. Randomness and loops.</p>

**the tinkering studio**

Experiments with science, art, technology, and delightful ideas.



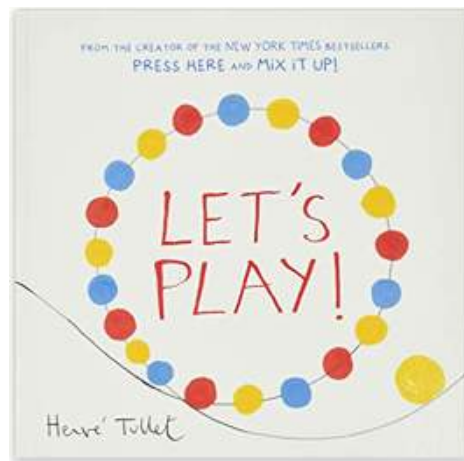
Check the website for more information and PDFs with detailed instructions in several languages (© 2017 Tinkering Studio, Exploratorium):

<https://www.exploratorium.edu/tinkering/projects/scribbling-machines>

*“A Scribbling Machine is a motorized contraption that moves in unusual ways and leaves a mark to trace its path. It’s made from simple materials and demonstrates the erratic motion created by an offset motor. We like using harvested motors and switches from discarded toys and electronics and everyday objects like strawberry baskets and milk cartons in our creations. Try changing the length and weight of the eccentric motors, testing various drawing tools, experimenting with materials used for the base, and increasing and decreasing the speed of the motors. You will be amazed at the different motions and patterns you can create”.*

## imagine

To introduce this activity to lower-primary children, it is nice to read them a book, for example *“Let’s Play”* by Hervé Tullet (Chronicle Books, 2016) to talk about play, randomness and colour.



After the reading, the teacher can ask children: *Would you like to build a scribbling machine? How do you imagine it?*

Then, invite children to bring recycled materials from home.

It’s also important to create an environment that fits well with these types of activities. A warm and comfortable environment can help to turn on the imagination of children. So we suggest covering the table (or some part of the floor) with large pieces of paper or cardboard, so they can experiment with the scribbling machines.

If the children are older and have already completed Workshop 16 (Art with Scratch), you can also start by asking them how we can generate random movements in the physical world. In Scratch it was easy because we had instructions that generated random values, but how do we create random processes in the physical world without using programmable devices?

## create

To create a scribbling machine you need a battery, a hobby motor (1.5 to 3V) that you can find in a lot of toys, recycled containers such as a yoghurt cup and markers.



To the axis of the motor we have to attach some off-center element, with the intention that when the motor rotates, it causes vibrations throughout the whole of our "robot". These vibrations will make our creation move over the surface where we have left it, and if its legs are markers, it will draw shapes (more or less random) on the paper.

The idea is for the children to experiment by changing some of the objects, or their positions, to see how this changes the result of the final drawing. Let the children collaborate in teams and decorate their creations.

## play

In this part, the teacher can suggest the children decide a name for their robot, put all the scribbling machines in the same paper and enjoy the beauty of a lot of colours together.



This is a very playful activity, and children can play with their creations, exchange them, try different designs, colors, surfaces, etc.



Ask the children if they would like to display the results. It is possible to hang the papers on the walls, making an exhibition of scribbles.

**share**

**reflect**

At the end of the activity, children can share all their creations together and reflect on what they've learned and how they want to keep going on.

There are many physics concepts to think about: vibration, surface friction, etc. Depending on the age of the children, this activity is a very good opportunity to go deeper into them.

Beside using their journal to design the prototypes and to write down their reflections,

children can also use them as canvases on which the scribbling machines can move. This way they will have the result directly in their journal.



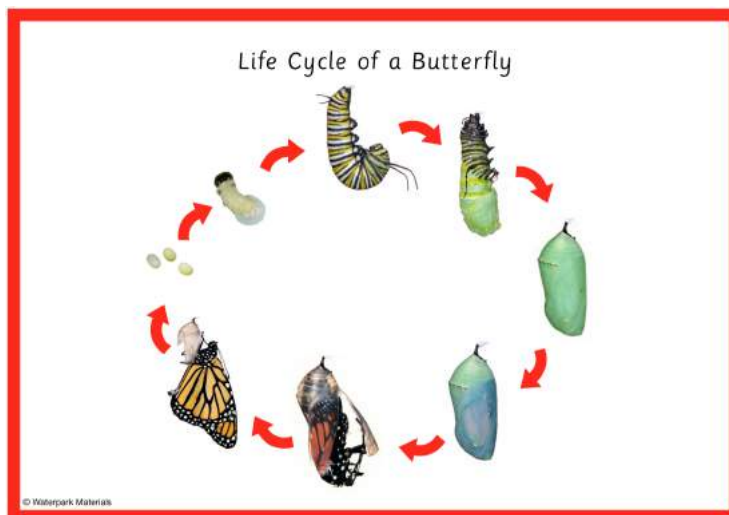
<b>WORKSHOP 18: Life Cycles in Nature - Loops</b>	<b>Unplugged</b>	Ages 6-12
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Loops are also found in nature. We can find loops or “cycles” in all living things. There are also cycles in non-living things, such as the rock cycle and the water cycle.	<b>Aim</b>	To show how loops also occur in nature
	<b>Materials</b>	Life Cycle charts and cards (Butterfly and Pumpkin) - see shared Drive
	<b>Sequence</b>	After exploring sequences and Workshops 7 and 8 about loops

### imagine

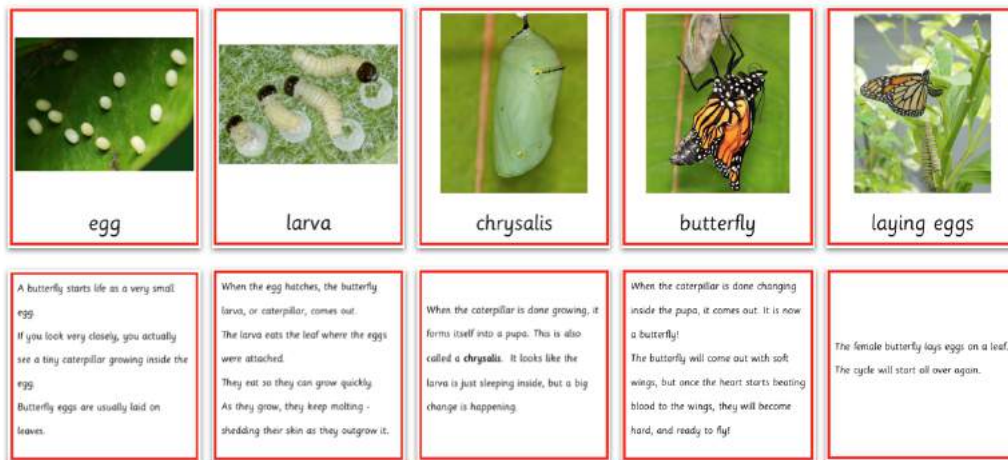
Ask the students if they can think of anything in nature that has a sequence of events that happens over and over. Explain that in nature there are many different cycles, for example the water cycle, the carbon cycle, photosynthesis, and life cycles. Living organisms have life cycles that continue on, over and over.

Present the impressionistic chart for the life cycle of an animal or a plant. (*Life Cycle of a Butterfly and Life Cycle of Pumpkin are included in resources*). Discuss the stages of the life cycle and how these stages are in sequence. This whole cycle repeats itself over and over in a loop.



## create

Present the cards for each stage of the life cycle of the butterfly. Students can read the information on the cards for each stage.



Encourage the students to find other cycles in nature, for other animals and plants. Using a variety of resources, show the students how to choose a cycle in nature, and how to find the different stages in the cycle. They can then create a project to display their cycle, for example by drawing each stage on a poster with arrows showing the cycle, or by creating objects representing each stage with available materials and arranging them in a display.

## reflect

In their journals, ask the students to reflect on cycles in nature. Some prompt questions might be:

- Why do cycles exist?
- What would happen if each loop ended and didn't repeat?
- What happens if something disturbs a stage in the cycle/loop? Would the loop end or change?
- Are cycles true examples of loops? Why or why not?

<b>Follow-up activity: Life Cycles in Nature with Scratch</b>	<b>Plugged</b>	<b>Ages 6-12</b>
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**Material:** Computer with access to Scratch and previous life cycles stages drawings.

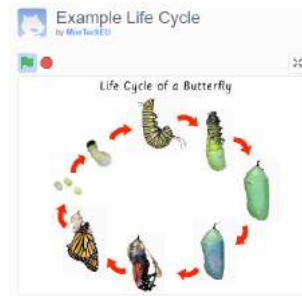
## Create

After the unplugged work, students may also try programming an animation of the life cycle they have investigated in Scratch.

These two projects of the life cycle of a butterfly offer an example of two different ways to create an animated loop in Scratch:

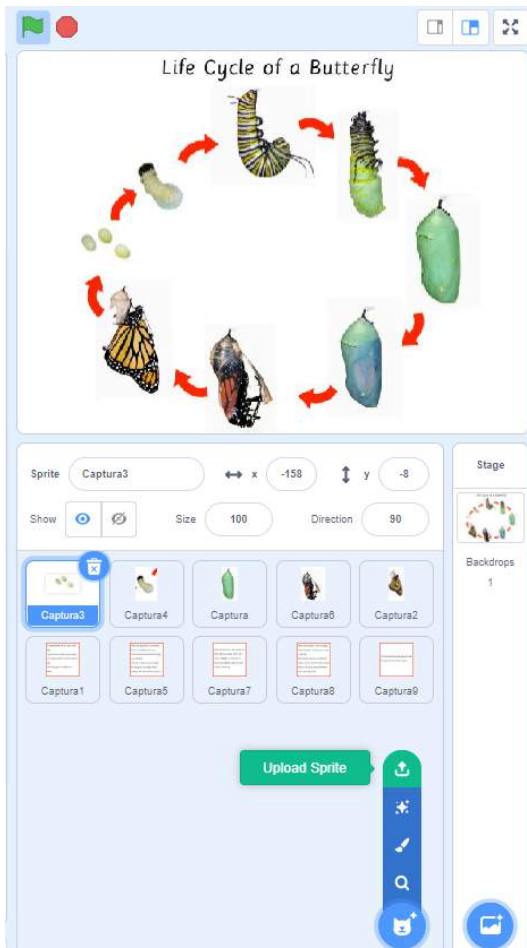


<https://scratch.mit.edu/projects/708316871>

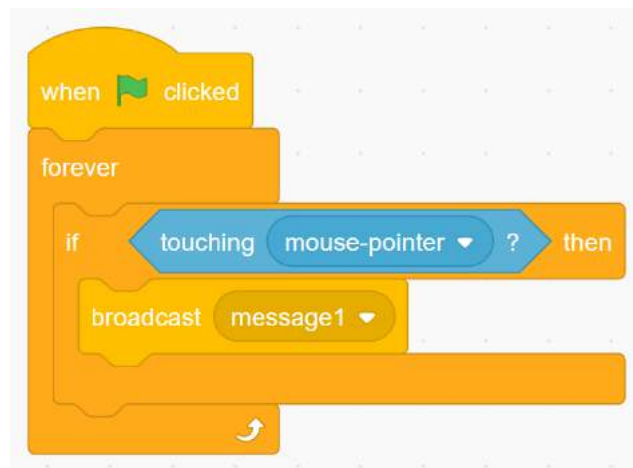


The first one shows a cycle diagram with the stages of butterfly life. When the mouse pointer is placed on one of the phases a description about it pops up.

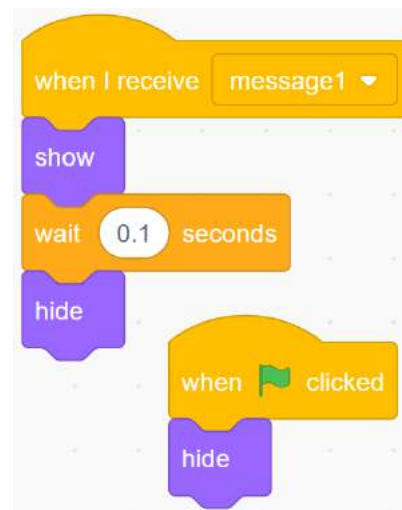
To reproduce this project, pupils upload their life cycle poster as a backdrop and the photos of its stages and their explanations as sprites. Then children create a script for the images and another for the text. See the example below or look inside the project to find out more. Please notice that the picture's program has to broadcast the same message (broadcast message X) its description needs to start running (when I receive message X).



