

Cosmos with Hopscotch

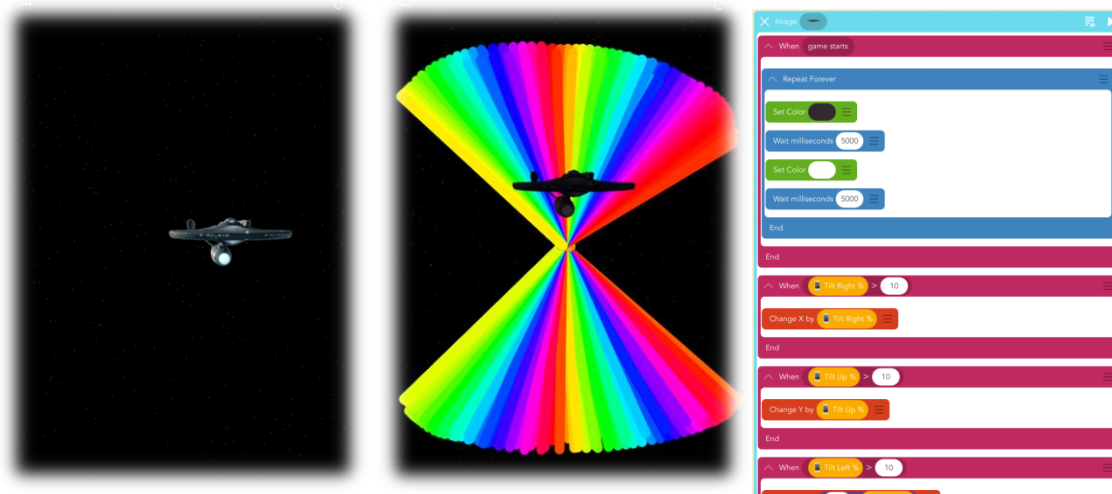
Second edition

Diane Boulanger

For more than 50 years, the Star Trek series has continued to inspire our young people towards science and exploration. The mission is to explore space, the final frontier. It explores strange new worlds to discover new lives and new civilizations. To go where no one has gone before. The film Star Trek Beyond (2016) illustrates very well the contrast between two examples of mindset: the fixed mindset and the growth mindset. Under the supervision of Captain James T. Kirk, the Enterprise's mission is to rescue a team in an unexplored region of space. With his growth mindset, he explains to his team that there is nothing that is unknown, it is only temporarily hidden. He thinks he is capable of confronting everything, that he can find solutions to all the problems he faces.

His opponent, Krall, however, has a fixed mindset. He does everything to lengthen his life. He goes so far as to destroy other civilizations, to accomplish his goal. He acquires a war artifact to destroy the City of York. We realized at the end of the film that Krall was considered a hero on Earth. He was a decorated former soldier. With the new emerging vision of his civilization, during the transition from a military society to an exploration society, he did not know how to adapt and kept an intense hatred for his civilization. As a soldier, he fought for humanity in the wars against the Xindis and the Romulans. During the change of vision of society, he was asked to become captain of a spacecraft and share his bread with the enemy. His fixed mindset did not allow him to change his work habits. He wanted to destroy lives as he had always done as a soldier. He did not want peace. He wanted to continue living without change, as he had always done.

One wonders what is the relationship between the film and the curriculum to be taught. We want to encourage students to choose the growth mindset of Jim T. Kirk to explore their surroundings, use science and critical thinking to break away from the irrational, use science to improve their society, to build peace. Students can explore the space and all the tools of exploration, putting themselves in the role of this inspiring character. They can create a Hopscotch game that simulates the travels in space and the science and mathematics behind space exploration.



Name of the program :Face à l'inconnu <https://c.gethopscotch.com/p/yodzsslmj>

It is an inspiring film to link the text of the film to the curriculum. Readers write a reading response using Hopscotch. A color program is already available on Hopscotch. It can be remixed and modified by adding a photo of the Enterprise itself, taken from the Internet, and programming a simulation of the spaceship traveling in unknown space, with all the special effects that this implies. The program is interactive and responds to commands easily programmed with Hopscotch. This type of reading response will undoubtedly help students develop a positive attitude towards science, technology, engineering and mathematics while having fun.

As important as the growth mindset of students towards their learning is the growth mindset of adults towards their students. Will we allow and help our students to explore with new tools, new approaches that we are not familiar with. If a teacher believes that her students are limited, she will have very low expectations of her students and will not give appropriate challenge to the students. Students become more intelligent when they have a growth mindset and have challenging work (Seely, 2016).

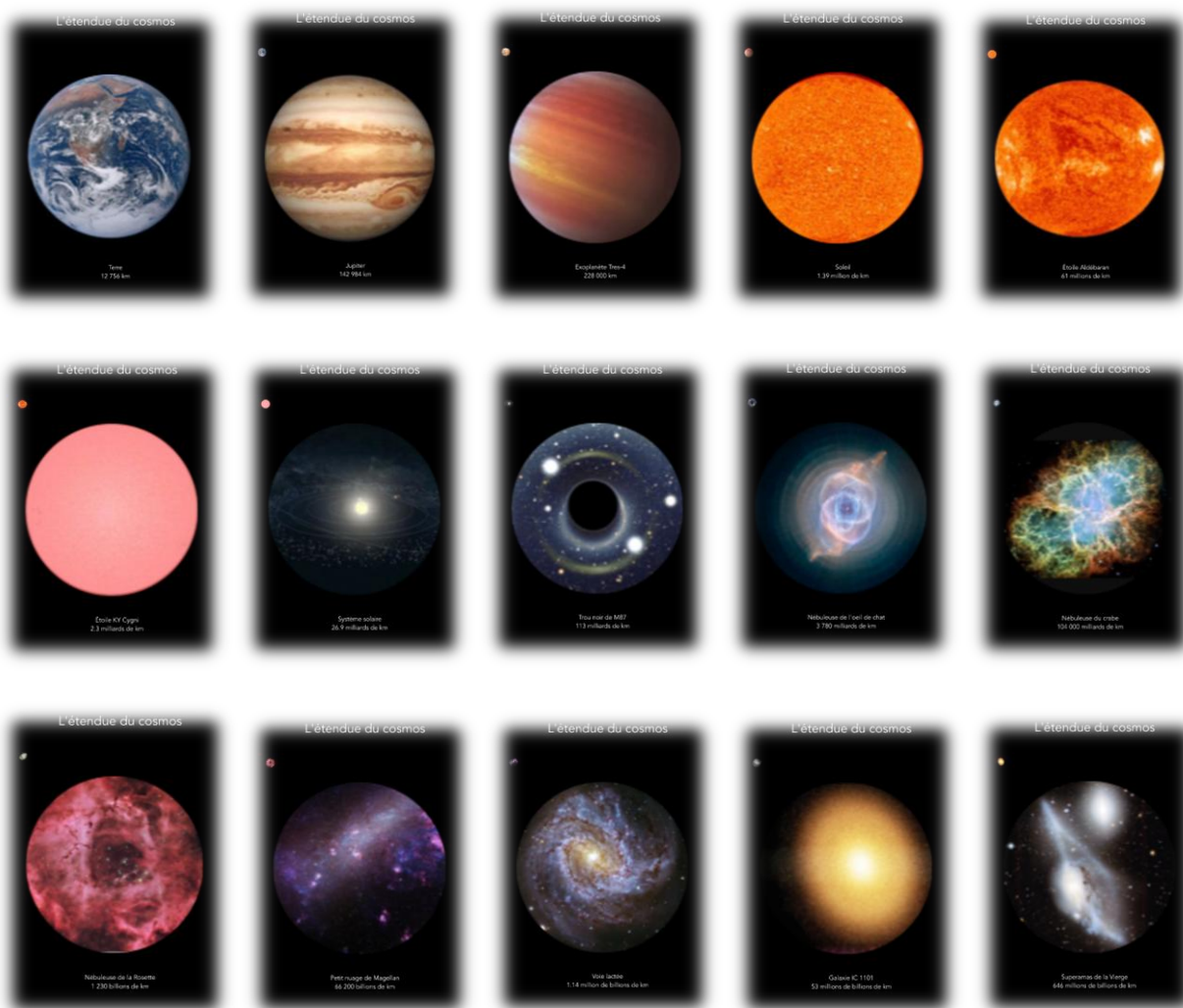
To be successful in Science, Technology, Engineering and Mathematics (STEM), students must have a growth mindset and a positive attitude towards STEM. If students and their teachers do not believe in themselves, they will not have the interest and will not make the effort necessary to solve the problems. In general, 40% of students have a fixed mindset and 40% have a growth mindset towards mathematics. Students with a growth mindset have results that show at least one year ahead of other students in

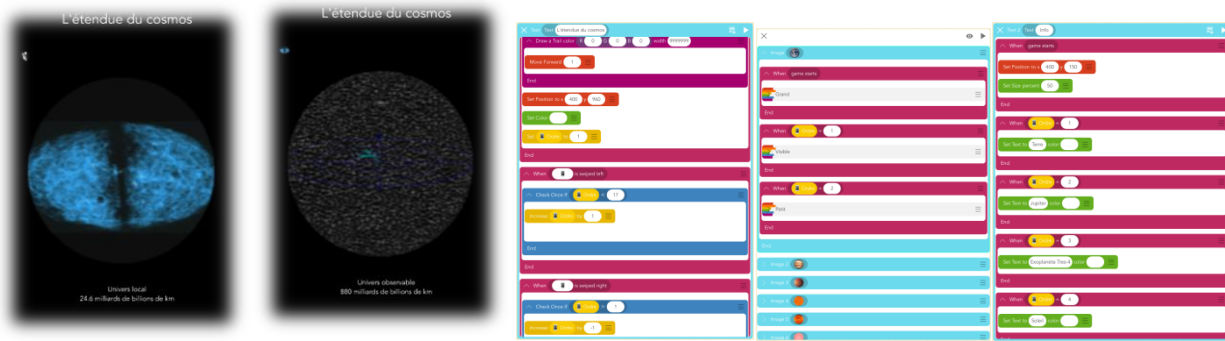
mathematics. It is the kind of encouragement that is given to students that makes a difference.

In this example, the Hopscotch program faces the unknown, using the following strategies. The student programs with a growth mindset, which allows him to face the challenges before him. We use a visual element that is one of the most important sources of information to understand our world. We make a mathematical link that is relevant to the students, since they have probably seen the film on the big screen with their parents. One integrates the futuristic vision of a captain in the problem to be solved. We use what students like, an excellent Disney movie and technology. A simulation game is programmed that students can play, once completed. The value of mathematics and science is demonstrated by making meaningful connections and exploring the unknown world through science. Since there are several ways to write a simulation, anxiety is reduced by allowing simple or complex simulations to be written. In this example, when you press the iPad, or the iPhone, you discover a new place of space. We see the effect of the Enterprise and its shadow in the immensity of space. By putting yourself in the shoes of an inspiring character you can realize that it is possible to change one's intelligence and make maths and sciences that make a huge difference and inspire a vision of peace.

Genius Hour

When I went to school, astronomy and space studies were not in the school curriculum. Even at the university, in the science department, astronomy was not on the agenda. What sparked my deeper interest in the cosmos was a little-known picture book I bought for my children, entitled *My Place in Space*. This book proposed a profound question and inspired a multitude of other questions. Where do we dwell in the whole extent of our universe? What is the size of the universe? Why does the world exist? What is our place and function in this universe? How does the universe work? What forces are at the base of our universe? How did it develop? Are we alone in this universe? These are multigenerational and multicultural issues that drive scientists to understand the world we live in.

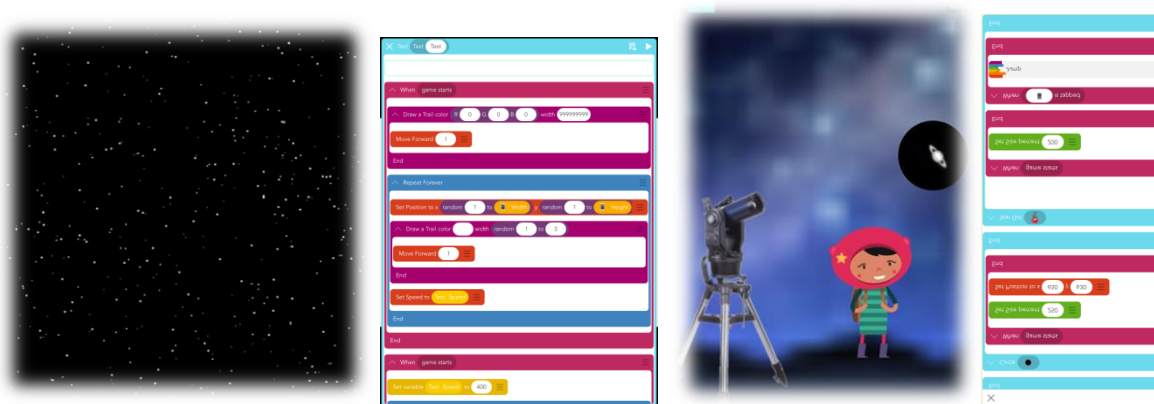




Name of the program : Taille du cosmos <https://c.gethopscotch.com/p/ytx0z2htp>

Each new image of the simulation is approximately 10 times larger than the image of the previous spatial object placed in comparison. The simulation data comes from the book *Science as you have never seen it* (2015). We see the Earth that we know well, with all its immensity. The Earth is much smaller than the planet Jupiter, with its diameter of 12,742 km. Jupiter is much smaller than the exoplanet Tres-4 and the sun with its diameter of 1.39 million km. If we continue, we realize that the sun is much smaller than other stars including Aldebapan or KY Cygni with its diameter of 2.3 billion km. These stars, however, are much smaller beside the entire solar system, black holes, nebulae or our galaxy, the Milky Way with its diameter of 53 million trillion km. The Milky Way is much smaller in other galaxies, the supercluster of the virgin, the local universe and the observable universe with its diameter of 880 billion trillion km.

The small telescope that I had bought afterwards made it possible to see with our own eyes the celestial objects. The first images of the Hubble telescope were quite fascinating, but, the feeling of being a scientist, could not develop without exploring space ourselves, with our own instruments and taking a liking to understanding science, with our own deep questions. The euphoric feeling of seeing Saturn's rings with a telescope, and not only with an image, is quite memorable and pushes many young children to pursue further studies in science. Instruments like a small telescope allow students to realize that science is based on real observations, on evidence. Science is not a collection of facts or beautiful images taken at the Hubble telescope. Science is a way of thinking to understand our world and to develop a better future for all of us. Science allows us to evaluate our beliefs based on real facts and not on superstitions or captivating stories. If we have false beliefs, scientific exploration allows us to change and improve these beliefs, based on reality. Observation with the telescope is an essential step in developing this scientific spirit.



Name of the program : Univers <https://c.gethopscotch.com/p/ytg7dzptr>

Name of the program : Saturne photoShop <https://c.gethopscotch.com/p/yomzs6jxl>

The power of science comes from the way we collect data and evidence. These data are analyzed by several independent scientists who review the work of their colleagues to ensure that the understanding of data and evidence is as accurate as possible.

During Genius Hour, once a week, we can challenge all our students to create something that they value that interests them. Is this a reasonable solution, considering your context? This is the same concept that Google uses with their employees. They have the autonomy to work on a fascinating project of their choice if they follow the vision of the corporation. For one day a week, employees build something of their choice that will benefit the business. For example, using this process, an employee developed the Google eyeglass prototype in just 90 minutes (Schmidt & Rosenberg, 2014). During genius hour, our students can also create exciting new projects that fascinate them.

In his book *Freedom To Change*, Michael Fullan, gives us main guidelines to help all education leaders and those who want to take a new initiative. Each of us is more motivated if we have a goal, or a common vision. The group you work with can be powerful, but also go with great power in a wrong direction, without considering other options. Krall, of *Star Trek Beyond*, refused to consider another option. Furthermore, most innovations in the digital world have been made in a collaborative way. Cooperation and autonomy must be balanced. With our autonomy, we can work with the group, develop ideas, but also generate ideas regardless of the group we work with.

The role of astrophysical simulation

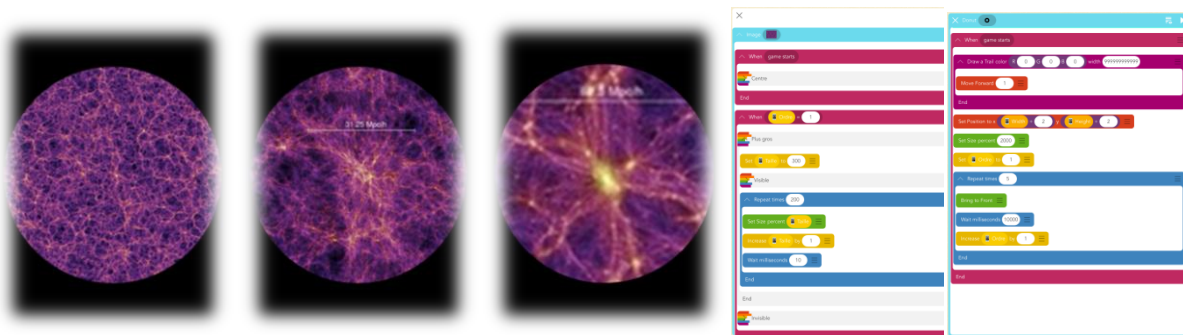
The methods of work in science are constantly changing. The 21st century is the age of computer simulation (Winsberg, 2010). Several important domains make full use of computer simulations, including engineering, astrophysics, climate science and evolutionary biology, for example. The simulation supports experimentation and observation. Computer simulation is used when the phenomena to be observed have little data. The simulation creates images based on a model that is validated by data that can be observed. In general, these models are very complex.

Astrophysicists tell us about their work. They indicate that astronomical observations, by themselves, do not deepen our knowledge of the universe (Rowan-Robinson, 2013). Experimentation by itself is not sufficient. The telescopic observations are only useful when compared to the predictions of the theoretical model. Before scientists can use land-based or space-based telescopes at a cost of billions of dollars, scientists must have chosen an interesting question, investigated all our current knowledge about this issue, made a prediction about what observation the telescope could bring back as knowledge. If the question is sufficiently interesting, the committee responsible for the telescopes will let the scientists, who request it, use a telescope. Scientists analyze the results and return to the scientific model in order to understand their observations and develop new questions.

Computer simulation, which contains the theoretical knowledge and observations of scientists from decades of research, becomes an essential and irreplaceable tool for understanding the cosmos. Simulations often replace experimentation as a source of information. However, they must be validated. The validation process determines whether the theoretical model chosen, behind the simulation, is a satisfactory representation of the real system, depending on the objective of the simulation. Here we see a radical transformation of scientific experimentation in this important field of science.

The simulations are intended to replace experiments and observations as a source of data on observed phenomena (Winsberg, 2010). In 1922, our instruments allowed us to know that the Milky Way, with its diameter of 100,000 light-years. With the instruments

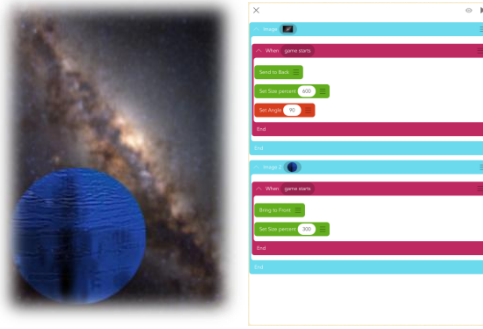
available today, we are expanding our visible universe to 93 billion light years. For example, the millennium race is the most precise and detailed simulation of this universe. The simulation traces the evolution of the large-scale structure of the universe, how the galaxies observed were formed. The simulation is used by scientists working in cosmology to compare their observations with theoretical predictions. The objective of the simulation is to simulate data that should accurately predict phenomena or accurately represent the phenomena to be simulated.



Name of the program : Millenium simulation <https://c.gethopscoth.com/p/yho7ibvow>

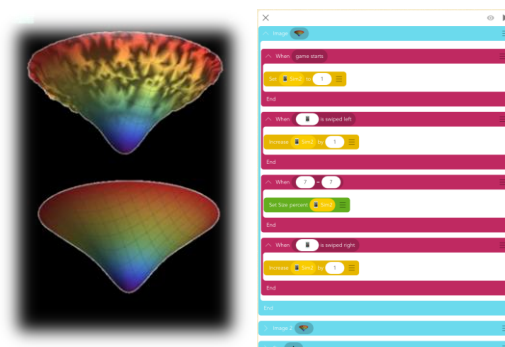
When the simulation makes excellent predictions or reproduces the model correctly, the credibility of the simulation as a reasonable source of information is enhanced. At this point, simulation takes the place of experience and the scientific instrument. With the Hubble telescope, scientists often take a full day to visualize a small point in the cosmos. Simulation becomes essential to obtain information about the entire system that one wishes to observe.

With only theory and mathematical calculations, Spanish astrophysicists possibly discovered a 9th planet in the solar system, 20 times farther than Neptune (CBC, 2017). The planet X, as it is called, takes between 10,000 and 20,000 years to rotate around the sun. This discovery is entirely based on theory and mathematical calculations. Its existence has yet to be confirmed by observation either with satellite or with space telescope. Without theory and calculations, it would be much more difficult to discover this planet in our solar system, with the instruments at our disposal.



Name of the program : Planet X <https://c.gethopscotch.com/p/yu7ffid4v>

Another example is the Big Bang simulation. The beginning of the universe is one of the greatest questions of science. It is really difficult to experiment at the beginning of space-time. Scientists use instruments that already work at their limits. It becomes essential to develop simulations based on the theory that explain the phenomena observed. These simulations are based on very advanced mathematical models. The classic explanation of the Big Bang, according to Einstein, seen at the bottom of the image, fails to explain everything scientists have observed. Mathematicians of the Perimeter Institute indicate that according to their calculations, a beginning of the universe in a smooth and regular way could not explain our universe that exists today. So they proposed another mathematical simulation (Hunter, 2017), which we see at the top of the image. According to the Perimeter Institute, the classic Big Bang should be replaced by the "quantum big bounce". Their simulation takes into account quantum physics and gravity. They re-evaluate the theories of the beginning of the universe and the models of quantum gravity.