Eggs image:



Eggs explanation:



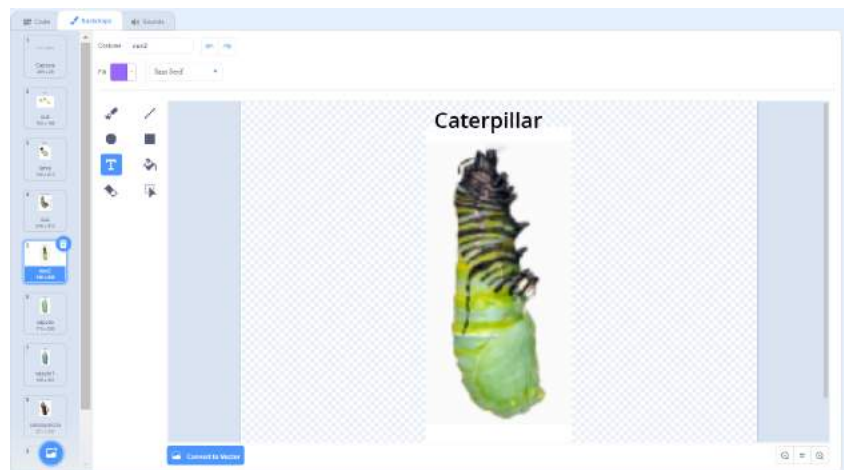
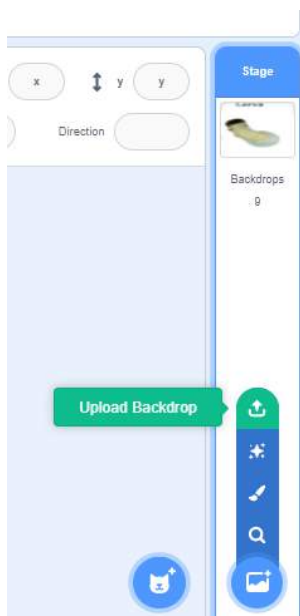


<https://scratch.mit.edu/projects/710135221>



The second one is a butterfly life cycle animation that resembles a stop motion. Once you run the project, a loop that goes through all the butterfly stages gets started and plays forever.

To redesign this project, students upload the drawings of the different phases as backdrops. They can name them by adding text, and erase the background if needed in the backdrop editor.



Then, it is time to assemble the program. Look inside the project to learn more.



<b>WORKSHOP 19: Music and Conductivity - Musical Instruments with Micro:bit and Scratch</b>	<b>Plugged</b>	Ages 8-12
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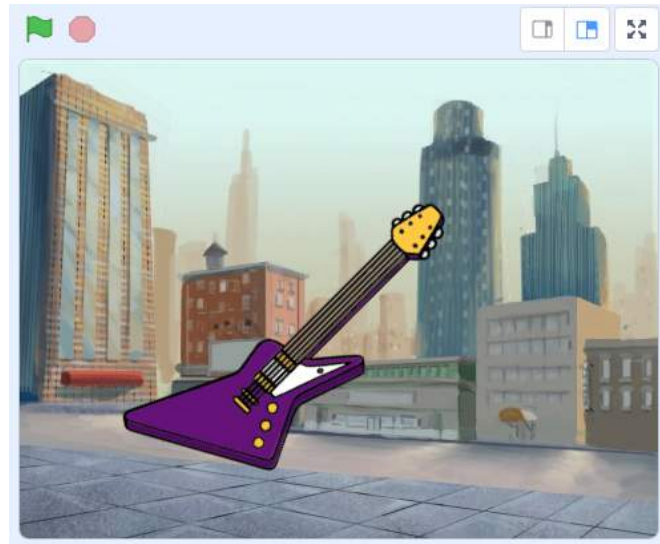
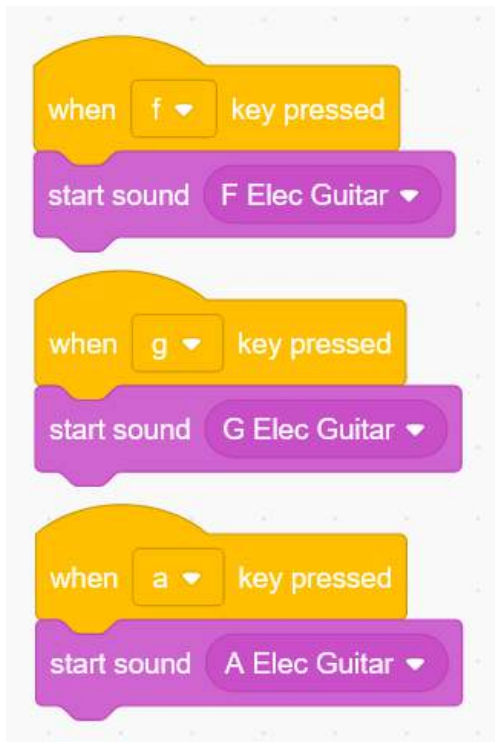
<p>Electrical <i>conductivity</i> is a measure of a material's ability to conduct an electric current.</p> <p>In creative computing, we can play with conductivity to make fun things and to express ourselves. For example, in this activity, we use it to create music.</p>	<b>Aim</b>	Understand conductivity and dive into a maker education activity.
	<b>Materials</b>	micro:bit, computers, Internet connection, cardboard, tin foil, alligator clips.
	<b>Sequence</b>	After Discovering Micro:bit and discovering Scratch.
	<b>Related activities</b>	Workshop 7: Discovering Micro:bit and Discovering Scratch workshops

### imagine

This activity revolves around musical creation. A good way to start is to challenge the whole class to find songs that can be played using only 3 notes. Divided into teams, the children can search the Internet, then open Scratch and try to play some part of the song using blocks from the music and events menus.

If they open one of the characters in the music category, these will already have notes stored inside sounds.





### create

When they have decided what song they will play, or perhaps even imagined their own melody, it's time to create our musical instrument with the micro:bit, cardboard, tin foil and alligator clips.

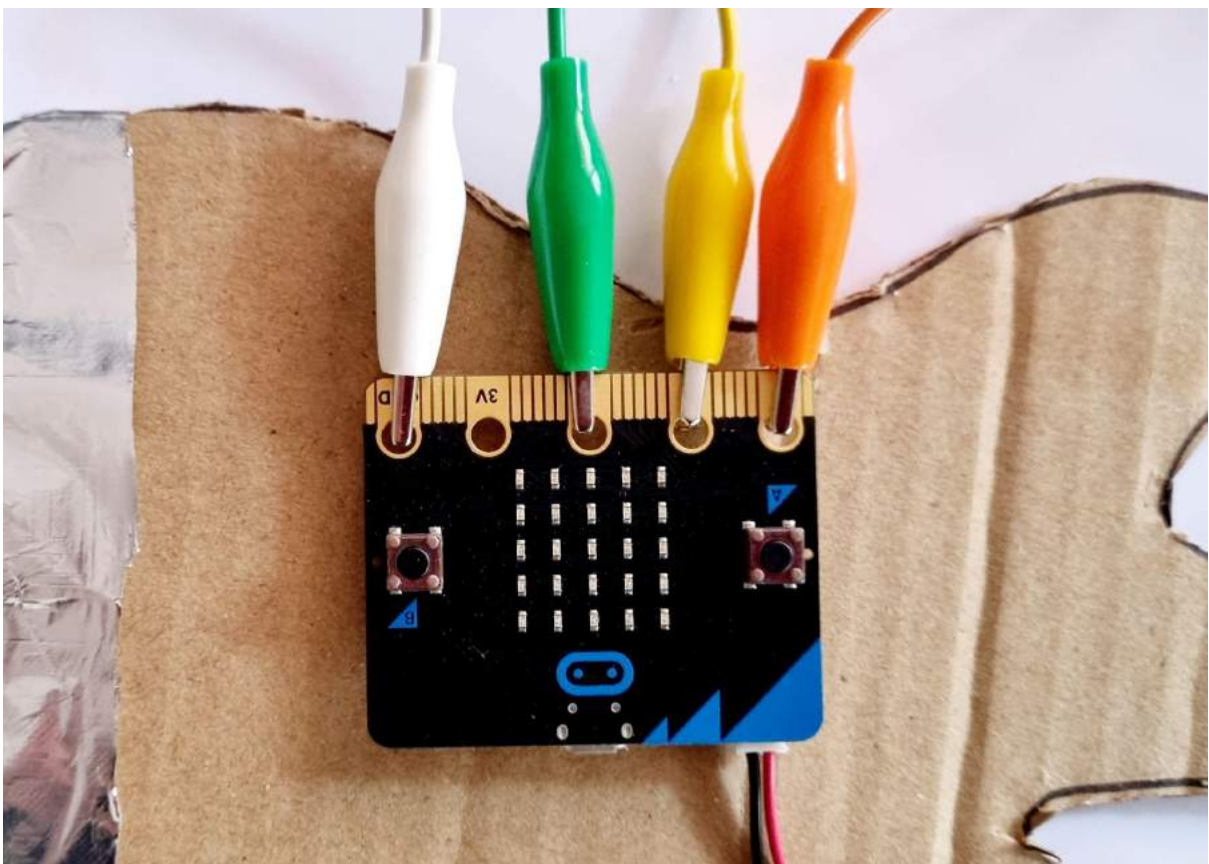
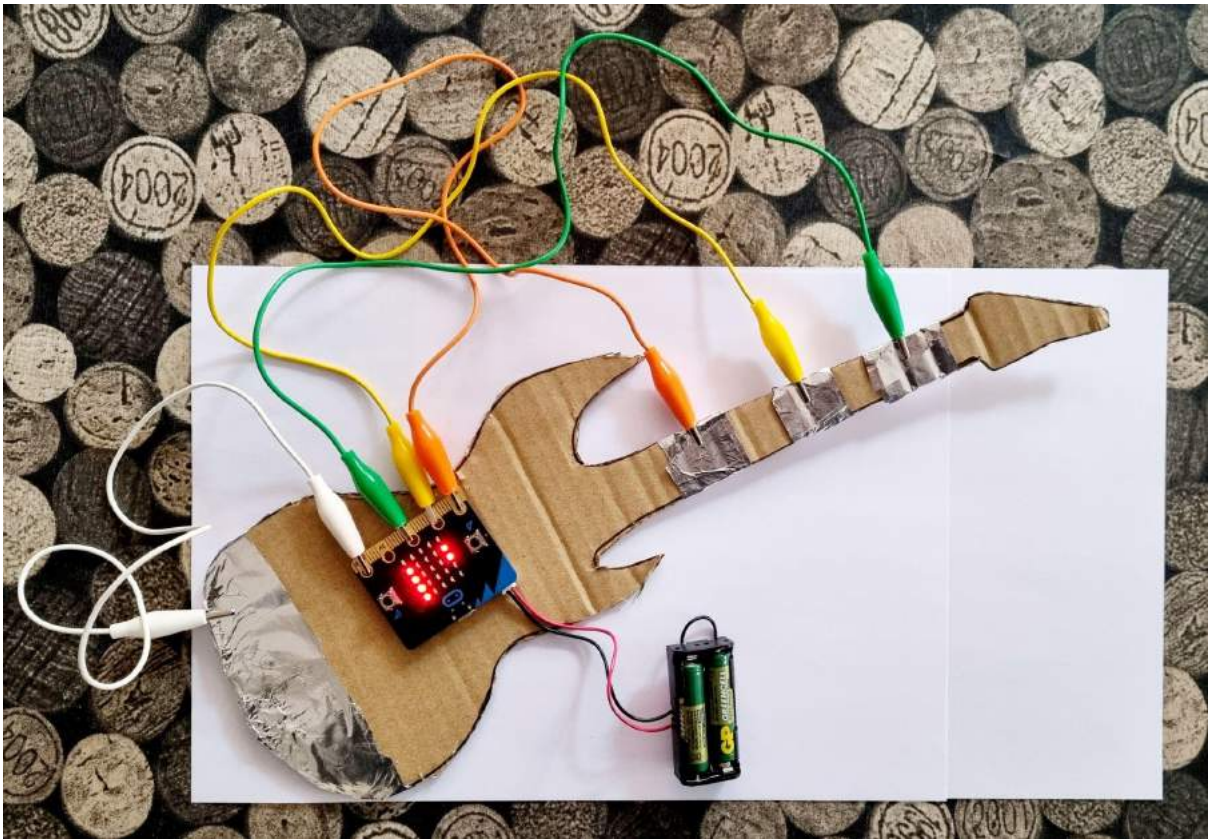
In the following example, we will use an electric guitar, but it could be any instrument that they know how to draw and cut out the silhouette of (or even an instrument of their own invention).

In fact, the moment of choosing the instrument can be a good opportunity to introduce into the activity the different cultures represented in the classroom. We can ask the students to explore which musical instruments are typical of their countries of origin.



For this activity, it is necessary to connect the micro:bit with Scratch. Here you can read how to do it in Windows, macOS, ChromeOS and Android: <https://scratch.mit.edu/microbit>.





In the pictures you can see that we use the alligator clips to connect pins 0, 1 and 2 of the micro:bit to three areas of the guitar arm, which we have previously wrapped with tin foil.

On the other hand, we also use an alligator clip to connect the ground (GND) of the micro:bit to the bottom area of the guitar, which has also been wrapped with tin foil.

In this way, every time we touch the ground area of the guitar with one hand and with the other hand we touch one of the three areas of the guitar arm, we are closing the electrical circuit with our own body.

With Scratch we simply use the micro:bit extension (the extensions are activated with the blue button in the lower left corner) to play sounds when pins 0, 1 and 2 are connected (that is, when the circuit is closed).

We can also program buttons A and B from the micro:bit to increase or decrease the pitch effect of the sounds produced.

Below you will find an example of programming.



A slightly simpler version of this activity, but equally enjoyable, is to use Makey Makey (<https://makeymakey.com>), which allows us to turn any conductive object into a touchpad. The advantage is that we don't need to install anything on our computer, the disadvantage is that Makey Makey always has to be

connected to the USB, so we can't move the musical instrument too far away from the computer. Also with micro:bit we can program the musical instrument in many ways and add functionalities to it.



If you are interested in trying the Makey Makey option, here is a step-by-step tutorial:

<https://makeymakey.com/blogs/how-to-instructions/creating-a-guitar-in-scratch-or-soundplant>

### play

Children can play music with the instrument they have created, starting with the three-note songs they have found and imagining new ones themselves. This should be a time of creative play.