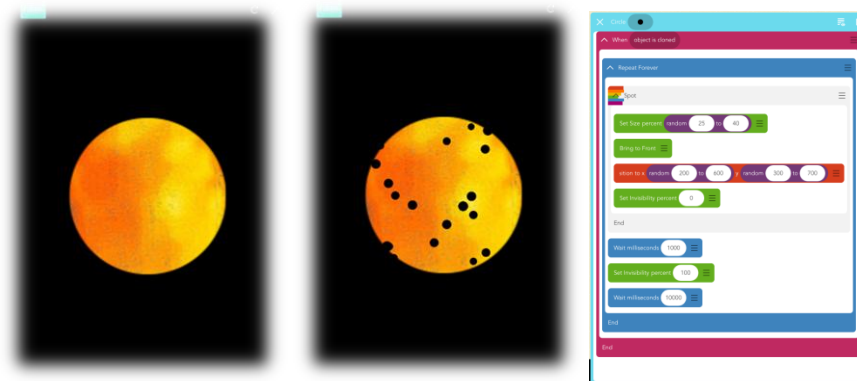


Name of the program : Simulations Big Bang <https://c.gethopscotch.com/p/yshg1rfq5>

The simulations also allow us to predict the effect of the solar cycle on our Earth. No one makes scientific experiments in the center of the sun. We must find other ways to

understand nuclear reactions at its center that affects the Earth. Since data from the sun's interior is very difficult to obtain, it is necessary to develop models or simulations in order to make projections. It takes many years of work by scientists to get the level of precision needed to make excellent predictions. The sun's cycle can tell us about the effect of the sun on the Earth's climate or on the solar storms that disturb satellites and electrical systems. In 1989, all of Quebec had been deprived of electricity because of solar flares.

Galileo had noticed sunspots in the Middle Ages. Today's scientists have noticed that the cycle of sunspots returns every 11 years. These spots are caused by chemistry and the magnetic field inside the sun. The models developed by the scientists take into account the overall rotation of the star and the brightness of the star. Here we see a Hopscotch model of the sun cycle. It shows a period of reappearance following a cycle of 11 periods. Like scientists, we do not yet have enough data to predict the amplitude of the cycle is difficult to predict, it is not yet achieved. The simulation shows a random amplitude.

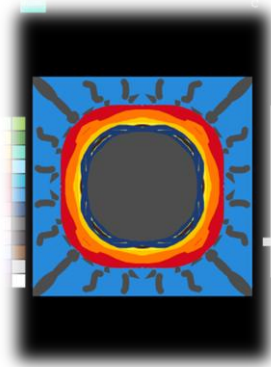


Name of the program : Taches solaires <https://c.gethopscotch.com/p/yv5hu0ih5>

This research on the sun also helps in the search for exoplanets. The transit method is used extensively to identify exoplanets. Research allows us to recognize if we observe a spot or a planet (Années Lumières, 23.07.2017).

Simulations are also useful for explaining images that we receive from space. For example, images from the Mars planet show that asteroids collided with Mars. Craters of 20km wide were left with marks on the edge of the crater. From these images, scientists develop simulations to explain what happened several billion years ago. To explain this

image and a dozen others, a scientist assumed that Mars was covered with an ocean of 1,000 meters. The explanation of the scientist Alexis Rodriguez, confirmed by the simulation, explains the phenomena observed (Science & Life, 06.2017).

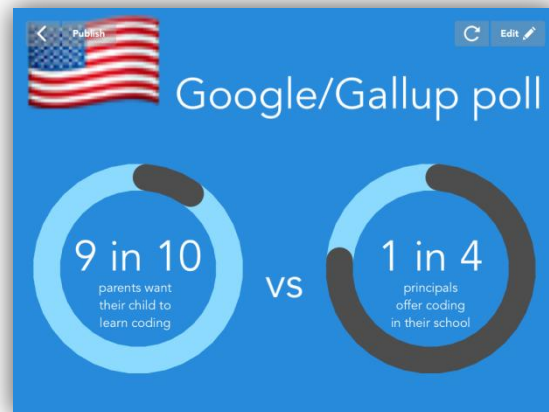
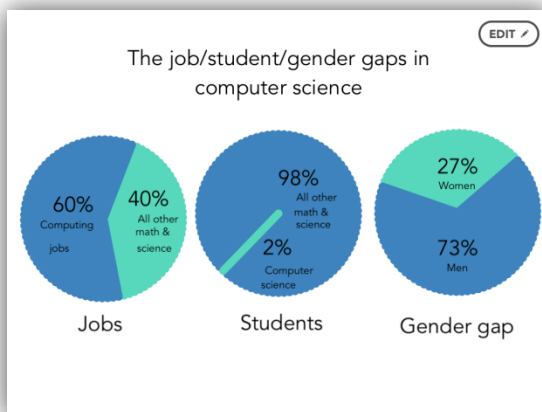


Name of the program : Mars ravagé par un tsunami <https://c.gethopscotch.com/p/yv2qh3xa6>

Observations give rise to the theories behind the simulation model. Computer simulation is not something boring that one does. Computer simulation becomes a new, radical source of knowledge on an equal footing with experience and observation. A validated simulation offers more answers than experience can provide.

Computer work opportunities

The work opportunities for future scientists and engineers, for students who know how to code, are enormous. Here are CODE.org statistics. In the area of mathematics, science and technology, 60% of the jobs available are jobs for people who know how to code. And if you look at the number of graduates in mathematics, science and technology, only 2% have the necessary training to be able to work in this field. Of the qualified persons, only 27% are women. In addition, most parents want their children to learn to code, but only 1 in 4 school principals offer programming courses at their school. How can we teach mathematics to inspire future engineers and scientists?



Several terrestrial and space telescopes are under construction including the James Webb space telescope that will open the doors largely to astrophysics. With the James Webb telescope, we will be able to see the cosmos 100 times better than with the Hubble Space Telescope. Astrophysicists use simulations, based on code, regularly in their work. What can we do to give each of our students a better chance to have access to a current field and whose benefits are phenomenal? Our kids have the chance to use computers and all of their products. One of the best ways to include all our students in science is to introduce them to scientific thinking at a very young age, before negative attitudes are formed. Beginning young, they will have the chance to develop personal ties and interests to science, while having fun. We can make connections between science, our entire curriculum, and the interest of all our students. We can build the links between math behind computers, science and the world.

BYOD

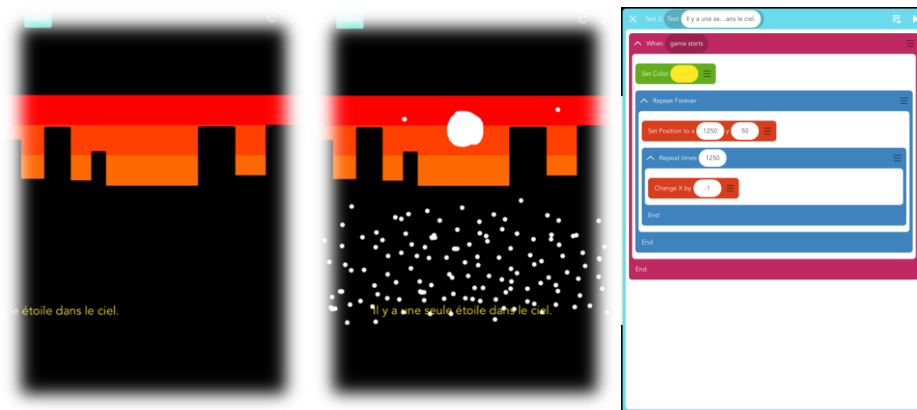
Koechlin (2010) quotes Albert Einstein in her book *Des questions pour apprendre*, "I do not have any special talents. I am only passionately curious. " What can we do to have little Einstein in our class? What can be done to cultivate students' natural curiosity? Is it possible to include student's interest, passion and questions, to help them ask better questions, and to pique their curiosity? Students develop much of their curiosity at home, with their own toys, their own devices, their own source of knowledge and their own questions. By including the student's environment in the classroom and developing questions around their passion, we can continue to arouse the curiosity of our students.

On the technological side, the Bring Your Own Device (BYOD) model is incorporated into the classroom so that students can use their own personal device anytime and anywhere (Fiévez, 2015). There are economic sides to schools, but I see pedagogical benefits. Students can integrate their interests, questioning and programming skills. It is possible to combine a number of technological devices that engage students in programming: books, digital books, the Internet, websites like NASA, radio, television, digital cameras, infrared camera, microscope, and social networks for example.

For several years, the Peel School Board has encouraged its employees and students to be innovative, creative and leaders in the use of technology. One approach is to allow students to bring their own electronic device, BYOD, Bring Your Own Device. Many students already have an electronic device. Many of them brought their own device into the classroom and were distracted by technology. There are many financial problems in purchasing computers and tablets in order to have a model where every student can have very frequent access to the computer. Allowing students to use their own device as instructed by the teacher helps to begin to solve problems of distraction and funding problems. By suggesting creativity tools, students can be creative in class and can pursue their projects at home with their device. Many of my poorest students had a phone and brought it to school. Instead of being distracted by his phone, we can use the phone to stimulate curiosity, inspire them and be more engaged in the classroom. The motivation and commitment of students is increased.

In this example, after a visit to MuslimFest, where the actor indicated that there was only one star in the sky, he invited the participants to simulate the stars by turning on the

light of their phone and projecting it forward. It could be seen that the vast majority of the people in the assembly had a telephone and used it to project the light. The student with a critical mind looks at the sky and realizes that there is the full moon and several stars present in the sky, even in an urban setting. The creative student makes a simulation of what he saw using Hopscotch on his own device.



Name of the program : BYOD <https://c.gethopscotch.com/p/yw59dxyp2>

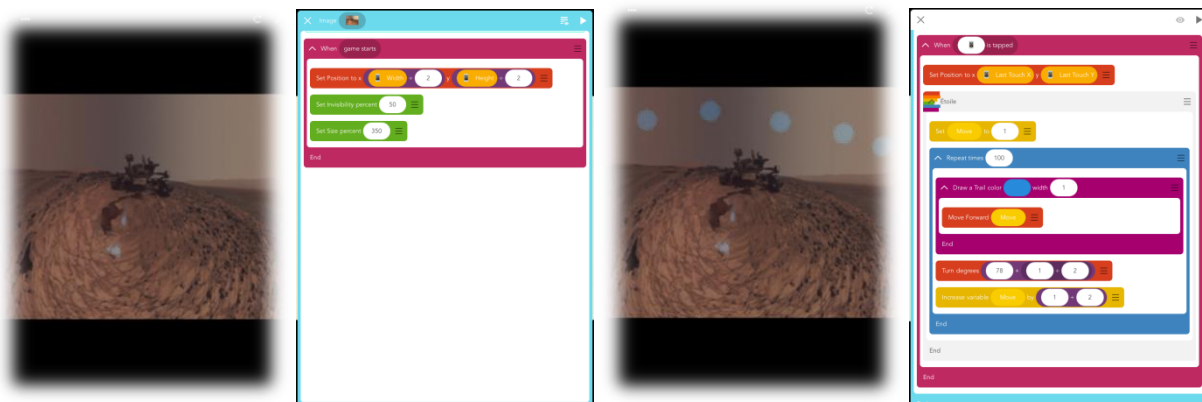
Social media like Twitter is most useful to inspire the user and get new ideas. You can find references to books, reviews, websites, various media that stimulate the passion of many people. They can be used as a constant source of inspiration for programming.

One can see on Twitter that Tycho Brahe noticed in 1572, the explosion of a star. This star has become supernova. One can look today as the vestiges of the supernova with a telescope. At the time of the explosion, however, the supernova was visible to the naked eye on Earth. The student creates a simulation of what Tycho Brahe sees when drawing an explosion. Since digital technology and organized media did not exist in 1572, he creates a fake news stating that the media have published in real time the discoveries of this scientist.



Name of the program : Fake News <https://c.gethopscotch.com/p/yw58xwg1z>

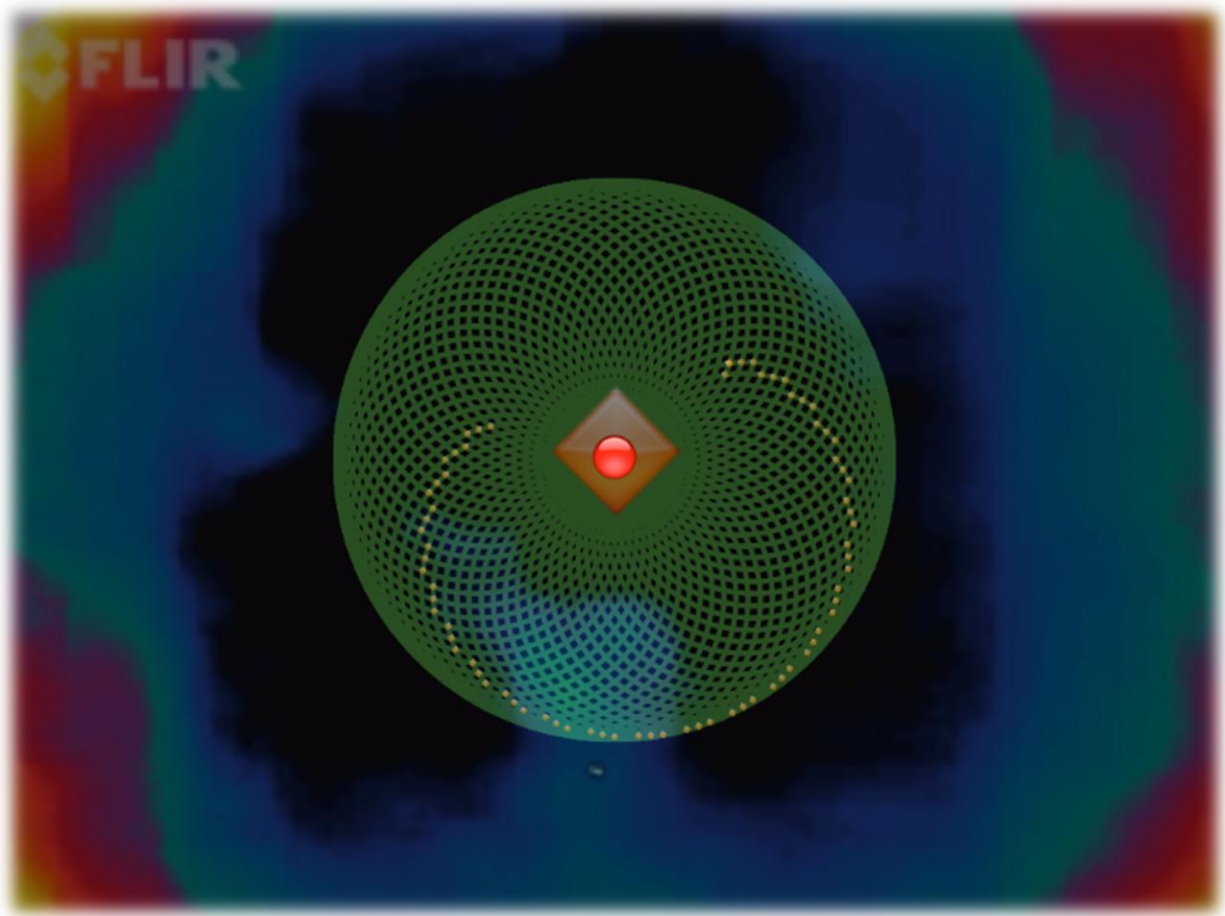
NASA offers a large amount of images that can be included in any Hopscotch program, without fear of copyright issues. A NASA image of the Mars planet and the Mars rover is added to the Hopscotch program. On August 5, 2017, the Martian Rover celebrated its 5 years of presence on Mars. To celebrate, the student draws light from 5 candles in the Martian sky. In the Martian atmosphere, the color of the stars appears in blue.



Name of the program : <https://c.gethopscotch.com/p/yw5cevl4>

It is possible to take our own pictures with any camera and add these images to Hopscotch programs. A Flir camera can be attached to the iPhone or iPad to take infrared pictures. Currently, scientists try to capture an image of a black hole using an ingenious idea: the combination of radio telescopes that makes it possible to have a telescope the size of the entire Earth. However, it takes a long time to get all the data from all the telescopes used since you cannot use the Internet to send the data. For example, one must wait 6 months before obtaining the data from the telescope in Antarctica (AlJazeera, 13.04.2017). The future James Webb space telescope will be much

faster than the radio telescopes since it will take direct pictures of a black hole using infrared. Here we see a simulation of a black hole on an infrared background as we could see using the future James Webb telescope.



Nom du programme : trou noir <https://c.gethopscotch.com/p/ywc43z0tr>

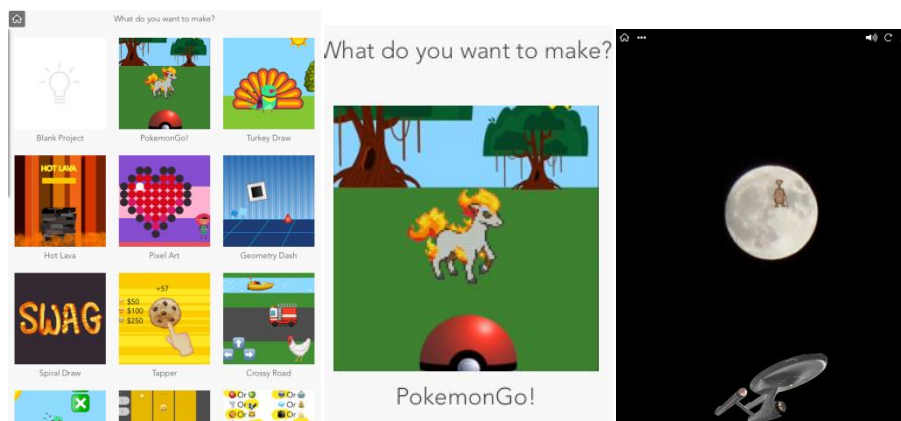
BYOD allows the differentiation of the teaching while following the interest and the questioning of the students.

Hour of code

In order to change the student's mindset towards a mathematical growth mindset used by engineers, the not-for-profit corporation CODE.ORG offers activities and resources in order to make information technology accessible to women and minorities. Their vision is that every student has the chance to learn computer science. Code.org recommends Hour of Code, an hour of programming offered to students, once a year in December, where each participant has the opportunity to program for one hour in order to familiarize themselves with programming. Several companies, including Hopscotch, have joined this movement to develop a growth mindset toward mathematics behind programming.

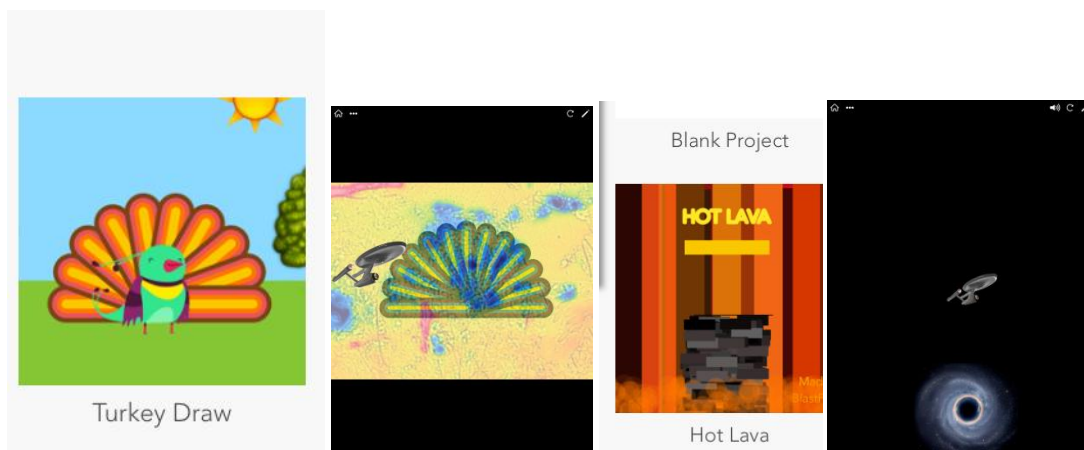
More than 50 years ago Star Trek's programs and films inspired our society to pursue aerospace science and technology. Several books, including *Star Trek - the official guide to our universe* (2016), explain the science behind Enterprise's travels. During the hour of code, we can explain the technology behind the Enterprise's travels. Hopscotch also published a book (Leavitt, 2016) and videos to support the teacher and students in their learning of programming.

Each program takes roughly an hour for a novice to code, depending on their age and ease with the technology, and can be used with content that interests each student. There are at least 13 different videos distributed by Hopscotch on the iPad and Hopscotch adds new ones regularly. These videos teach the basics of programming. In thirteen hours or a week, one can have an excellent idea of the basis of programming. Each of the following programs was done using the code explained in the videos, using the Star Trek theme. The Conscience program is inspired by the *PokemonGo* model.



Name of the program : Conscience – Pokémon Go <https://c.gethopscotch.com/p/ydr20v63c>

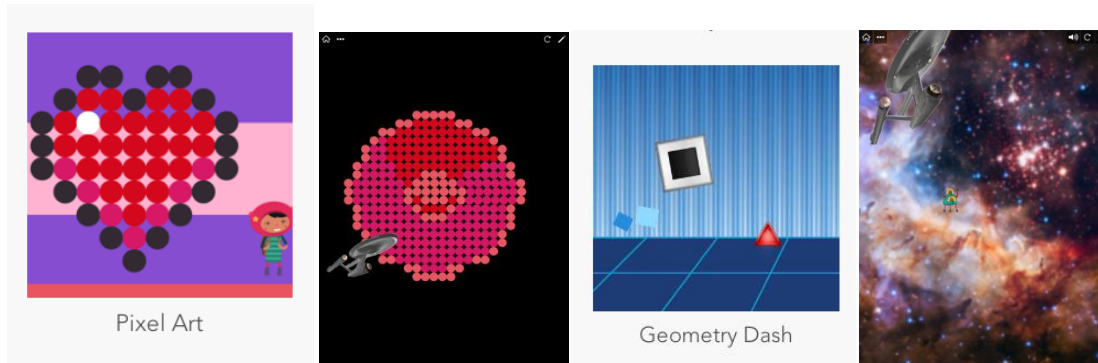
In the book *Star Trek* (2016) it says: 'I went to you because, despite your attempt to convince me otherwise, you seem to have a conscience, Mr Kirk. -Khan '. One sees there the frightening alien Khan and the Enterprise, which received a lot of damage. This idea is transformed into the Hopscotch program to make it a little less frightening for children. An ET terrestrial is in the atmosphere and walks from left to right in front of the moon. The Enterprise has the ability to go up or down, sliding our finger up or down on the iPad. If E.T. and the Enterprise go on the same path, ET disappears from space and goes aboard the Enterprise. The Enterprise continues his journey. One sees consciousness where the alien is not attacked but is greeted on board the ship.