### reflect

Children explain with their own words in their design journals how and why their cardboard instrument works. They can also describe the various instruments they created, the songs, tones, etc.

<b>WORKSHOP 20: Geography and Conductivity - Electric Board with Makey Makey and Scratch</b>	<b>Plugged</b>	<b>Ages 9-12</b>
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<p>Electrical <i>conductivity</i> is a measure of a material's ability to conduct an electric current.</p> <p>In creative computing, we can play with conductivity to make fun of things and express ourselves. For example, in this activity, we use it to create an interactive board.</p> <p>This activity is designed to take the first steps in Makey Makey playful.</p>	<b>Aim</b>	Understand conductivity and dive into a maker education activity.
	<b>Materials</b>	MakeyMakey, computer, Internet connection, cardboard, tin foil, adhesive copper wire and alligator clips
	<b>Sequence</b>	After Discovering Scratch.
	<b>Related activities</b>	WORKSHOP 19: Music and Conductivity - Musical Instruments with Micro:bit and Scratch

### imagine

This activity is a great opportunity to study geography and history with a practical activity. Teachers can show children books about interesting places or directly use a map of the place to discover, asking them questions about what they already know or are interested in discovering. The children can then do a search for the main monuments of the place, choose one of them and find out about its history.



In addition, as a complementary activity, the teacher can ask the children to think about which materials are conductive and which are not, in order to understand how the Makey Makey works.

### create (unplugged)

After the search, the children can build their monuments with recycled materials (cardboard, paper), play dough and everyday materials, such as sticks, etc. and they can paint and decorate as they wish.

You can prepare a table with all the materials needed to build and decorate (everything well organised). It is important that at the end of the activity you take some time for the children to clean up and tidy up so that the resulting project and work space are tidy for the next step. .

### create (plugged)

When they have decided on the monuments, they can record their voices explaining their monuments.

In the following example, to connect Makey Makey and Scratch we will use an adhesive copper wire and tin foil to make the circuit, but it could be any conductive materials.

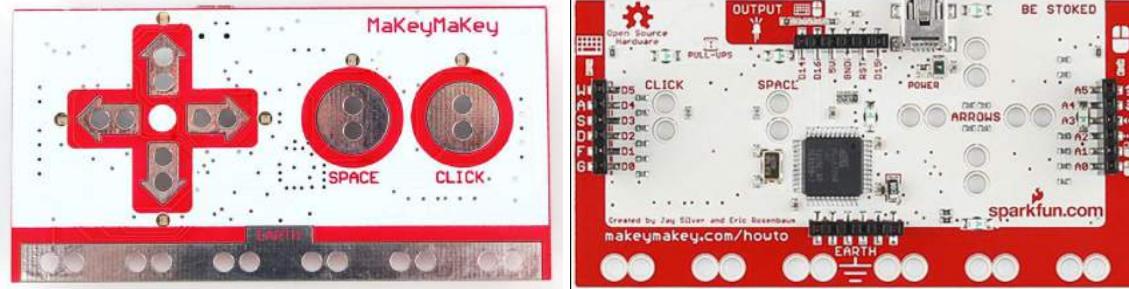


The **Makey Makey** is a programmable electronic board at a very affordable cost. It started as a project by two students at the MIT Media Lab under the supervision of Mitch Resnick, to create an invention kit for everyone.

For this reason, in a short time, it has become very popular in the world of educational technology, educational robotics and the maker movement.

The Makey Makey has a small size, is very simple to program, and uses open-source software. All this has led to the fact that, apart from its more educational aspect, it is also used by makers of all kinds, creators and artists from different disciplines.

On the front side it looks like a joystick with the four arrow keys, the spacebar and mouse left click. In the lower part there is the ground area (or earth), which is a reference point in the electrical circuit.



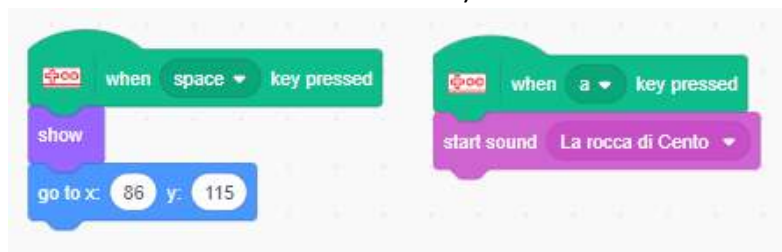
On the back side there are 12 more keys: W, A, S, D, F, and G on the keyboard side, and up/down/left/right mouse movement and left/right clicks on the mouse side.

The Makey Makey board works with conductive materials (food, human body, plants, tin foil) and you can discover with your children which materials are conductive and which aren't. This part of the activity is the tester of materials. After this test, children have to choose how to make the button.



In the pictures you can see that we use the alligator clips to connect the board with the objects. But, as we said, we need alligator clips also to connect the ground (GND) of Makey Makey to the board by the adhesive copper wire.

To program Makey Makey with Scratch we simply use the Makey Makey extension (from the blue button in the lower left corner).

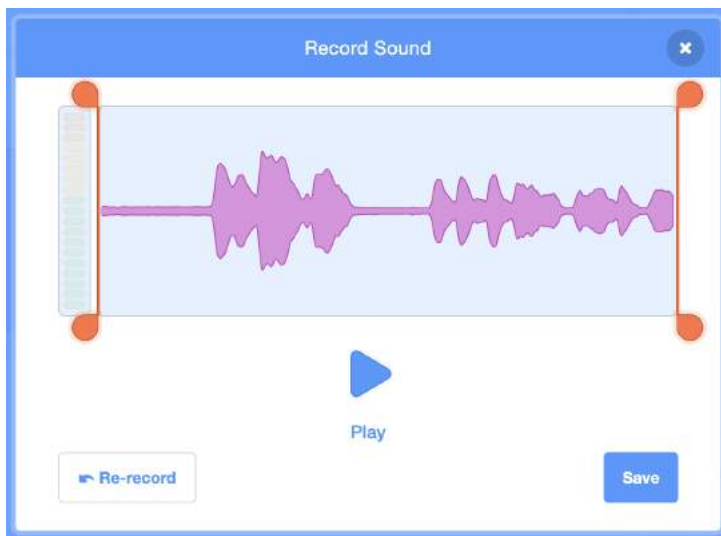


## Recording children voices:

The Sound Editor in Scratch allows a user to edit and remix sounds. We can import and export sounds and music and edit them. There is also a library with pre-defined sounds. Children will love to explore and discover the sound editor. It is a great experience but we strongly recommend using headphones.

To do it, we go “Sounds” tab, then “Choose a sound / Record”, and we will be able to use our microphone (Scratch will ask permission to use it) to record sounds or our own voices.

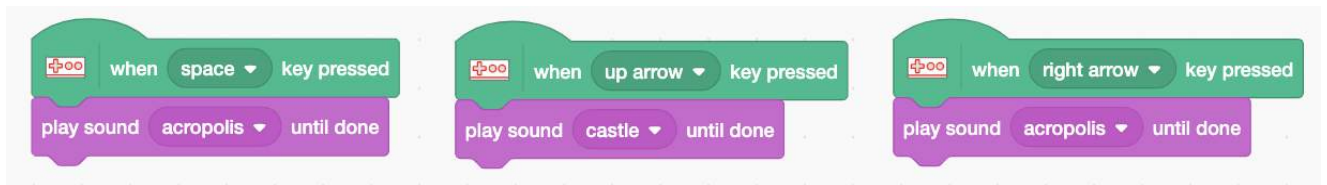
This is how a recorded sound looks:



Then we can edit the sound :



And finally, we can use it in our programs:



## play

Once they discover how to use Makey Makey, children can enjoy themselves with a lot of activities on the Internet.



On this web site

<https://makeymakey.com/pages/plug-and-play-makey-makey-apps>

you can find a lot of games programmable with Makey Makey.

## reflect

Now is the time to reflect and let the children write down what they have been doing in their journals, and to draw and design new projects.

Teachers can ask children: *Did we learn or play during this activity?*

This question can open a discussion about how it's important to play and do hands-on activities to learn.

Another topic of discussion could be what changes they should do in a project like this in the future.

*What was wrong with working in teams? And what was good?*

<b>WORKSHOP 21: Measuring Time</b>	<b>Unplugged/ Plugged</b>	<b>Ages 8+</b>
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<p>In this activity, children are going to hear the history of measuring time and how early technology helped to develop our understanding of how time is measured.</p>	<b>Aim</b>	Engage the children to think about time, what this can tell us about nature's cycles and discover ways of measuring it through technology, from primitive to digital.
	<b>Materials</b>	<ul style="list-style-type: none"> <li>- 12 colored wedges that form a circle (see shared Drive for template)</li> <li>-Construction light or strong flashlight</li> <li>-Globe</li> <li>-Cards with names of the seasons, months, and sun's boundary lines</li> <li>-Empty identical pairs of bottles</li> <li>-Sand / salt / seeds</li> <li>-Chalk to draw on the yard floor on sunny days</li> <li>-Long stick to plant on the yard</li> <li>-Computers or tablets with Scratch downloaded or internet connection</li> </ul>

### imagine

#### Spark:

Start the activity reflecting with children about **time** being something that is always present in our day-to-day life: we have a schedule for our routines (sleep, meals, school, free time...), we celebrate our birthdays and the beginning of the year, traditions and festivities are commemorated according to certain days and seasons...

Ask children to suggest words related to the passage of time (for example: minutes, years, days, months, seconds, weeks...). They can be written on the board, or put on the table with labels. Then they can be asked in a collaborative way to put them in order from shortest to longest: seconds, minutes, days, weeks, months, years, centuries...

We can then explain that nowadays we have clocks and calendars around our houses, and also digital devices tell us the time and the date all the time... but how were humans counting time through history? Which ingenious ways did they have to use? Why was it important to do it?

#### Story:

From here, we can use the following story to tell why we, as humans, came up with these ways of dividing time and what relation they have with nature:

## The Starry Sky over Sumer

Close your eyes and travel back in time with me. We are going to go back not only a year or two, not just a few centuries, but many millennia! Let's go back 6000 years ago.

We're going to travel back to 4500 BCE, and we want to find our way to the first civilization in Mesopotamia. Can you imagine with me? What can we see?

I can see a sprawling city, full of houses made of mud bricks and marsh reeds. I see ziggurat temples standing tall above the houses. I see pottery everywhere – vases, dishes, and jars. I can hear music from lyres and flutes. I see the Rivers Tigris and Euphrates, with the farmers tending their crops by the riverbanks.

Can you remember that we talked about the Sumerians when we heard the Story of Writing and the Story of Numbers? The Sumerians used cuneiform writing in the clay slabs from the river, so they were already developing a way of recording important information, news from the day, receipts for the sales that were going on in the markets, and even poetry (like the Epic of Gilgamesh we have explored) and law codes. Another important thing they documented in cuneiform was astronomical texts – what was going on in the skies.

Consider for a moment all the technology we use to understand the universe. Not many of us have traveled to space, but we have an immense amount of information about our galaxy, the stars and planets, other further galaxies, and places people have never even been. Now imagine yourself back in Sumer, where almost none of these technologies have been invented yet. The Sumerians have two important technological inventions, however – the wheel and a sundial – the first clock.

Today I want to tell you about one more invention from the Sumerians – the *lunisolar* calendar. Now, that might sound a bit odd, and I will explain the word to you. But first, let me tell you about the priests and their important role in creating this calendar.

From the earliest moments, people have looked up into the sky and wondered what was out there, beyond what they could see or touch. How far did the sky go? What were those twinkling lights? Were we alone in the universe? Those twinkling lights in the night sky must be something very special, and often they were connected to religion – perhaps they were the gods watching over the mortal humans?

The Sumerian priests were very learned and had many important tasks, but among these tasks was that of studying the night sky – they became the first astronomers! They tracked the movement of the sun and the moon, and as they did this, they noticed that, just as the sun moved across the day sky, and the moon was in different positions over time, those twinkling lights in the night sky also moved over time!

Every night, the priests would look up at the sky and notice important details – some stars were brighter than others. Some were in clusters, others far apart. They observed how the stars in these clusters stayed in the same pattern, and soon began naming the groups – we call the constellations. The priests also noticed the movement of the stars and began to document the movement. There was one particularly bright star in the sky, Sirius. The priests



observed this star in particular, writing down the star's position every single night. Night after night, they looked up to see where Sirius was in the sky. Night after night, they wrote down where it was. Then, the star disappeared from the night sky! But these learned priests who studied the skies thought that if they waited long enough, the star would reappear in the night sky. So, they waited. And as they waited, they kept a record of how many nights passed when they could not see Sirius in the sky. Then, just as they predicted, one night, Sirius was back in the night sky, shining brightly!

The priests looked at all their records and they discovered that it took 360 days and nights for Sirius to travel from one point in the sky, across the sky until it disappeared, reappearing on the other side of the sky and back into the same original point. The priests decided that the time it took for the star to travel all the way around would be called a *year*. So, the year was 360 days.

Now, we know that the year actually is 365 days (almost). But the priests were almost on target, especially as they were calculating and observing without telescopes. And some historians speculate that perhaps the priests knew it was actually 365, but decided that 360 was a better number, because 60 was a sacred number in Sumer, and 60 multiplied six times is 360.

So, through their observations, the Sumerian priests noted that the sky moved in a circular pattern, and what they could see was half of that circle – a semi-circle. Therefore, a circle was made up of 360 points in a way. Today, in geometry, we know that a circle has 360 degrees. This is based on the Sumerian priests, observing the night sky 6000 years ago!

The priests then decided that a year was divided into 360 days. But they wanted to divide that up into smaller increments. They thought about the movement of the moon and so they divided the year into 12, each one they called a month. The year was 360 days long and had 12 months. Each month began when a new crescent moon was seen low on the western horizon at sunset. However, just as there are more than 360 days in the year, there are more than 12 moon cycles in a year. So, the Sumerians would decree that an extra month be added every time the year and moon cycle needed to be re-calibrated. This was the *lunisolar* calendar that I told you about in the beginning - a calendar based on the moon (*lunar*) and the sun (*solar*)!

Because the Sumerians were so dependent on agriculture, they relied on the months of the year. They needed to be able to calculate the best time for preparing the earth, sowing their crops, and how long the crops would need to grow before they could be harvested. The Sumerian year began in the spring and was divided into three seasons – the beginning, middle, and end of the year.

Later, you can find out more about their seasons, the names of the gods that represented each month, and how the Sumerian calendar was so important for the many civilizations that came after. The Sumerians also divided time into weeks, hours, minutes, and seconds! For now, we can send our gratitude to the Sumerian priests who spent years observing the skies and writing down what they saw on clay tablets so that we can learn from them, 6000 years later!

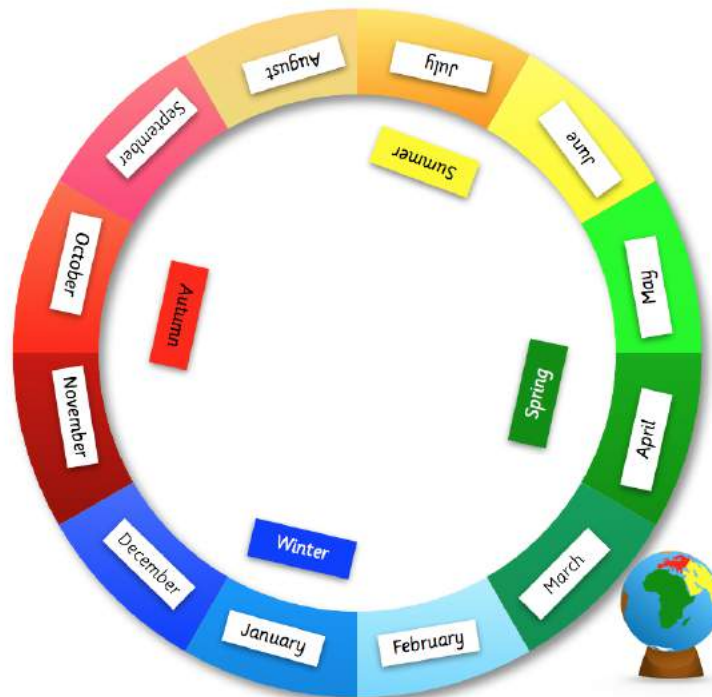
### **Presentation: Seasons and Months**

Lay the colored wedges in sequence in a circle. The blues represent the winter months (December, January, February), the greens represent the spring months (March, April, May), the yellows represent the summer months (June, July, August) and the reds represent the

autumn months (September, October, November). The months should be in sequence counter-clockwise.

Place the labels for the seasons inside the circle. Place the name labels for each month on the wedges.

Place a globe on the outside of the circle by March.



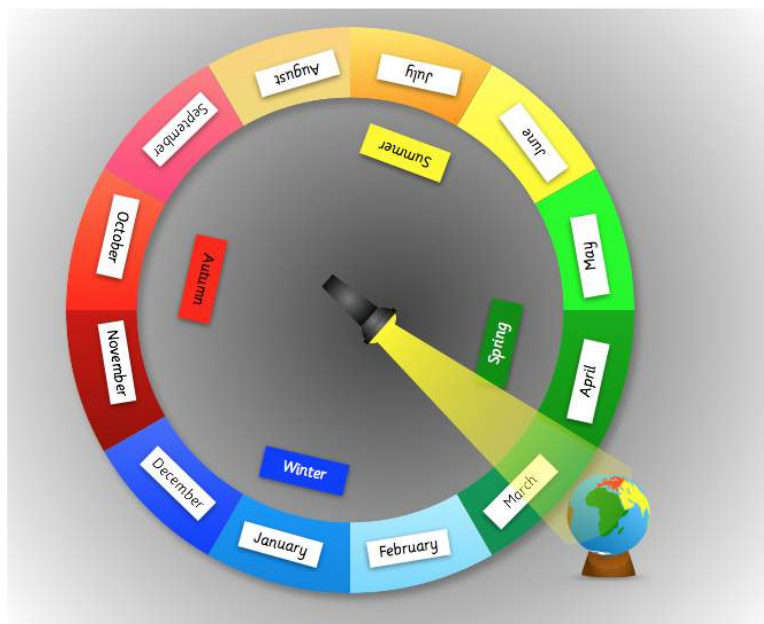
NOTE: If using the Montessori globe, make sure that the shorter side of the base faces winter, and the higher side of the base faces summer (as pictured below). This ensures that the earth's axis is in the correct position. If you are using a standard globe, make sure you have the angle in the right position. You can test this by shining the light from the center of the circle toward the globe standing at June and making sure the light hits on the Tropic of Cancer.



In the center of the circle, place a strong light to represent the sun, and aim it at the globe.



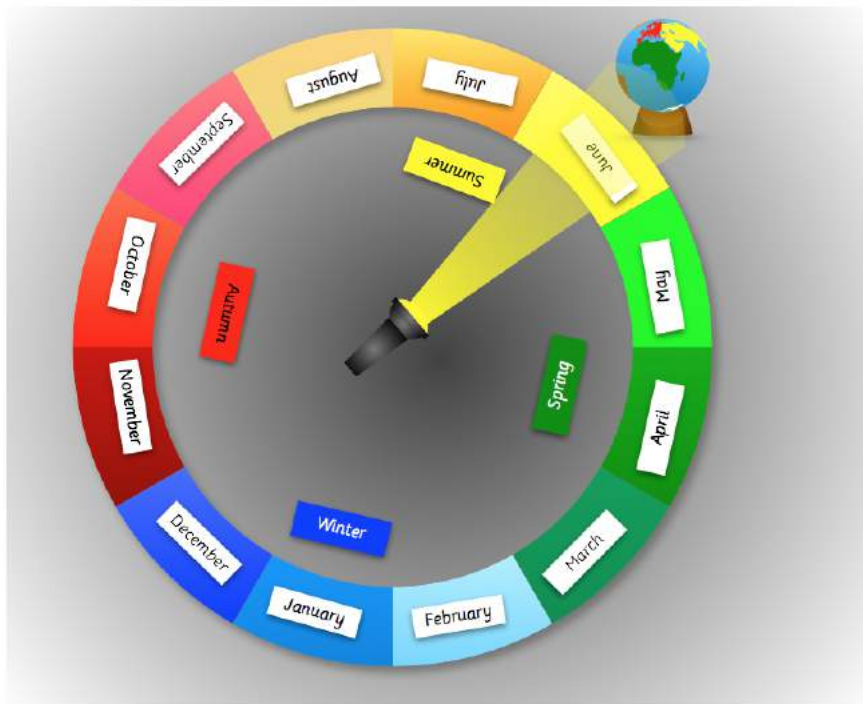
With the light shining at the globe, which is standing by March, slowly rotate the globe on its axis and notice the point where the light reflects off the globe.



As you turn the globe on its axis, you can place small stickers on the place where the light hits, or alternatively use a whiteboard marker so you can remove the marks later. The points will join to create a line around the earth. Tell the children that this line is one of Sun's boundaries and has a special name. This line is called the *Equator* because it divides the globe into 2 equal parts, the northern hemisphere and the southern hemisphere. Place the label that says "Equator". When the sunlight hits directly at the equator, this means that the day has an equal number of daylight and night.

Now slowly move the globe to April, and continue to spin the globe, but keep the base in the same direction. This keeps the Earth's axis in the correct position. Continue to slowly move the globe to the next months, spinning the globe on the axis. As you move the globe, also pivot the "sun" light so it hits the globe. Note that the point where the "sun" reflects on the globe is now moving away from the equator.

Continue moving counter-clockwise from March until you reach June.



Now stop at June and repeat the same process that you did at March, but now mark the points where the sun hits the globe. These will now connect as a new line. Explain that this is another important sun boundary line. This one is called the Tropic of Cancer. This can be a point of exploration later, where it got its name. Place the label “Tropic of Cancer”. Slowly spin the globe on its axis with the sun reflecting, and ask the children to consider what the climate might be like in the Northern Hemisphere with the direct sunlight. Explain that this is why we have summer in the Northern Hemisphere. Now ask them to imagine how it might be for the Southern Hemisphere, with little direct sunlight. The Southern Hemisphere has winter at that time. Explain how in the Northern Hemisphere there are more hours of daylight compared to night. (Children living in northern countries such as Norway will be very aware of the midnight sun.)

Continue moving around the circle, slowly spinning the globe, until you reach September. Repeat the process as you did at March and June, and again note where the sunlight reflects. Point out that the sunlight is back shining directly at the equator. Place another label for “Equator” and ask the students to consider what the ratio of daylight and night could be if the sun is back at the equator.

Continue again to slowly move the globe, spinning on its axis, until you reach December. Proceed as before, now noting that we have new points of sunlight reflecting on the globe. Mark the points and connect the line. This is a new boundary of the Sun. This is called the Tropic of Capricorn. Place the label “Tropic of Capricorn”. Again, encourage the students to

later explore how this line got its name.

Continue to move around the last months and return to March. Explain that the full cycle is called a year. The Sumerian priests observed this same thing as they observed the sun, moon, and stars 6000 years ago.

At this point the create/play part of the workshop can be plugged, unplugged, or both activities. We present first the unplugged activity and then the plugged one.

### create [unplugged]

Build an hourglass (sand clock, salt clock...), with mineral water bottles or similar, half filled with sand, salt, seeds.

If you do the plugged activity “Program a chronometer with Scratch” explained in the following pages, this hourglass can be adjusted varying the amount of content (sand, etc) to empty in the amount of time measured by the chronometer.



### play share

- Play with the sand clocks, comparing them and adjusting to measure events (songs, races, etc) with the same amount of time.
- In the yard, draw the silhouette of the shadow of the students at different times of the day, with the feet every time in the same place. Reflect about where the sun was every time. Why are the shadows pointing in different directions? Why did the sun move? (relate to Earth's rotation)



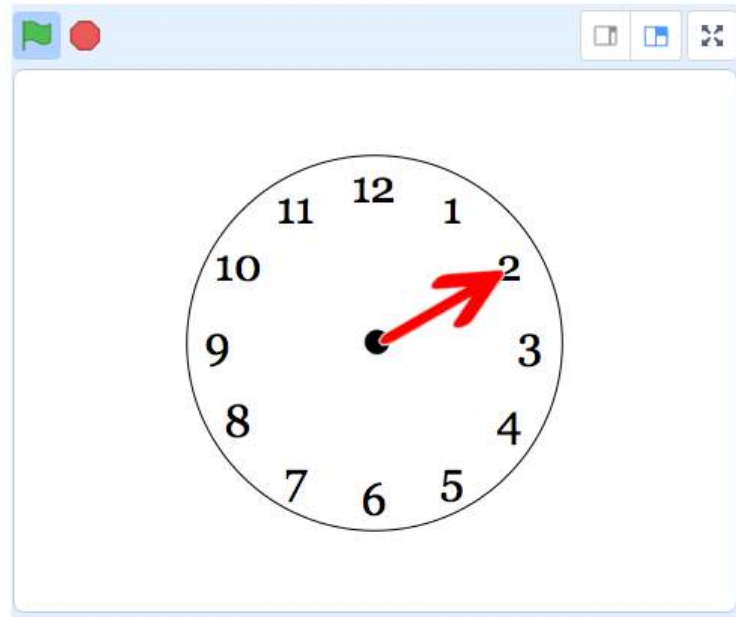
This last proposal can be extended long term in this way:

- Have a gnomon (long stick) planted in a given place of the yard. Every 2 or 3 days, at the same time, mark the tip of the shadow. Reflect after some period, and at the end of the seasons and in different seasons, about what the marks are showing us: variation in the length of the shade... (relate to Earth's rotation, orbit, axis, and seasons)

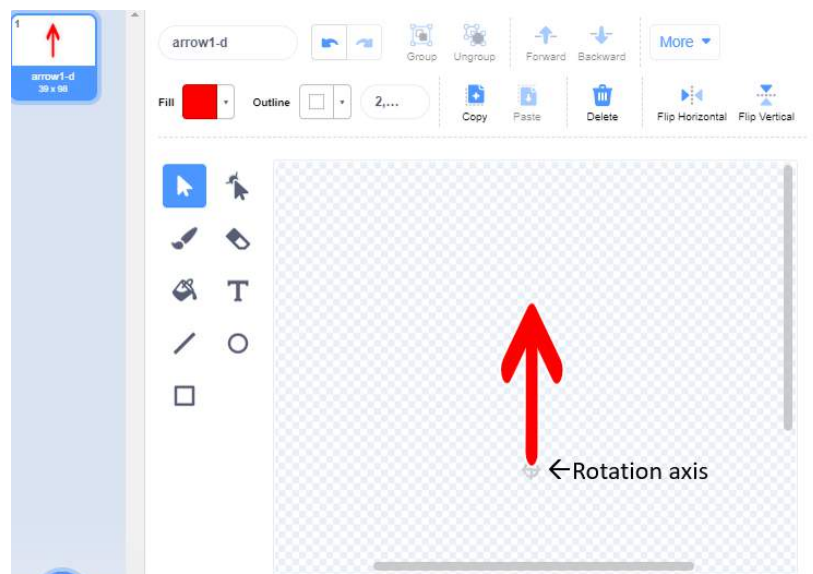
### create (plugged)

In this activity, children build a chronometer with Scratch that counts seconds up to one minute. Optionally, it can be used to adjust our hourglass with the right amount of sand/salt/seeds to count 1 minute every time we turn it.