Name of the program : Exploration <https://c.gethopscotch.com/p/ydshdnuir>

Name of the program : Trou noir <https://c.gethopscotch.com/p/ydsl9e7av>

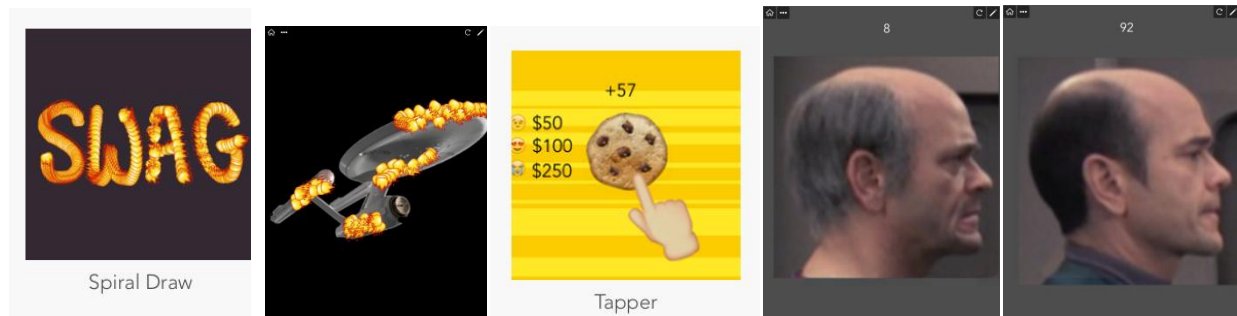
The Enterprise travels in space and sees all kind of new phenomena. Here we see a singularity that resembles a turkey of the program *Turkey Draw* which is accompanied by a background image taken with an infrared camera. In the game *Black Hole*, we see the Enterprise who is attracted by a black hole and must sail to avoid it. The player must press repeatedly on the iPad to bring up the Enterprise that is attracted to the black hole.



Name of the program : Pixel art Star Wars <https://c.gethopscotch.com/p/ydsovin91>

Name of the program : Star Trek Geometry Dash <https://c.gethopscotch.com/p/ydt3ftc8f>

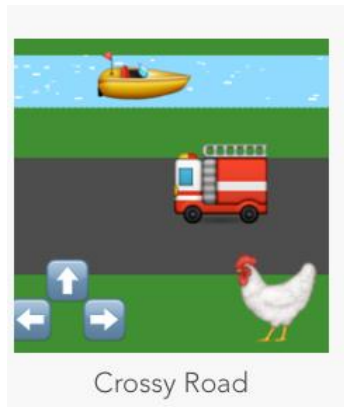
With the *Star Wars Pixel art* program, Enterprise encounters a different form of singularity with completely different programming properties from the previous program. In *Star Trek Geometry Dash*, the player must avoid a collision with the interstellar robots and climb while making a complete rotation before descending to avoid the collision. We see the image of a known constellation.



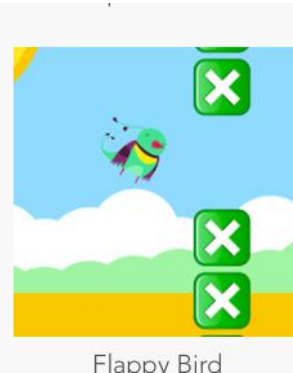
Name of the program : Star trek sous attaque <https://c.gethopscotch.com/p/ydszi0jco>

Name of the program : Star Trek Dr Lewis Zimmerman <https://c.gethopscotch.com/p/ye0s0dxs0>

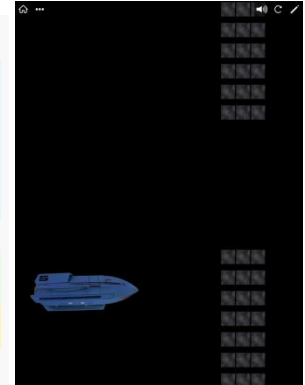
Using the *Spiral Draw* model, you can create a game where the Enterprise is under attack. By keeping the suspense, it is not yet known if the protection of the vessel is sufficient. In the Dr. Lewis Zimmerman, we see the engineer Lewis Zimmerman of the program Star Trek Voyageur who created the artificial intelligence of the holographic doctor in his image. By tapping on the iPad, one can see the image of Dr. Zimmerman turning into Doctor of the Traveler. The number of times you press the iPad to make the transformation is displayed on the screen.



Crossy Road



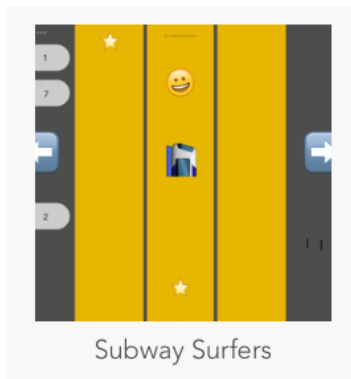
Flappy Bird



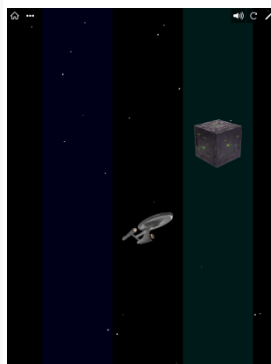
Name of the program : Star Trek Crossy Road <https://c.gethopscotch.com/p/ye0ulr494>

Name of the program : Star Trek It will fit <https://c.gethopscotch.com/p/ye12e5c72>

With the *Crossy Road* model, we simulate the Enterprise ship which is to go to STARBASE I, a spaceport in orbit around the Earth. The vessel must avoid other ships passing through the area. Using *Flappy Bird*, we simulate a well-kept situation of the movie *Star Trek into Darkness*. An Enterprise shuttle run by Captain Kirk and Spock is pursued by Klingons and ends up in a cul-de-sac. Kirk sees a small opening and decides to bring his ship through the small opening. Spock says with the emotion of the scene: 'Captain, the ship is not going to fit.' Kirk responds with such intense emotion: it will fit, it will fit! The shuttle passes through the small orifice in order to escape from the Klingons.



Subway Surfers



Emoji Quiz

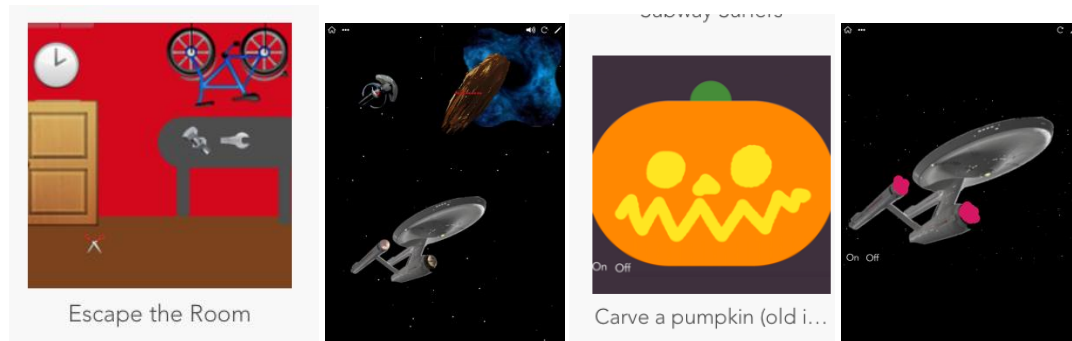


Name of the program : Star Trek Borg Subway Surfer <https://c.gethopscotch.com/p/ye14ea921>

Name of the program : Star Trek Emoji Quiz <https://c.gethopscotch.com/p/ye15jk3o4>

The *Subway Surfer* model allows to simulate a moment in the space where the Enterprise must escape repeatedly the approach of the Borg. The Borg cube travels up

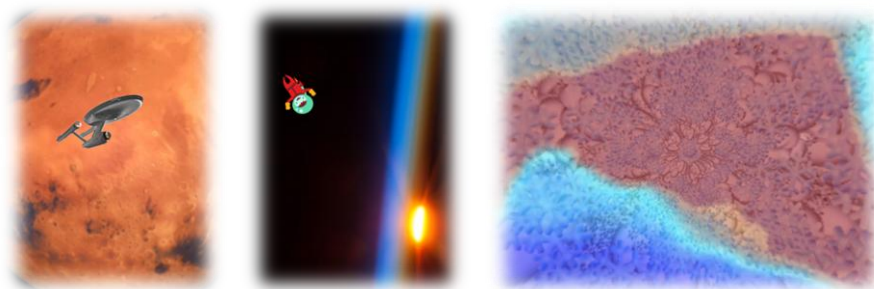
and down randomly through the three transport corridors. As the Borg cube approaches, the Enterprise must move in order to avoid the collision or be spotted by the Borg. You can use the *Emoji Quiz* model to analyze an image of Star Trek. Where are the ships that surround the Enterprise?



Name of the program : Star Trek Escape the Room <https://c.gethopscotch.com/p/ye17paaag>

Name of the program : Star Trek Carve a pumpkin <https://c.gethopscotch.com/p/ye1ct8cyz>

At the end of the movie *Star Trek* by J.J. Abrams, the Romulan ship is attracted by the singularity. The ship from Spock's future is on the way to destroy it and launches red matter. Kirk offers a refuge to the Romulan aboard the Enterprise, but he refuses. His vessel is absorbed by the singularity. The Enterprise must eject its kernel in order to free itself. Once the kernel is ejected, the Enterprise resumes its route. The *Escape the Room* model helps you plan this entire scenario. The model *Carve a pumpkin* can inspire to show the engines of the Enterprise when they are on and when they are stopped.



Name of the program : Warm Star Trek <https://c.gethopscotch.com/p/ydsz0xeib>

Name of the program : Levé du soleil à SSI <https://c.gethopscotch.com/p/ytukb2ai0>

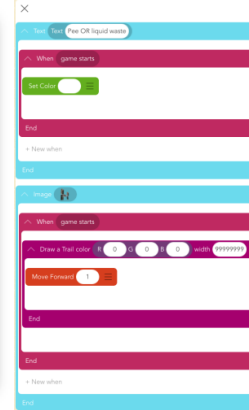
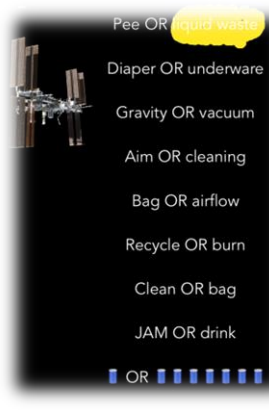
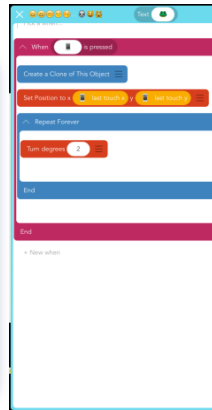
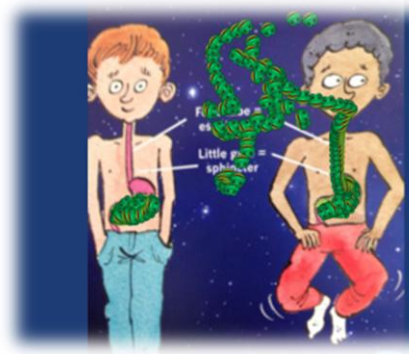
Name of the program : Cool Cosmos <https://c.gethopscotch.com/p/yucit4fxc>

Finally, for those who do not want to follow a model, they can always create their own challenge. Here we see the Enterprise near Mars. The Enterprise moves on the screen with the movement of the iPad. We also see an astronaut taking a walk in space during the sunrise on Earth.

Star Trek became very popular because the fiction of television became reality with the Apollo mission and the astronauts who visited the Moon. During hour of code, we can also see actual examples of Canadian space missions. Canadian physician and astronaut Dr. Dave Williams demonstrated a growth mindset to become an astronaut. As a young man, when he saw the work of astronauts, many people discouraged him, showing him that only Americans went into space, that this profession was not open to Canadians. He did not understand why this should be the case and still continued his studies to become an astronaut. He was able to pursue his dream and visit the International Space Station in 2007. Dr Dave Williams has published the first in a series of four children's books on space exploration to educate children about Canadian contribution to space exploration.

In these three following programs that can be done during hour of code we cross two barriers of fixed mindset, programming and becoming an astronaut. Following the *Emoji Draw* model of Hopscotch, we show the science behind digestion in space, as learned in Dr. Dave's book. It is not advisable to burp in space, the risk being very great. In space, where there is no gravity, the air is also distributed with food in the stomach. If you burp, you cannot predict what will come out. You could just see a little air or all the contents of his stomach!