One option is to build the Scratch Chronometer using a clock face as a background and an arrow which represents the seconds hand (the clock face image can be uploaded and the sprite can be the arrow in the Scratch gallery or can be drawn with the editor). The arrow will have to turn every second by the right number of degrees. Children have to find how many degrees by an trial and error process and reflection. There can be some mathematical reasoning here: the arrow has to turn 360 degrees in 60 seconds, so that makes 6 degrees every second. But the process can be that they find out by trial and error and then, once they get to the right angle reflect what it was.



Be aware that the turning movement of the sprite can be a bit tricky if the rotation axis goes through the center of the arrow. In this case, the axis has to go through the starting point of the arrow (the one that's stuck at the center of the clock face). This can be regulated in the costume Scratch editor area.

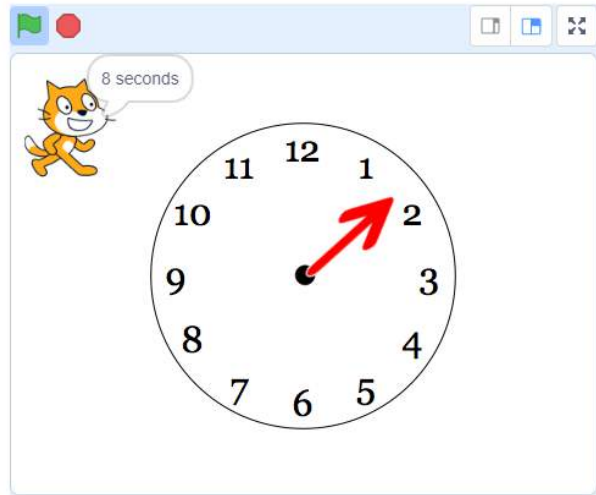
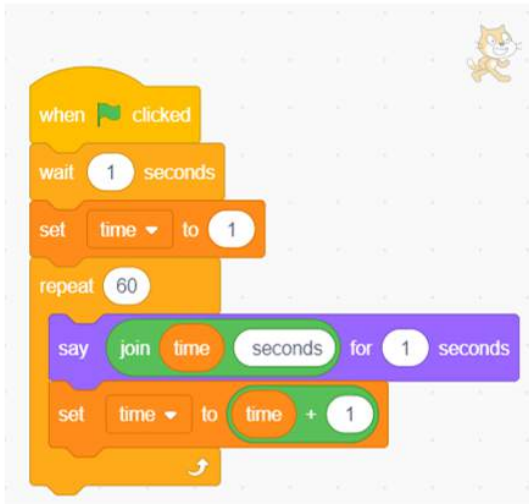


As a continuation of the plugged activity, in addition to drawing an “analog” chronometer, children can program a digital version using a sprite that counts the number of seconds since start.

This is what the cat (scratch sprite) is doing in the following example:



This program can be found to explore and remix in:  
<https://scratch.mit.edu/projects/636152946/>



In this case, there are variables involved, and it would be advisable to have gone through the variable activities in previous chapters of the guide.

### play

### share

Children can play with their programmed chronometers and share them, adjusting chronometers from different teams to measure events (songs, races, etc), or to adjust the sand clocks built in the unplugged part of the workshop (if done) with it.

### reflect

Children can explore many topics after this presentation.

- They can see how the year is divided into 12 months. A further presentation is the division into weeks and days.
- They can explore how the Tropic of Cancer and the Tropic of Capricorn got their names, returning to the Sumerians and constellations.
- They can reflect on the story of the Sumerian calendar and why the Sumerians might only have identified three seasons in their year.
- A reflection of different methods of measuring time throughout different periods of history (sundials, astronomical monuments and charts, moon phases, hourglasses, pendulums, mechanical clocks, quartz clocks, digital clocks...) can be made using flash cards, so they can place it in order and according to the historical epoch. Images about nature (moon phases, seasons, river floods, sea tides, day and night...) can also be used to reflect why since ancient times humans were interested in measuring time (be prepared for cold or hot seasons, floods, droughts, hunt migrations, crops,

fruit and vegetables recollection and seed, agriculture activities...).

After the Plugged Activity, there can be also these reflections:

- Reflect about mathematical problems and learning encountered (for example the determination of the angle to turn every second, and why the solution is what it is).
- It's a good opportunity to reflect with the children about how a problem can be solved in many ways. There also has to be sharing and reflection about the problems encountered, the ways to solve them and the things they have learned.
- Discuss also how the teamwork has gone, and about helping each other and learning from the others.

These reflections can be collected in a mind-map, a word cloud or written in their design journal.



<b>WORKSHOP 22: Experimenting with Light and Sensors</b>	<b>Plugged / Unplugged</b>	Ages 9-12
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<p>In these activities, children are going to experiment with <b>light phenomena</b> and relate them to mechanisms and devices that work with <b>light sensors</b>, and we encounter in our day-to-day life.</p>	<b>Aim</b>	<p>Identify light as physical phenomena, experiment with its properties, colour decomposition, detect light that we don't see (like infrared).</p> <p>Introduction to the concept of sensor</p> <p>Get an understanding of how light (infrared) sensors work and how they can be used in our technological projects.</p>
	<b>Materials</b>	<p>For the unplugged activities: prism, cardboard box and 3 or 4 thermometers (to measure room temperature).</p> <p>For the plugged activities: robots with light sensors (Edison Robot, or similar).</p>
	<b>Prerequisites</b>	<p>Some knowledge of Scratch programming: Discover Scratch activities and Workshops 10 and 11 about Conditionals</p>

### imagine (unplugged)

We make our own kit to reproduce the experiments and discoveries made by scientists like Newton and Herschel on the nature of light and colours: with cardboard boxes, sheets, prisms and thermometers, we break down the rays of sunlight into colours and measure the temperature of each colour.

It can be seen that the temperature rises from blue to red and beyond the red. Where our eyes do not detect light, the thermometer even reaches a higher temperature. This means there's still light in that spot, but it's a "colour" that our eyes do not see. We have detected infrared rays discovered for the first time by Herschel and conclude that there are types of light that humans do not see (such as infrared).

We do not have the detectors —or better said, sensors— of infrared incorporated in our body, but other animals, like owls and cats, do. Even if we don't see this colour, it exists and can be detected with simple experiment like the one described below.



Using a prism, a cardboard box, three very well-aligned thermometers and a sunny day we can build a setup like this.

This brings us to technology in the next step:

### **imagine (plugged)**

The teacher can spark some questions and debate to introduce it:

*Can you think of ways in which in our daily life infrared light is used?*

*Have you ever wondered how a remote control works? Can you guess it?*

The answer is that the remote control communicates with our TV, or the garage door, through a beam of light that we do not see, because it is infrared light (although there are other types of light that we do not see and not all are infrared).

*How come the elevator door does not close when we are at the threshold?* The answer is that when we are at the threshold, we block an invisible light beam (infrared) therefore, we prevent it from touching the sensor. The sensor signals the door to close.

### **play (plugged)**

This activity is going to be done with Educational Robots, such as the Edison Robot. It can be any robot available which has an infrared beam and sensor, for example Lego robots.

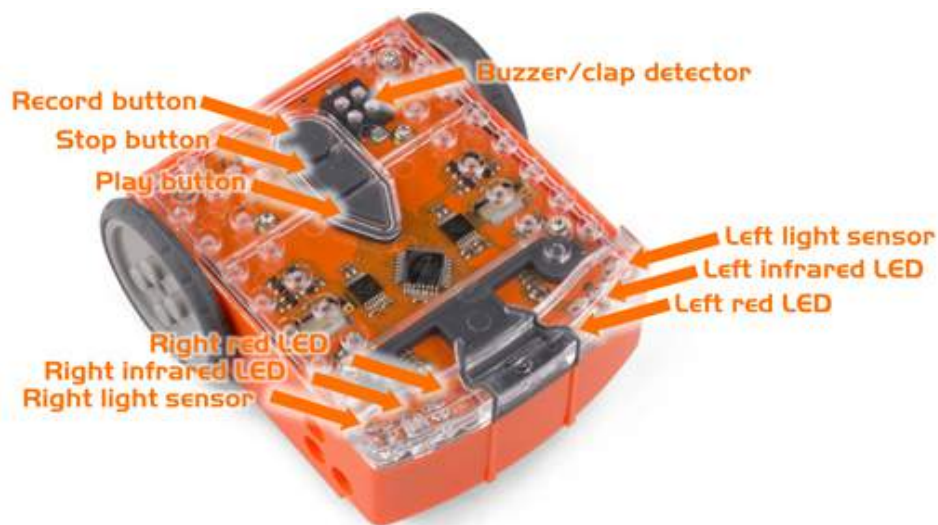
The infrared sensor can be programmed and used to detect obstacles, so the robot can do some action when it detects infrared light, such as turn around, make a beep, light a signal, etc.

This is a paragraph taken from the Edison Robot platform, where it explains in a very understandable way how this works:



*Edison can emit infrared light from the two infrared LEDs. If that infrared encounters an obstacle, like a wall, the light is reflected back towards Edison. Edison's infrared receiver detects the reflected light, telling Edison that there is an obstacle. The robot can be programmed to respond when it detects an obstacle, for example, by backing up and turning away.*

<https://meet Edison.com/edison-robots-sensors/>



The first activity that children can do with the robot is to input a program that is already built that avoids obstacles, so they get familiar with the robot, and they see how it reacts when it encounters an obstacle.

To put this program in the robot, the teacher has to have a printout of the Activity 3 in page 6 in the EdBlock activity plan:



<https://meet Edison.com/robot-programming-software/edscratch/>



## Avoid obstacles

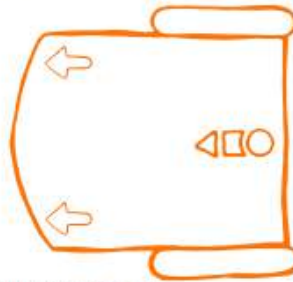
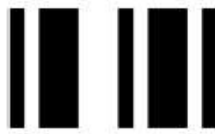


Edison can tell when there are things in front of it.

How?

Edison uses Infrared light to detect objects. You can't see this light because Infrared light is invisible to people.

Edison uses Infrared light to find things in its path. If there is something in front of Edison, Edison can turn away and avoid running into it.



### Read the barcode

Put Edison on the outline above.

Press the record button (round button) three times.

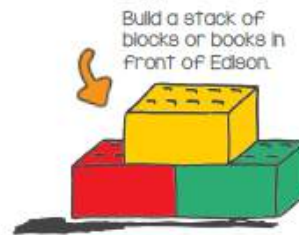
Edison will quickly drive forward and scan the barcode.

### What to do with Edison

Put Edison on the floor or table.  
Put some objects around Edison.

Press the play button (triangle button).

Watch as Edison drives towards an obstacle. Edison will see the object, turn and drive away in a different direction.



Build a stack of blocks or books in front of Edison.

It should be printed from the original at full A4 scale.

Children then start the robot and allow it to scan the barcode. They can then start playing with it, allowing it to move and placing obstacles in its path, so it turns away.

### reflect (unplugged)

The teacher and the children are now going to reflect together about how the program that the robot read in the code bars must be. What are the sequence of instructions that we would program to tell the robot to turn away from the obstacle?

They can talk about it and write down in their journal the instructions with their own words. The result, after talking, writing down, erasing, trying again, can be something like this (but there's never a single solution):

*Forever:*

*Move forward 10 steps*

*If you "see" an obstacle, move backward 10 steps*

*Turn 90 degrees to the right*

**create (plugged)**

**play**

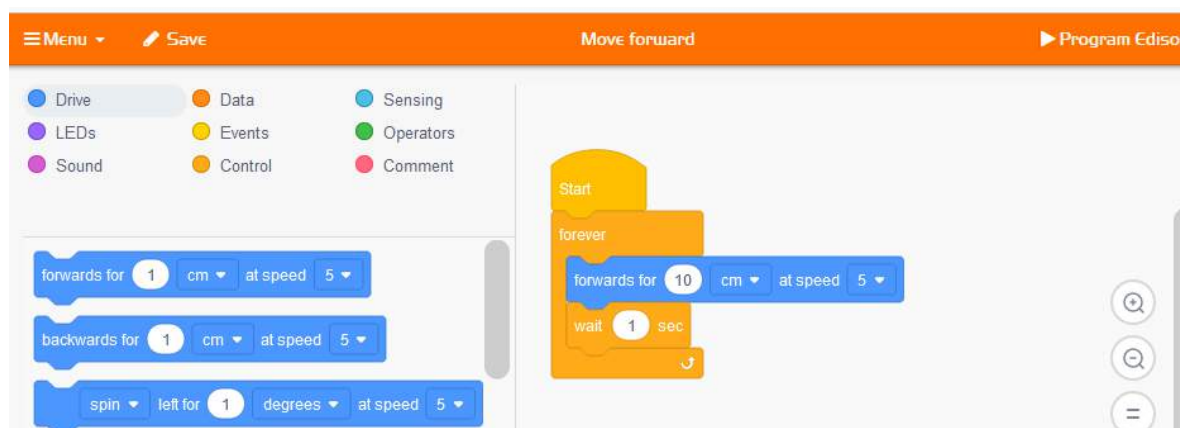
**share**

We now can ask the children to program the robot with EdScratch, which is a language very similar to Scratch.

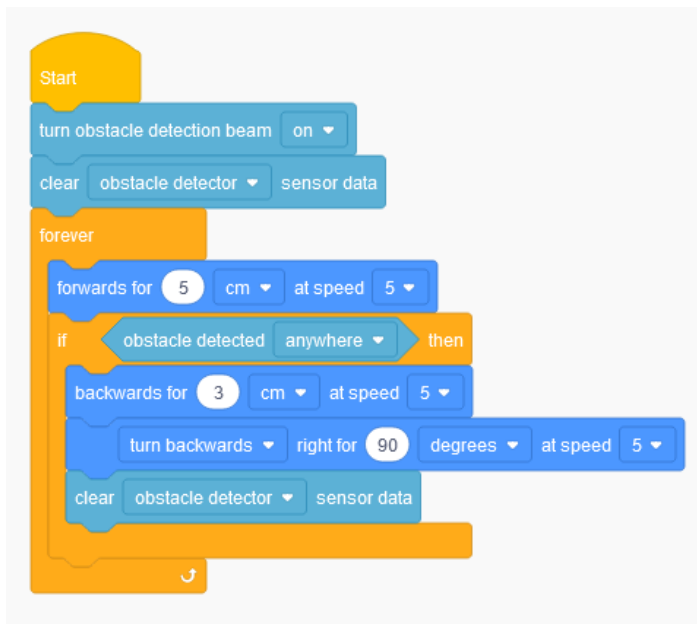


To do so, they need to access the webpage (<https://www.edscratchapp.com/>) where they will find an environment similar to the one of Scratch.

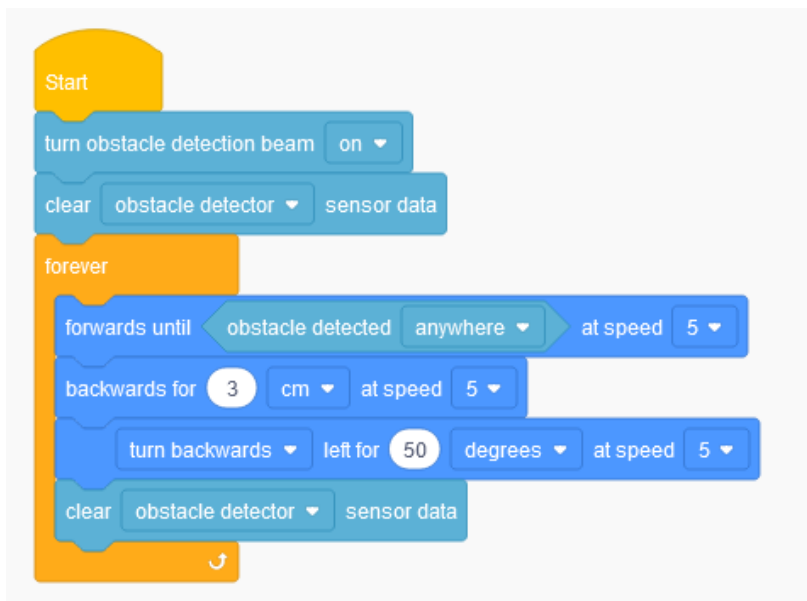
They can explore the instructions and start creating their own programs, for example, a program for the robot to move forward would look like this:



And the program to avoid obstacles could look like the following:



Or the following:

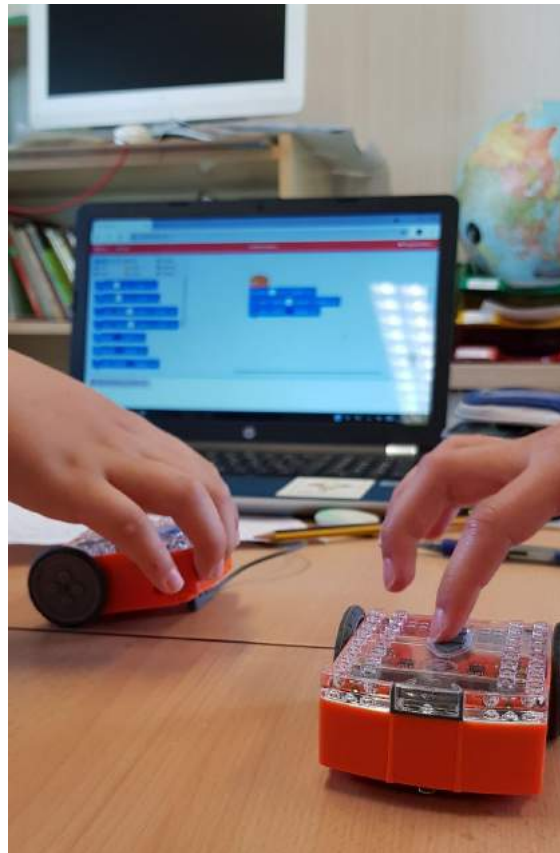


The teacher will find the indications of how Edscratch works and how to download the programs built for the robot here:



<https://meet Edison.com/robot-programming-software/edscratch/>

Children are going to build their programs, download them to the robot and try out how they work. This is an interactive process, with a lot of tests, debugging and redoing, which requires time.



### **reflect (unplugged)**

It's a good opportunity to reflect with the children that a problem can have many solutions and all of them can be valid.

Allow time for sharing and reflection about the difficulties encountered, the ways to solve them and the learnings made.

Discuss also how it has been working in teams, helping each other and learning from the others and ask students to record their answers in their journal.



<b>WORKSHOP 23: Simple Machines</b>	<b>Unplugged</b>	<b>All Ages</b>
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Simple machines were invented long ago in order to be able to do a task more easily. Many of the machines we use today use one or more simple machines!	<b>Objectives</b>	Get an idea of the usefulness of machines and the name and operation of simple machines, various tools
	<b>Materials</b>	History of energy, images to illustrate the story, inclined plane, a long ruler, plasticine, sharp pencil, piece of wood, nails, books, eraser, felt pens, pulley, gears

### imagine

#### THE STORY OF ENERGY

*(Teachers should collect images to use while telling this story. The story can be divided into shorter "episodes" where you give more details on each section.)*

Throughout history, thanks to the knowledge of the different forms of energy and how they might be used, human beings could satisfy their fundamental needs and make life simpler and more comfortable. Consider energies like light, heat, movement, and force - how might these energies have helped humans to satisfy their needs?

Let me tell you a story about how human beings obtained and used different forms of energy. We will look at many ENERGY SOURCES - How did people get the energy? How did they use it in the past? How can we use it in the future?

To study the evolution of our need for energy, we must go back to the very beginning. The need for energy has been something that has existed from the first signs of life on the earth. A living being, no matter how big or small it is, needs energy to grow and reproduce. The first organisms from the sea got their energy directly from the sun. As life developed, organisms continued to get their energy from the sun - some directly and some by eating other living beings that had gotten *their* energy from the sun.

Human beings get energy from the food we consume. After consuming energy from other sources, our body has energy to think and work. This source of energy, our body, was the only source of energy that human beings had for a long time. Imagine the very first humans - everything they did, day after day, was only possible thanks to the energy of their own body. About 350,000 years ago, human beings discovered something that would change this - they discovered FIRE! With this discovery, they realized that in order to keep the fire going, they

needed to add some wood. Without knowing it, they discovered the use of BIOMASS. Biomass is the energy that resides in all plants and comes from the sun. We can take energy from the plants, not only by eating them but also by burning them. Thanks to the discovery of FIRE, human beings could now use BIOMASS as another form of energy. Humans now had a very powerful energy! By harnessing the energy of fire, they could use it for many practical things. Can you think of what they could do using fire? (warm themselves, heat food, boil water, make better utensils and weapons, scare predators...) Imagine the special change that the discovery of FIRE meant for the life of the early humans.

However, human beings still did not know how to use fire for WORK. When we say *work*, we mean the use of energy to help **move** things. Early humans did not know how to use fire as energy for movement. Humans had to do the work themselves. For this, they depended on the muscular force of men, women, and animals to move things. This type of energy is called BLOOD ENERGY.

In the first century after the common era (1 ACE.), a machine was invented that made even better use of people's and animals' energy. This invention was called a MILL STONE, also known as a "blood mill". This mill was a wheel that was moved by workers or animals to raise weights and water, to grind grain, or as a part of other small machines. Why do you think people thought of inventing a machine to grind their grain?

Later, the Greeks invented what we call the Greek Mill. It was a vertical shaft, like a wooden pole, that held a wheel with paddles attached to it. Water flowing over a horizontal wheel caught the paddles, and the weight of the water turned the wheel. This meant humans had discovered HYDRAULIC ENERGY (water energy).

But in order to work properly, this Greek Mill needed a heavy, steady current of water. In the Roman Empire, the architect of the emperor Julius Caesar, a man named Vitruvius, invented a mill that had a *horizontal* shaft and with the stone and the paddles in a *vertical* position. This was the opposite of the Greek Mill. This type of mill made even better use of the HYDRAULIC ENERGY, and it started to be constructed everywhere.

The hydraulic mills now used the energy of the water, and so required less blood energy. Around the same time, humans realized they could take advantage of another force of nature, the WIND. The energy that comes from the wind is called WIND POWER. Humans thought, if the energy from water could turn a mill wheel, then what about using the energy from the wind?

The first windmill was invented by Heron of Alexandria also during the first century after the common era (1 ACE.). He was a Greek geometer and inventor. At first, the windmill was used to move elements of a musical instrument like an organ. Later, the windmill was used by the Persians, the Arabians, the Chinese, and even by medieval knights who took the idea and used it to fight against the Arabians!

Humans now had the energy from themselves (blood energy), from biomass, from the water, and from the wind. Using all these energies, they were able to do things and create more ways to use the energy.



One of those new ways was using *coal* - fossilised firewood that still has all the biomass energy of wood. People discovered that by using coal, they could create a lot of heat. With more heat, they could melt metals and even make new metals! They could also make water boil. Boiling water creates steam. By the end of the 17th century, this led to the great invention called STEAM ENGINE. By using steam engines people could now make machines **move!** Steam engine was such an important invention that it totally changed people's way of life. We call this period THE INDUSTRIAL REVOLUTION.

In order to make new machines and to heat water hot enough to get steam, people needed a lot of coal and steel. *Steel* is a metal that is very hard, and it is the result of mixing iron and coal. Coal was used for almost all energy at this time. But it was dirty, hard to transport, and contaminated the environment during production. Little by little, coal was replaced by PETROLEUM AND GAS. Petroleum and gas also come from fossilised plants and animals in the same way as coal, so they contain a lot of energy from the sun. Petroleum is a liquid and gas is... a gas. This makes it easy to transport, and therefore more available for machines everywhere.

Soon after, people invented ways to use ELECTRIC ENERGY. For hundreds of thousands of years, people observed electricity in nature, like lightning and magnets, but they did not know how to control it. In the beginning of the 20th century, people were able to study electricity in new ways, thanks to inventions from years before. They realized that everything was made of something smaller, the building blocks of nature that we cannot see with our naked eye. They discovered ATOMS, and they saw that atoms were made of different particles: neutrons, protons, and electrons. They observed the movement of these particles and discovered that they emitted energy.

With this new discovery, people realized that they could transport electric energy through a cable. This did not pollute at all, and it could be obtained by a mill or from heat. It could be transformed faster with new equipment to convert energy into light, heat and movement. This was an amazing discovery that again changed the way people lived!

To get electricity, people used petroleum at first. Later, natural gas was also used, and that too was extracted from the ground. This became more popular in the 1960s because it was cleaner and easier to transport than petroleum. So now, all the energy was coming from HYDROCARBON - petroleum, gas and coal. But then, people realized that they were using these sources up, and soon they would disappear. They needed to find alternative sources of energy.

One of the alternatives scientists suggested was ATOMIC energy. Remember the earlier scientists who discovered the particles of the atom? Well, scientists now observed that there is a lot of energy within the nucleus of some atoms. They thought that perhaps if they broke apart the nucleus of some of these atoms, they could channel this energy and use it as an energy source. Scientists built facilities called *nuclear reactors* that would be able to split the nucleus of some elements, like uranium, and transform it into enormous amounts of energy. But with the creation of so much energy, there was a new problem - radiation. Atomic energy gives off huge amounts of harmful radiation that kills living things around it. There

have been catastrophes using atomic energy that have had horrible tragedy for people, animals and the environment for many years after the explosions. This made scientists consider whether this energy, as powerful as it was, was more harmful than useful as a source of energy.

So let's consider all these energy sources and how they impact the environment. Coal pollutes the air, as does petroleum. Petroleum and natural gas deplete the environment of natural resources and will soon run out - they are not renewable. Atomic energy was far too dangerous and is potentially very harmful for the environment. People realized that they needed to find new sources of energy, ones that could harness the powers of nature but would not use them up.

Fortunately, there are some ways to create energy that do not use up the sources - these are called RENEWABLE ENERGY SOURCES. Remember we talked about the mill that used the power of water or wind? The water kept flowing and the wind kept blowing, and created energy to make the mill move. Well, scientists worked on ways to use water and wind to move new types of mills that would convert the movement into electricity! The water and wind moves a turbine and a huge magnet creates electricity. This electricity can then be sent along cables to be used in our homes!