Using the Hopscotch *Quiz App* template, we can write a quiz demonstrating our knowledge of space, while learning from Dr. Dave's book. With our finger, we can emphasize the responses to the touch of the screen.



Name of the program : To Burp or Not to Burp <https://c.gethopscotch.com/p/ycve5oefc>

Name of the program: To Burp or Not to Burp <https://c.gethopscotch.com/p/ycw1nv2ld>

Finally, a third suggestion for the hour of code is to write a first video game with Dr. Dave and the *Geometry Jumper* model of Hopscotch. During an exit in space, called Extravehicular Activity (EVA), Dr. Dave may be called upon to avoid objects like small space debris. He manipulates his space suit, the Extravehicular Mobility Unit (EMU), to avoid debris.

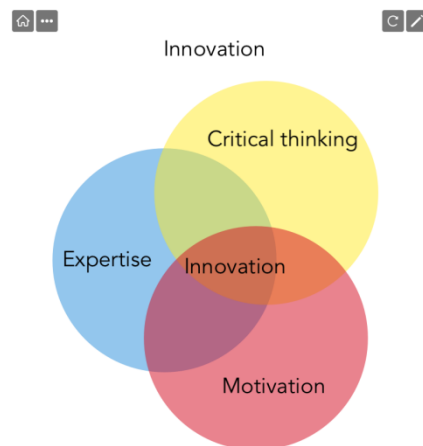


Name of the program: To Burp or Not to Burp <https://c.gethopscotch.com/p/ycw1m0wbd>

During the Genius Hour, students created, innovated and shared their mathematical project with an audience, the Hopscotch community. Using open and profound questions, they can continue to have a growth mindset towards mathematics and to have the taste to pursue other projects later.

From science to innovation

Teachers face a challenging challenge: to motivate the generation of video game players while creating a scientific culture and a culture of innovation. Wagner (2012) indicates that the three elements that encourage intrinsic motivation are: gambling, passion and purpose. Children develop their skills through play. The research on the importance of game is impressive. Also, passion is essential to understand and master something deeply. Exposing students to what they might become their passion is part of the teacher's role. Once they have discovered a passion, students will work hard to master it. The final ingredient is their goal. After playing and mastering something new, students need to find the goal to support their efforts, in a desire to make a difference, make the world better.



Marzano (2010) indicates that by using games in the classroom, students increase their performance with a gain of 20 points percentile. To be more effective, games must utilize a competition of no consequence, and target an essential academic content. One must also make a feedback from learning or debriefing games and students must have the opportunity to revise their understanding. This type of games can also be easily designed and played using Hopscotch.

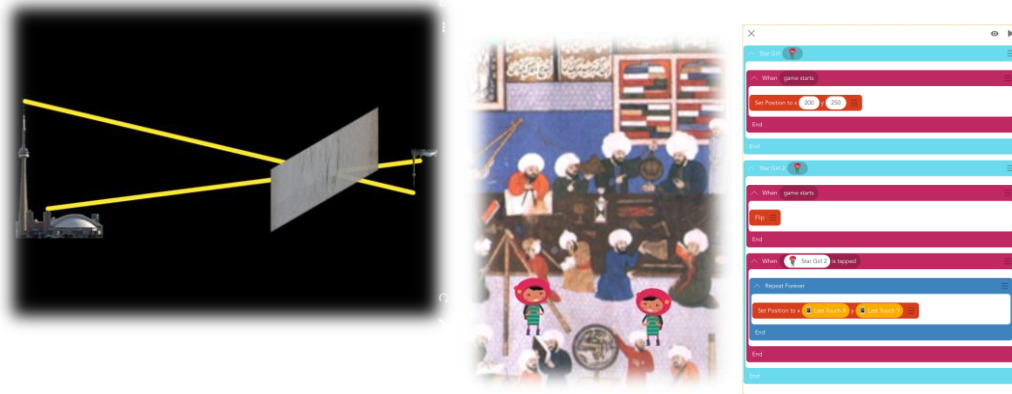
With Hopscotch, students can play games that others have created using their iPad or their phone. With Hopscotch, however, we add innovation. Students can create their own ideas, programs and games to promote an ideal like critical, scientific and innovative thinking and share their creation with the world. They can emulate as early as 8 years what the entrepreneur and the most innovative scientist do as work.

Learning to code is an easy game. Hopscotch staff has created several videos showing the basics of innovative game creation with Hopscotch. A search using the game keyword will display several games coded with Hopscotch. Jocelyn Leavitt, the founder of Hopscotch, says there are 6 million games already written by the Hopscotch community. It is possible to write some games related to the school program. In fact, using critical thinking as a basis for programming, game ideas are very easy to find and discuss, as you will see.

Games of the Muslim astronomer

It is only relatively recently that astronomy and space are in the curriculum of Ontario. Astronomers like John Percy of the University of Toronto were leaders in the introduction of astronomy into the science curriculum at the elementary and secondary levels. In the same way, it is only as a result of pressure on the Government that the history of the Middle Ages is now part of the Ontario curriculum. In the Middle Ages, during a black age in Europe, science flourished in the Middle East. Scientists like Galileo in Europe were persecuted by the Church to promote an idea like the one that the Earth revolves around the sun. Meanwhile, in the Middle East, Iran and Turkey had already developed the first observatories to serve the sky. I had to do a master's degree in education to discover that we are really indebted to the Middle East and Muslims for the initial development of science and scientific method (Boulanger, 2002).

Ibn al-Haytham was the first to study lenses and optics. He is considered the father of optics. He was the first to explain reflection and refraction and to use these concepts to explain why the sun and moon appear bigger near the horizon. He was also the first to describe the camera obscura and the scientific method, and pass his knowledge to the West, which used them for several centuries to come.



Name of the programme : Ibn al Haytham <https://c.gethopscotch.com/p/ywl7ibbud>

Name of the program : Muslim woman astronomer <https://c.gethopscotch.com/p/yonoeq096>

In the Middle East and even today, the field of cosmos, science is dominated by men. Although there are many women studying in astronomy programs today, few women occupy the positions of professor at the university. There is always Dr. Priyamvada Natarajan of Yale University or Dr. Quinn Konopacky who has done research at the University of Toronto. In order to encourage the girls to consider this area, the status quo is broken and the female scientists who move in the observatory to the touch of the finger on the iPad are inserted in the historical image.

The beginning of astronomy is often attributed to Copernicus, Galileo and Kepler. Copernicus claimed that the Earth turns every 24 hours and the Earth rotates around the Sun each year. Kepler discovered that the planets followed an elliptical rather than circular motion around the sun. Galileo was the first to use a telescope to look at the sky and see a whole new world in the sky. Kepler's work was based on the earlier work of the Muslims, namely al-Battani. Muslim astronomers used astrolabes, quadrants, celestial globes, sundials and compasses as scientific instruments inside their observatories.

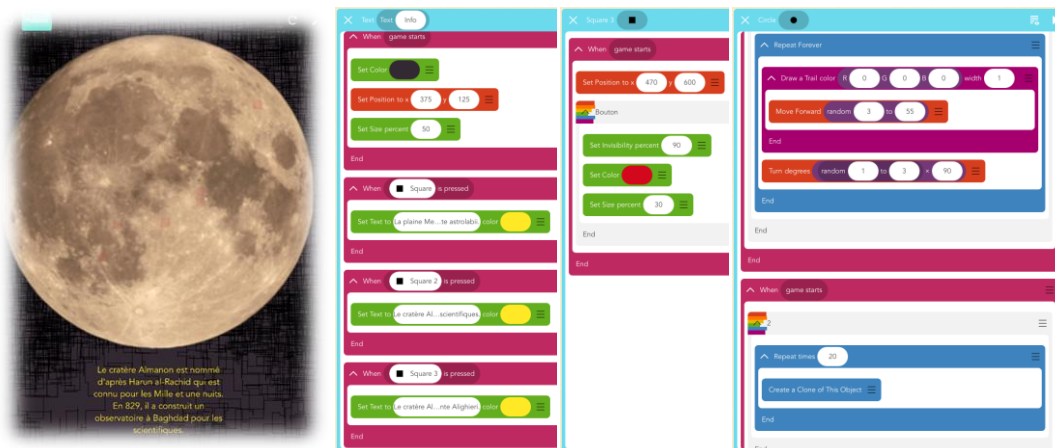


Name of the program : cadran solaire <https://c.gethopscotch.com/p/ywlgkv06d>

Name of the program : astrolabe <https://c.gethopscotch.com/p/ywlrz5bwr>

Name of the program : Observatoire Ulug Baig <https://c.gethopscotch.com/p/yvv57qhsb>

Al-Battani used scientific thinking to improve his predecessors and Kepler's work was based on al-Battani. The western Middle Ages is indebted to the Middle East for their scientific contribution.



Name of the program : Carte de la lune <https://c.gethopscotch.com/p/ywm1e35cc>

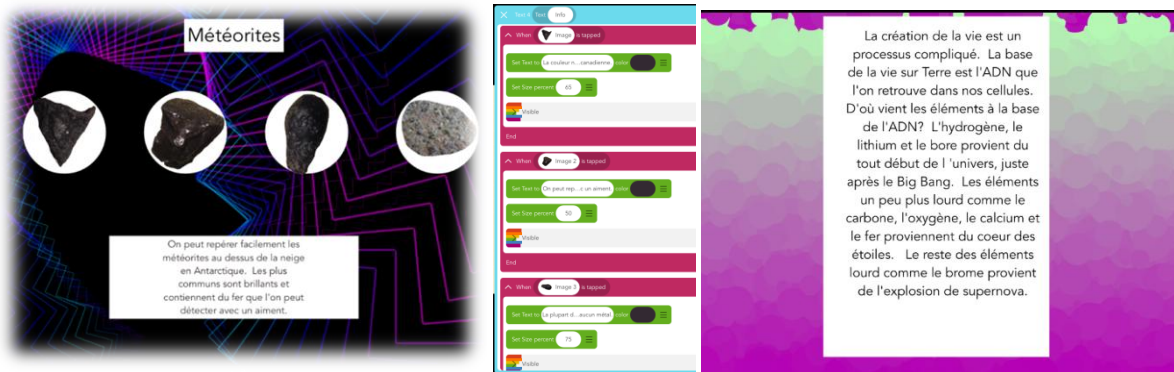
Several craters and plains on the moon were named after Muslim astronomers of the Middle Ages. One can find for example the plain Messala which took the name of Masha'Allah. Around the year 809, this Egyptian Jew who accepted Islam wrote two books of astronomy which were later translated into Latin: *De Scientia Motus Orbis* and *Compositione et utilitate astrolabii*. There is the alfraganus crater which is named after chief scientist al-Farghani. His Book of the summary of astronomy was a major influence

of the Italian poet Dante Alighieri. The Almanon crater is named after Harun al_Rachid who is known for the Thousand and One Nights. In 829, he built an observatory in Baghdad for scientists. Albategnius is a plain named after al-Battani. His observations of the sky were very detailed. He used an astrolabe and an observation tube, similar to a telescope without a lens. The Arzachel plain is named after al-Zarqali who worked in Muslim Spain in collaboration with other Muslim and Jewish astronomers. He prepared the Toledan tables that influenced Copernicus. Finally, we also find the plain of Thebit which is named after Thabit Ibn Qurra who translated a large number of Greek and Syrian scientific works. He also made contributions in mathematics (Al-Hassani, 2007).