Water energy used to create electricity is called HYDROELECTRIC ENERGY. Wind energy used to create electricity is called EOLIC ENERGY.

Now, there is also another powerful source of energy in nature. Think back to the very beginning of life. What gave all living things energy? The SUN, yes! And the sun is also an energy source that won't run out or that we can use up. Scientists invented a way to capture energy from the sun to produce electricity! We call this SOLAR ENERGY. Just like plants and animals get energy from the sun, now we can also get electric energy from the sun to heat our houses!

There are even more sources of renewable energy that scientists are working hard to find ways to harness. Imagine the energy inside the layers of the earth, for example heat from magma. This is called GEOTHERMAL ENERGY. Or what about the ocean, when the tides come in and out, day after day? Scientists have found ways to use this energy, which we call TIDAL ENERGY.

Humans are still searching for the best sources of energy that can replace the non-renewable sources. But this will take time and lots of human imagination and cooperation. Perhaps one of you will discover new ways of creating energy that will not harm our planet? Maybe you will invent a small part of a machine that improves life on earth for all of us? The future is in your hands!



## create

## play

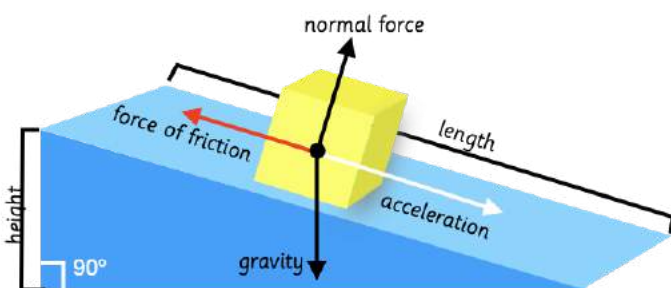
Refer to the story of technology and the story of energy to consider ways to use energy to do things more easily. (For example, using sharp tools to cut, etc). All these tools that make life easier and allow us to use less energy are called *machines*.

Many of the early simple machines that early humans invented are still used today! Some in the same way they were originally meant, others as smaller parts for bigger, more modern machines.

*The main idea of these activities is to let the children experiment with materials and tools, and let them discover what happens and ask themselves questions.*

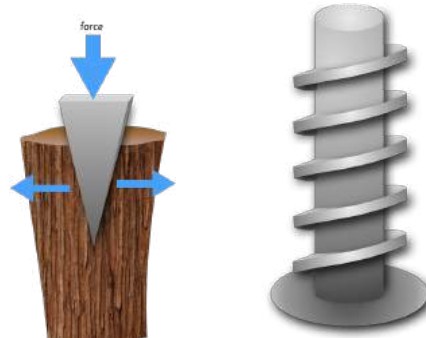
### INCLINED PLANE

*EXPERIMENT: Try to pull a weight up an inclined plane with the help of a dynamometer to compare the force needed in each case.*



This inclined plane can be found in many machines, tools and other things. Think about knives, nails, ramps to get inside some places instead of stairs. There is also an inclined plane that is the spiral ramp, because it is twisted in itself. We call this a **screw**.

People also realized that the sharp part of the inclined plane was also useful. If you put two inclined planes together, you can make a **wedge**. A wedge could be used as a spear tip to go faster through the air. Or it could be used to hit into a piece of wood to split it.

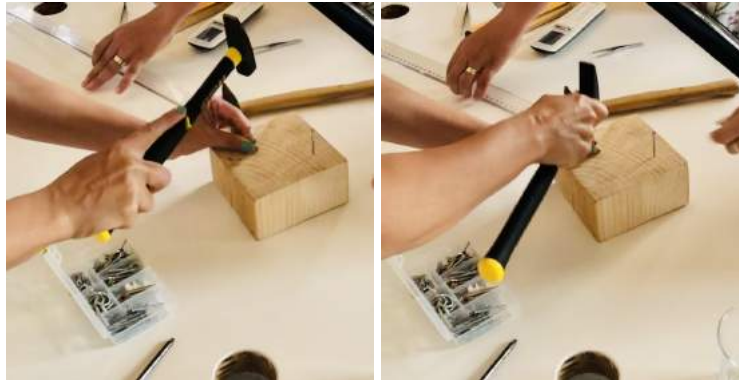


### LEVER

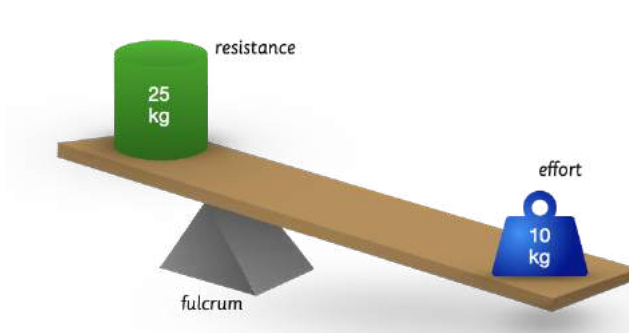
A lever was invented to make the distance longer from the point in which the force was done (the hand) and the point in which they did the work (cutting the meat, for example). Using a lever, they also realized that they could do more work with less muscular force. Look what happens with a hammer. When we hit with a hammer, holding it from the tip (from a

long handle) we must use much more force than if we hold it from the other end. You can try it. Notice how we can create more force by using the longer handle, but we do not have a lot of control. We cannot control where the hammer hits , whereas, with a shorter handle, we have more control, but we use less force.

*EXPERIMENT: Stick a nail in a wooden piece with the use of a hammer. Try to do it using the hammer from both ends of the handle.*



The lever has been also used to lift weight throughout history. If we have a point on which to support the lever (for example, a stick) , we can make the distance shorter or longer between the point in which we lift the force (effort) and the point in which we want to apply force (resistance). In this way, we can get a lot of force, or not a lot of force but a lot of control. The clearer case is when we want to raise a weight with the help of a stick.



*EXPERIMENT: Let's try to raise a weight directly and then with the use of a lever. We can use books as resistance (or a plastic cup with marbles, so it will be easy to vary the weight) and a rubber as the point of support and a ruler as a lever.*

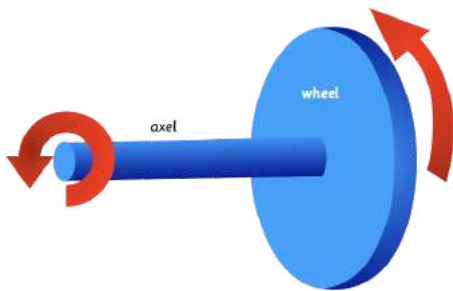
This principle has been used in history in many tools and machines (pliers, a spoon to lift food with less effort, a can opener, bottle opener, wheelbarrow, hammer, nutcracker, fishing rod, laboratory clamp or tongs, excavators... We can show different tools (laboratory clamp, scissors, pliers). We use the lever to make more force or to have more control. For example, when we use tongs, we want to make a lot of force but with clamps we want to do the opposite, we want to use less force but have more control.

## WHEEL AND AXLE

Also in prehistory, they discovered another technique that allowed them to do more work with less effort. They often needed to carry heavy weights from one place to another by dragging them. They realized that by putting some logs underneath, they could do it more easily - they could roll it. In this way, they started using the first version of THE WHEEL.

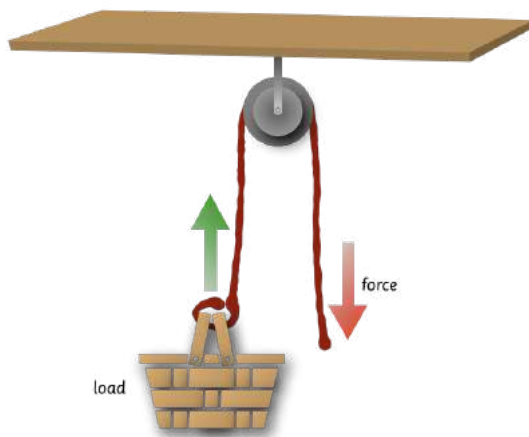
You may also know that later wheels were used for carriages, bicycles, cars and many other devices and equipment.

*EXPERIMENT: Drag a heavy pile of books across the floor without anything under them. Now, try to do the same but this time, lay some markers or round dowels together in a row and then place the stack of books on top. What happens when you drag the pile now?*



The Wheel, apart from helping with the transportation of weights from one place to another, was used for many other situations. They realized that a cylinder could have a string rolled on it and it helped to raise weights. It is called the WHEEL AND AXLE.

## PULLEY

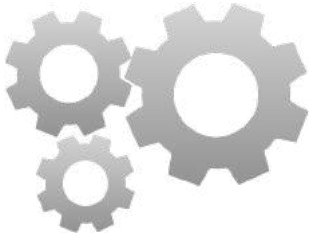


From this wheel and axle, pulleys were invented. A pulley is a disc where a string goes through. A pulley is used to raise weights in a more comfortable manner. Combining two pulleys can save you half of the force. If you combine three pulleys, you use the force three times less.

*EXPERIMENT: Use one pulley to lift a weight and test your dynamometer. Try with one more and with three more and test your dynamometer. How much less effort did you use?*

You are now more aware about how our ancestors could manage to make the great constructions without the use and existence of the machines that we have nowadays. We can consider the pulley as one of the most important inventions that have improved the life of humans.

## GEARS



The latest great invention based on the wheel was GEARS. Putting a notched wheel next to another that was smaller or bigger, they could see that the movement was faster or slower, but in a more powerful manner.

### EXPERIMENT:

We can experiment this with the special material of gears, but you can also think about your bicycles. The chain that a bicycle has is a type of gear because it links notched wheels together.

If you take a look, you may see that if we connect the movement with the small pinion we will go faster, but we are not going to use a lot of force (in the descent) whereas if we connect the big pinion we are going to use a lot of force, but we are going to go more slowly (in the ascent).

### reflect

All these small basic machines invented throughout history are the fundamental elements in all our vehicles, utensils and complex machines that we have nowadays. Everywhere you look, you can find an inclined plane, a lever, a wheel, a pulley, and gears. When you see one of these, remember to thank all the people who came before and worked to find ways and tools to make life easier for us.

In your journal, make a table with five columns. At the top, write the names of the simple machines that you looked at. Can you list things you use today that are based on these simple machines?

<i>inclined plane</i>	<i>lever</i>	<i>wheel</i>	<i>pulley</i>	<i>gears</i>



**Follow-up Activity:  
The Cardboard Automata**

**Unplugged**

Ages  
6-12



This is an activity designed by the [Tinkering Studio](https://www.tinkeringstudio.com/) and inspired by the [Cabaret Mechanical Theater](https://www.cabaretmechanicaltheater.com/) (© 2017 Tinkering Studio. Exploratorium. [www.exploratorium.edu](https://www.exploratorium.edu)).



For more information and PDFs with detailed instructions in several languages, check this link: (<https://www.exploratorium.edu/tinkering/projects/cardboard-automata>)

The idea is to explore simple mechanical elements such as cams, levers, and linkages, while creating a moving sculpture with simple materials that lets you bring stories to life. In this activity, technical engineering is blended with artful narrative.

## imagine



To let children's imagination fly, a good way to start is to watch one of the videos with the wonderful automatons from **Cabaret Mechanical Theatre**:



<https://www.youtube.com/user/CabaretMechTheatre/videos>

Then it's time to imagine some small narrative with a couple of characters.

## create

After imagining the narrative, it's time to build the mechanical elements. You will need these materials:

- Cardboard
- Skewer sticks
- Paper drinking straw
- Masking tape
- Scissors
- Hot glue gun and glue stick

- Nail or wood screw (for poking holes in the cardboard)

Additionally, you will need materials to create the narrative on top of your construction. You can use foam sheets, feathers, corks, googly eyes, coloured felt, pompons, etc.

To see how to create the mechanisms, it is best to go directly to the original source of the activity, as it is very well described there, with photos and diagrams, and presenting alternative variations:



<https://www.exploratorium.edu/tinkering/projects/cardboard-automata>

### reflect

The motion of automata depends on various factors such as the size and shape of the cams, the position of the axles, and the number of cams and cam followers. Exploring those factors is a good starting point to understanding simple mechanisms. Introducing other elements such as gears, linkages, and springs will add complexity to the activity and enable learners to explore endless possibilities for creating mechanical motions in automata.

Ask students to create in their design journal a diagram or an infographic explaining how and why their cardboard automata works.