The image that students have of scientists affect their motivation in the study of science. Their motivation is an important element in their level of scientific literacy. It is important to include the contribution of cultures in the world to the introduction of scientific culture.

Writing games

For elementary school students, reading and writing are very important (Karsenti, 2015). Hopscotch allows students to write long texts with a medium they like. For a student who lacks motivation to write, the medium may be what makes all the difference. Students can write letters, books, newspaper articles, design posters, develop a website, write interactive stories, provide explanations illustrating the program they have written. The program may also be a response to reading a fictional text or documentaries. We see here a website explaining the difference between the rocks coming from the Earth and the meteorites, these rocks coming from the space. For example, the black color of a sample of coal could make us think that this rock was burned during its passage in the atmosphere. Coal comes from a mine. Meteorites, however, can easily be spotted over snow in Antarctica. The most common are shiny and contain iron that one can detect with a magnet. Most meteorites are silicate rocks that contain no metal. There are also nearly 100 meteorites on Earth that seem to come from Mars. They contain gas bubbles identical to the Martian atmosphere, as measured by the Vicking mission (Chambers, Mitton, 2017).



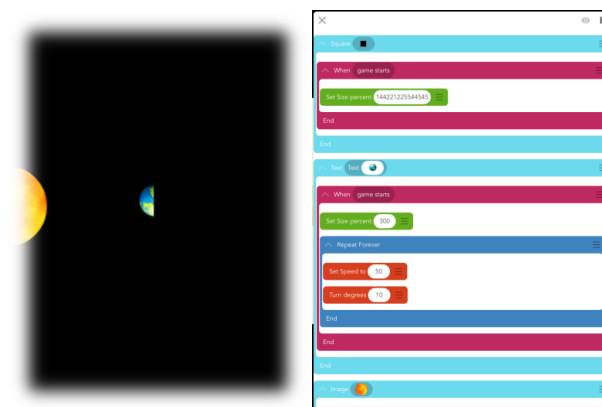
Name of the program : météorites <https://c.gethopscotch.com/p/yuxv68rv9>

Name of the program : poussière <https://c.gethopscotch.com/p/yy7co7skc>

We also see reading response to a graphic text that shows the student's understanding of the source of the elements that make up our body.

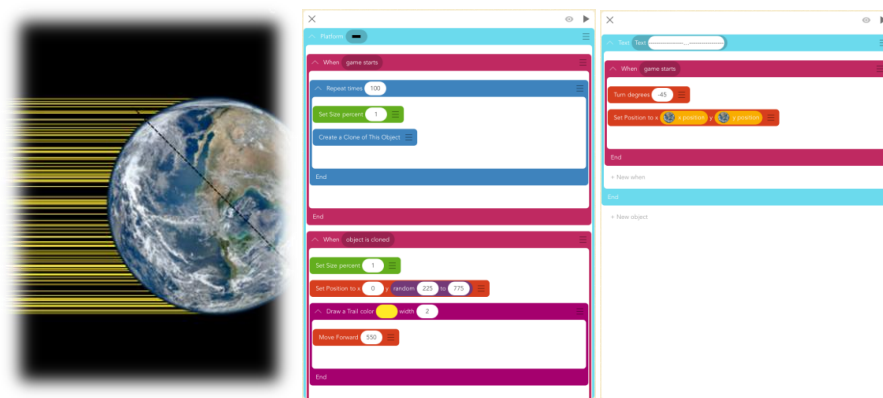
Games of the equinox

In his book, Micheal Allan (2014) offers many ideas of common misunderstandings in science. For example, many students think that the distance between the sun and the Earth is greater in winter than in summer because the distance between the heat source and the temperature on Earth is peer. The scientific concept is intimately connected with the mathematical concept. Here is an example of the false idea, the planet Earth is further away from the sun during the winter and closer to the sun during the summer. It is observed that in winter, the days are very short; And in summer the days are much longer.



Name of the program : équinoxe de l'été <https://c.gethopscotch.com/p/yszjzs73p>

In discussing this mathematical interpretation, one may wonder whether our idea works in all cases. Students who have traveled a bit can know that when winter is present in North America, it is summer in Australia, at a different Cartesian point on Earth. One loses some confidence in this explanation since Australia should be as far from the sun in winter as North America. We have to find a new explanation. The distance from the sun is surely an important factor on the temperature of the Earth. The temperature on Mercury is on average 167 degrees Celsius, while on Mars, the average temperature is - 63 degrees Celsius. Is there any other way of explaining what is happening? Is there a model that can be formulated?



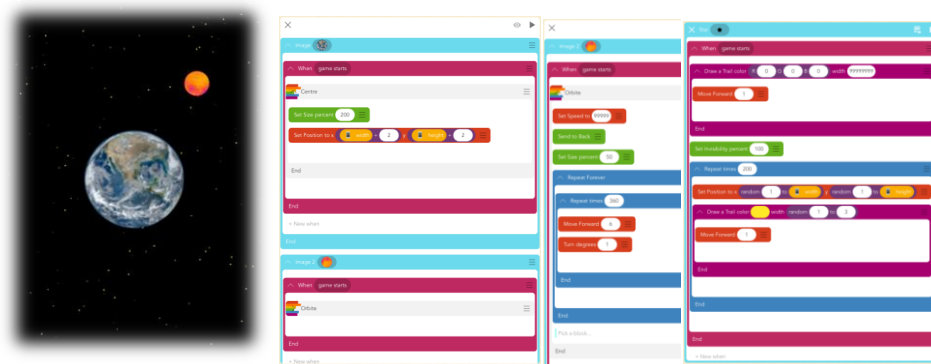
Name of the program : Lumière du soleil sur la Terre <https://c.gethopscotch.com/p/yba8r9so0>

The inclination of the Earth must also be taken into consideration. The Earth travels in space with an angle, in relation to the sun. The Earth rotates on itself with an axis of rotation that is not perpendicular to the sun. This axis of rotation is 23 degrees. During the summer, the days are longer and some parts of the Earth receive more radiation from the sun. During the winter, the days are shorter, and there is less radiation from the sun.

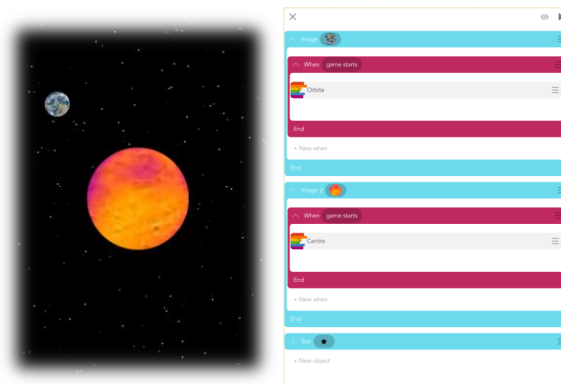
There is a great variation between the duration of the day and the night on the whole planet. At the solstices in early summer and early winter, in June and December, one of the hemispheres has one day the longest of the year and the other has a shortest day of the year . The equinox, which is observed in March and September, occurs when the duration of the day is the same length as the duration of the night, everywhere on Earth. The angle of the Earth facing the sun makes so that the whole planet is illuminated in the northern hemisphere.

Games of geocentrism and heliocentrism

Radical ideas have not always been welcome in Europe. One can think of Nicolas Copernicus who proposed changing the model of the movement of the Earth and the Sun of the geocentrism model, where the sun revolves around the Earth, to the heliocentrism model, where the Earth revolves around the sun. He found the geocentric model too complicated. He was afraid that his ideas would be badly received by his entourage and he published his book about heliocentrism just before his death in 1543. For 50 years his work did not arouse any interest until Tyche Brahe, Kepler and Galileo With its telescope can understand its radical meaning. His book was banned in 1616 by the Church and "corrected" by the Catholic Inquisition. The corrections were to say that the Copernican model was not a fact. It was only a hypothesis, but not reality.

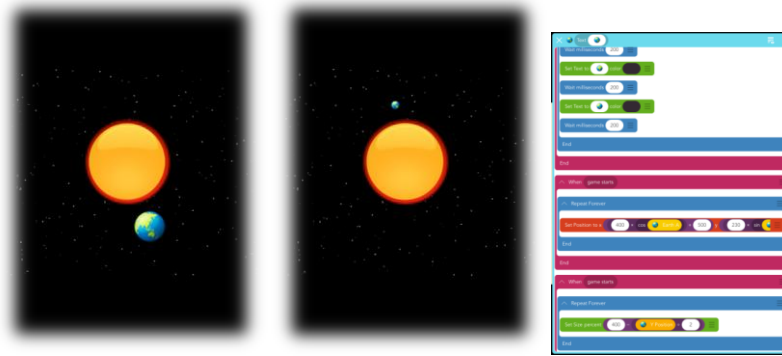


Name of the program : Géocentrisme <https://c.gethopscoth.com/p/yba24upvz>



Name of the program : Héliocentrisme <https://c.gethopscoth.com/p/yba2aqs08>

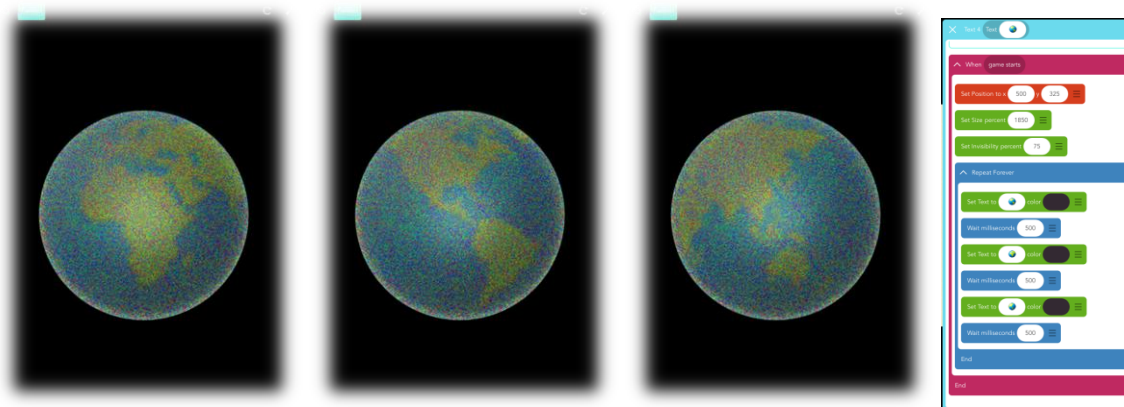
The heliocentric model, however, is the reality. The earth revolves around the sun with an elliptical orbit, of which we see a simulation here.



Name of the program : orbite de la terre <https://c.gethopscotch.com/p/yszm23iiv>

Game of the Magnetization of the Earth

From satellites, it is possible to see in detail the strength of the magnetization of the rocks on the surface of the Earth. This allows us to know the geological history of the Earth, even under the oceans. We can see places with high iron concentration. The colors demonstrate the differences in the magnetic field (Science & Life, 06.2017).



Name of the program: Aimentation de la croute terrestre
<https://c.gethopscotch.com/p/yv2simk23>

Games of the eclipse of the sun

Genius hour also allows us to explore current situations of science, including the observation of natural situations. An eclipse of the sun occurs when the moon passes in front of the sun. There are at least two eclipses of the sun per year that can be seen somewhere on Earth. If the moon passes only a portion of the surface of the sun, we

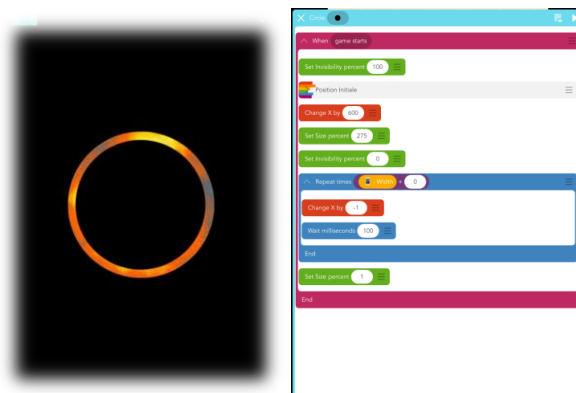
have a partial eclipse of the sun. If the moon passes directly in front of the sun and covers the entire surface of the sun, we have a total eclipse of the sun. The total eclipse of the sun can be seen only on a narrow path on the surface of the Earth while the partial eclipse will be seen on a much wider path on the Earth's surface.