# APPENDIX 1: Montessori Grammar (Parsing) Boxes

- (a) Box 1 – Noun and **Article** (Light Blue)
- (b) Box 2 – Noun, Article and **Adjective** (Dark Blue)
- (c) Box 3 - Noun, Adjective, Article and **Verb** (Red)
- (d) Box 4 - Noun, Adjective, Article, Verb and **Adverb** (Orange)
- (e) Box 5 - Noun, Adjective, Article, Verb, Adverb and **Preposition**. (Green)
- (f) Box 6 - Noun, Adjective, Article, Verb, Adverb, Preposition and **Pronoun** (Purple)
- (g) Box 7 - Noun, Adjective, Article, Verb, Adverb, Preposition, Pronoun and **Conjunction** (Pink)
- (h) Box 8 - Noun, Adjective, Article, Verb, Adverb, Preposition, Conjunction, Pronoun and **Interjection** (Yellow/Gold)

## MATERIAL:

- Boxes with long compartments for sentence cards and small compartments for the total number of parts of speech being presented
- Several phrase / sentence cards in the colour of the new part of speech added
- Individual cards for each word in the sentences on coloured cards according to the part of speech of that word
- Objects in boxes to go with Parsing Boxes 2, and 3

## SEQUENCE:

- After introduction to parts of speech
- Before symbolic parsing

**APPROXIMATE AGE:** 5-9 years

## NOTES:

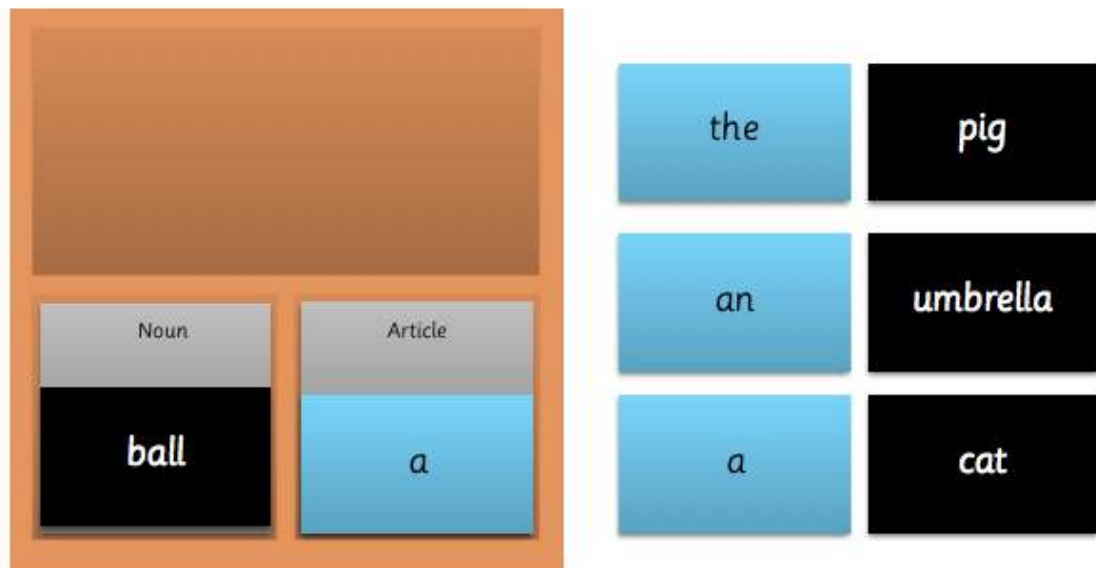
- The boxes are progressive. Each box contains the parts of speech from **all** previous boxes and no others. This reinforces previously learned knowledge and allows for comparison.
- The child should already be presented with the parts of speech and will therefore look for the correct card in the correct compartment by knowing what part of speech that word is.
- Some manufacturers make parsing boxes that use different colours for parts of speech. This exercise here uses the standard colours for each part of speech, corresponding to the colours of the grammar symbols.
- The boxes are expensive. It is possible to use packets and to lay the different parts of speech in bundles on the table for these exercises.

## PRESENTATION:

Take the first parsing box to the child's table. Show the little compartments and the headings for these. Place the headings behind the cards so the child can see the colour.


Explain that the cards for that part of speech are kept in there. Remove one phrase card and place it in front of the child. Ask the child to read the first phrase. Take out the object. Tell the child that you want to make this phrase with small cards. Ask the child to look for the first word from the selection of words available. The child places it on the table. The child continues to build the phrase. When the phrase is complete, ask the child to read the second phrase on the card on the table. Change the object according to the new phrase. The child will note that one word needs to be changed. Take the old word and place the word card face downwards and find the new word card. When completed, remove all the cards and continue with the next phrase/sentence.

**Box 1** is very simple and is used with preschool children. This box only includes two compartments for the noun and the article, and no phrase/sentence cards. The children can use these cards as a matching exercise for finding the articles that match the nouns. In English, this is very simple, as there are only *a*, *an*, and *the*. However, this is a more relevant exercise for languages that use masculine, feminine and neuter cases.




**Box 2** now adds the adjective to the series. Each phrase card should include an article, noun and adjective, where only the adjective changes, emphasizing the function of the adjective in the sentence. For Box 2, we now introduce the use of objects. There should be a selection of phrase cards and word cards that correspond so that the child needs to sort through the pile of word cards to find the correct one.

the large box the small box		
Article	Noun	Adjective
the	box	green

a green button a blue button		
a	blue	button




**Box 3:** This time the object requires an action, as the **verb** is being highlighted. **Note:** This is the first box in the sequence that will have complete sentences on the cards.

Toss a large ball. Roll a large ball.			
Article	Noun	Adjective	Verb
a	ball	large	Close

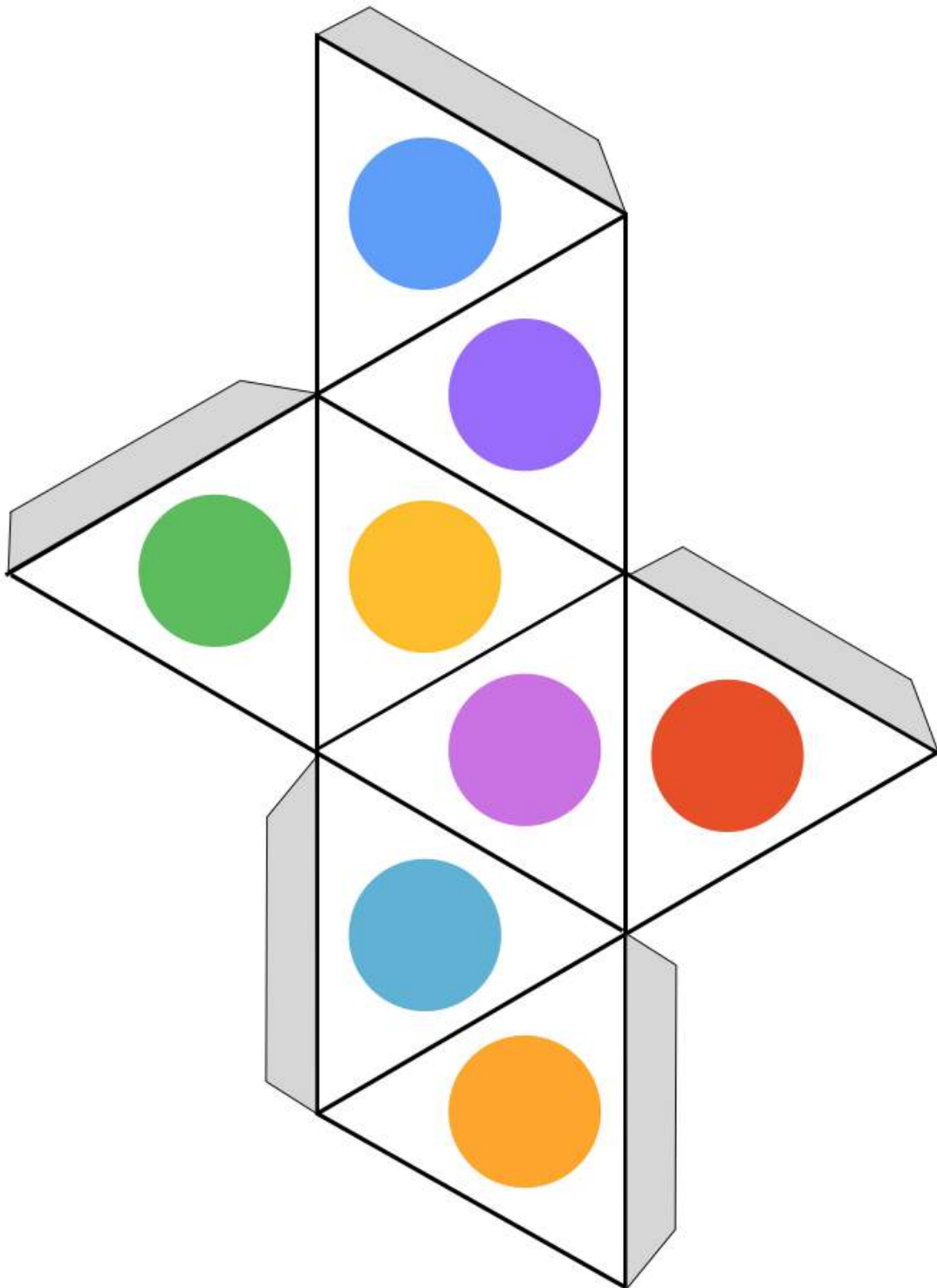
Open the gold box. Close the gold box.			
Open	the	gold	box



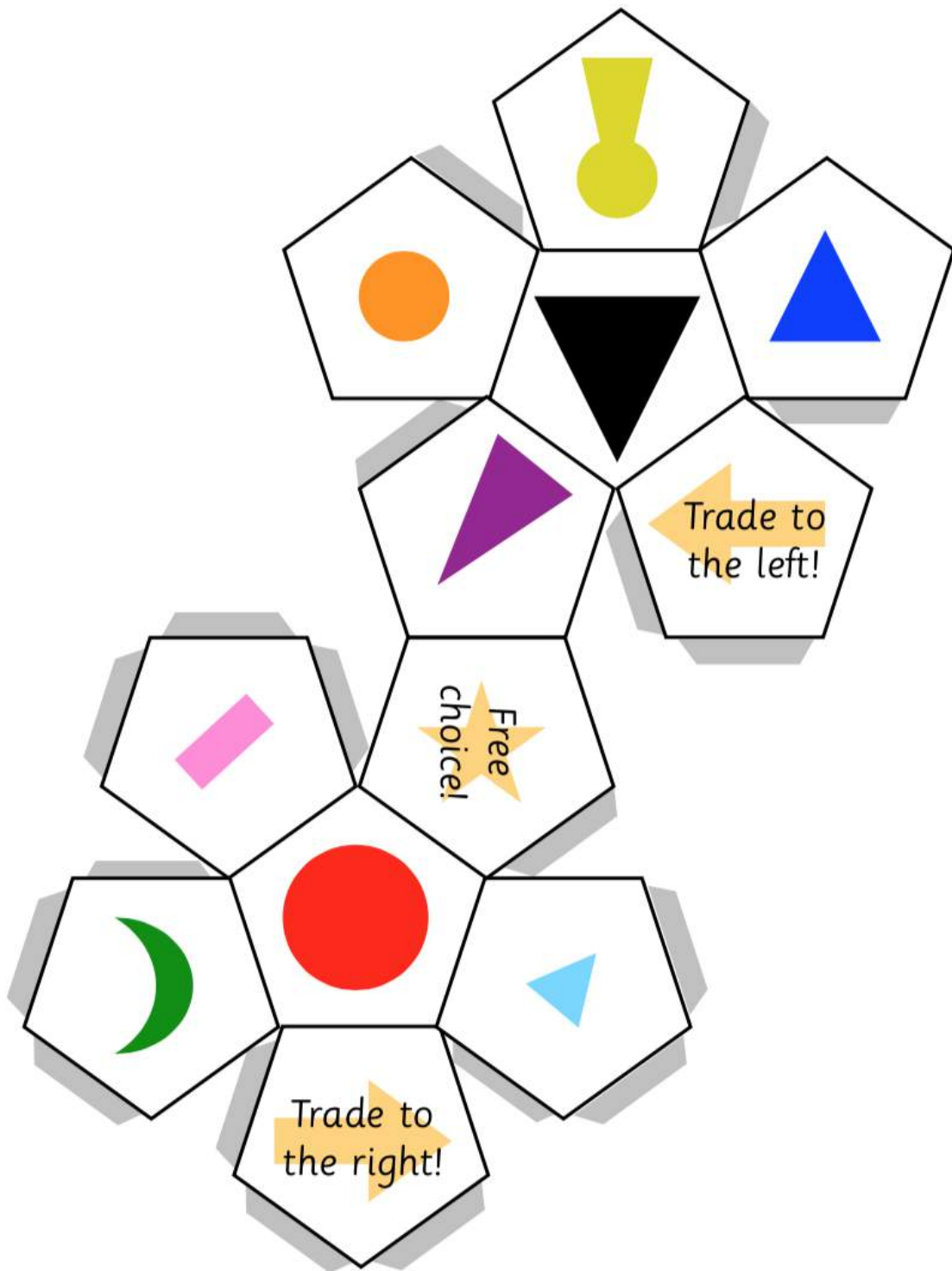
There are no objects with the rest of the boxes. The child will not need a full new demonstration, but will need to be guided to the new box and asked to note what new part of speech is in this box.



## APPENDIX 2: Scratch as a Language Dice Template



## APPENDIX 3: Grammar Sentence Dice Template



## APPENDIX 4: Scratch 10 blocks challenge

# 10 BLOCKS

### WHAT CAN YOU CREATE WITH ONLY 10 SCRATCH BLOCKS?

Create a project using only these 10 blocks. Use them once, twice, or multiple times, but use each block at least once.

#### START HERE

- Test ideas by experimenting with each block.
- Mix and match blocks in various ways.
- Repeat!

**FEELING STUCK?**

THAT'S OKAY! TRY THESE THINGS...

- Test ideas by trying out different block combinations. Mix and match blocks until you find something that interests you!
- Try brainstorming ideas with a neighbor!
- Explore other projects to see what others are doing in Scratch. This can be a great way to find inspiration!



#### FINISHED?

- + Add your project to the 10 Blocks Studio: <http://scratch.mit.edu/studios/475480>
- + Play with different sprites, costumes, or backdrops.
- + Challenge yourself to do more! See how many different projects you can create with these 10 blocks.
- + Swap projects with a partner and remix each others' creations.