Name of the program : Eclipse <https://c.gethopscoth.com/p/y7sji2wiw>

Name of the program : Eclipse <https://c.gethopscoth.com/p/xot2inldp>

The Greek astronomer Ptolemy, who lived in Alexandria in Egypt in the second century, better known for his book *Almagest*, was the first to be able to calculate the exact date of the eclipses. On the other hand, the Arab astronomer al-Battani, around 929, was the first to determine the possibility of annular eclipses (Science et Vie, 19.03.2015). Because the orbit of the moon is an ellipse, the distance between the Earth and the moon, and the apparent size of the moon seen from the Earth vary greatly.

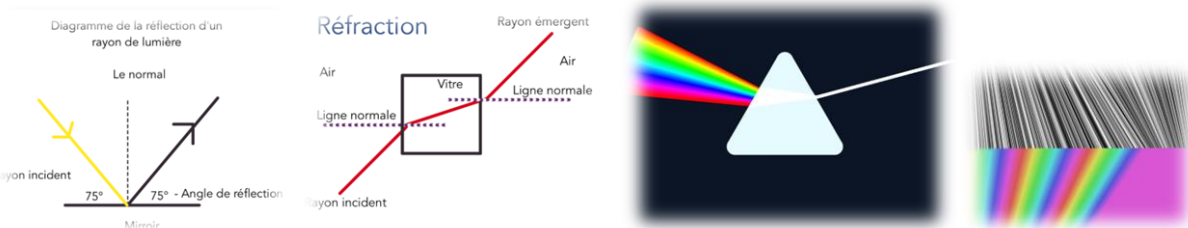


Name of the program : Eclipse annulaire <https://c.gethopscoth.com/p/vopk467q8>

An eclipse of the sun occurred in North America on August 21, 2017. The calculation of the eclipses schedule is now published by NASA.

Games of the property of light

When one observes the sunlight passing through the opening of an open window, one can realize that the light propagates in a straight line. One can notice the same effect with a laser pointer. If the light passes through different media of the air, we notice different properties. When the light passes from the air and strikes an object like a mirror, the light changes direction. The light rays are reflected. When the light passes from the air to water or glass, the rays change slightly in direction, the ray is deflected. This is refraction. This can be seen when a ruler is placed in a glass of water. The part under water appears smaller than the part that remains in the air. Refraction also allows us to see the light decompose into its primary colors. This phenomenon is observed in nature during the formation of a rainbow or with a glass prism.



Name of the program : Réfraction <https://c.gethopscotch.com/p/ytkhc96bf>

Name of the program : Réflexion d'un rayon <https://c.gethopscotch.com/p/ytkgwy3lw>

Name of the program : Prisme <https://c.gethopscotch.com/p/ytkiyki4z>

Name of the program : Arc-en-ciel <https://c.gethopscotch.com/p/yuxwigy2e>

Diffraction is the behavior of waves as they pass through an open. Once passed through the aperture, the waves distribute more amply beyond the aperture. If the aperture is larger than the wavelength, little diffraction is observed, for example when the light passes through a door. If the size of the aperture and the wavelength of the light is similar, more spreading, more diffraction will be observed.



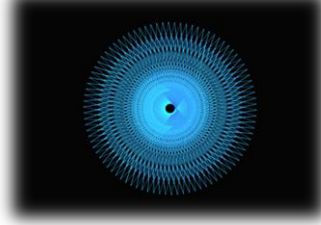
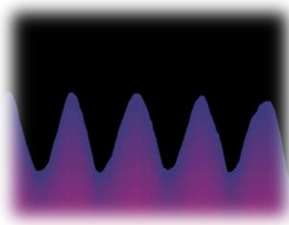
Name of the program : Diffraction <https://c.gethopscotch.com/p/ythmy4mva>

Name of the program : Spectre électromagnétique <https://c.gethopscotch.com/p/yc97e1xf>

The visible light is broken down into seven colors as seen in the rainbow or prism. Purple has the shortest wavelength (390 nanometers) and red has the longest wavelength (780 nanometers). Optical light is only a small part of all the electromagnetic waves emitted on Earth and in the entire universe. There are also non-visible waves such as radio, microwave, infrared, ultraviolet, X-rays and gamma rays. Infrared allows you to see deep space. 90% of the information collected in the study of space comes from telescopes using invisible waves. Visible waves, radio waves and some infrared waves cross the earth's atmosphere and reach the ground. The rest must be detected with space telescopes, because they are blocked by atmospheric diffusion (Luminet, 2014).

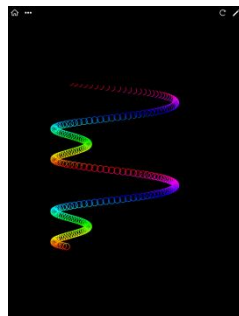
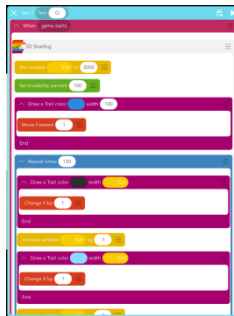
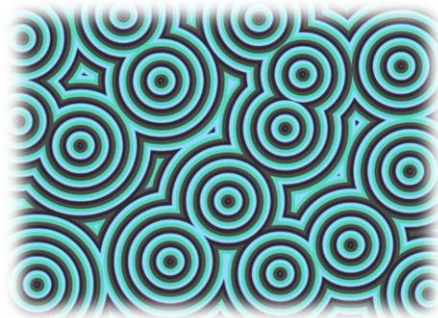
Games of the nature of light

For a long time the nature of light has been debated. Is it a wave or a particle? Light sometimes behaves like an electromagnetic wave, as Max Plank said, and sometimes as massless particles, energy grains, as Einstein said. The energy of the photon depends on its wavelength. The red light has a low energy level while the blue light has a higher energy level. The nature of the light observed depended on the experiments used. With astronomy using X-rays, the corpuscular properties of light are used, and with infrared astronomy, the undulatory properties of light are used. The light presents these two behaviors.



Name of the program : Onde lumineuse <https://c.gethopscotch.com/p/ytkfkdqyt>

Name of the program : Photon <https://c.gethopscotch.com/p/ythmh8knu>



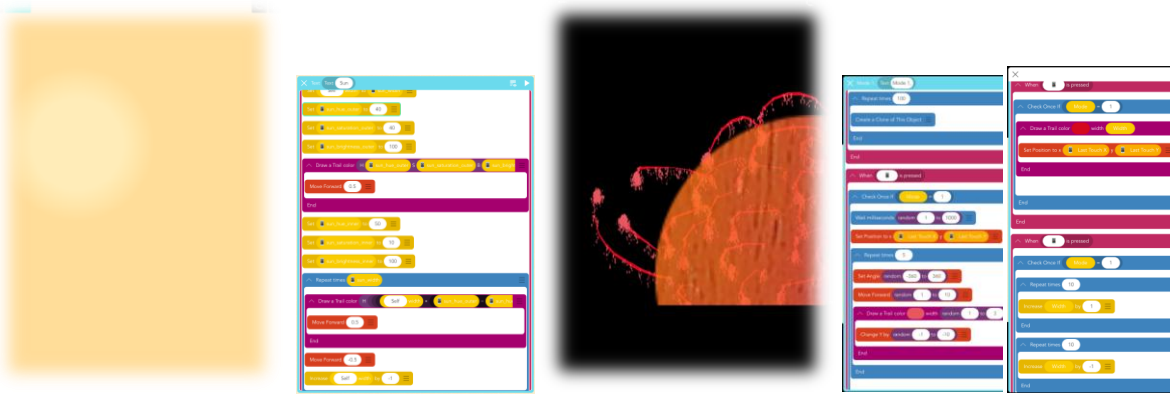
Name of the program : Interférence <https://c.gethopscotch.com/p/yu04tffc6>

Name of the program : Interférence constructive <https://c.gethopscotch.com/p/yu05cmtel>

In most situations, radiation behaves like waves, disturbances move energy from one place to another. When light beams meet other light beams, interference is observed where the waves can add or subtract.

Games of the solar flare

The sun is the most massive object of the solar system and an enormous source of energy. Light photons take 150,000 to 1 million years to travel from the sun's core to the surface of the sun while sunlight takes 8 minutes and 20 seconds to reach Earth. On the sun, watching with filters, one can observe eruptions. Eruptions are explosions in the atmosphere of the sun that eject high-energy particles moving at high speed in the solar system. When these particles strike the magnetic field around the earth, a solar storm is observed. The operation of satellites around the Earth is affected by solar flares.



Name of the program : Le soleil <https://c.gethopscotch.com/p/yuhjvs6qk>

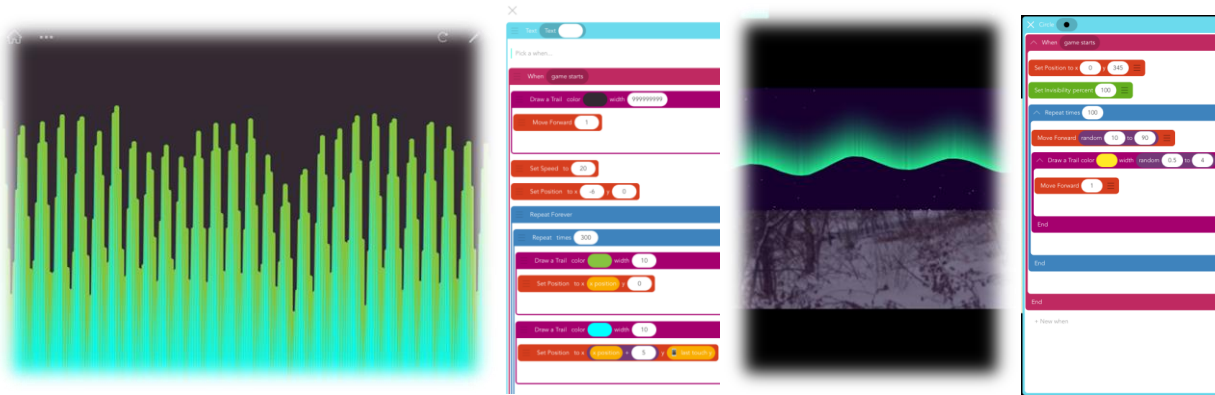
Name of the program : Eruption solaire <https://c.gethopscotch.com/p/ythp8ymun>

Games of the aurora borealis

In her TED conference, Zaria Forman explains that her mother has given her the ability to focus on the positive, and in her work she paints breathtaking scenes of the Earth to show what we risk losing if we do not take care of the Earth. We can see here a drawing of the aurora borealis.

You can see the Northern Lights in the Arctic and Antarctic winter during its very long nights. They are the result of the meeting of the solar wind with the magnetic shield of the Earth. The particles of the solar wind, electrons and protons, trap in the earth's magnetic field and fall into the atmosphere at a speed of 800 km / sec from where this breathtaking spectacle.

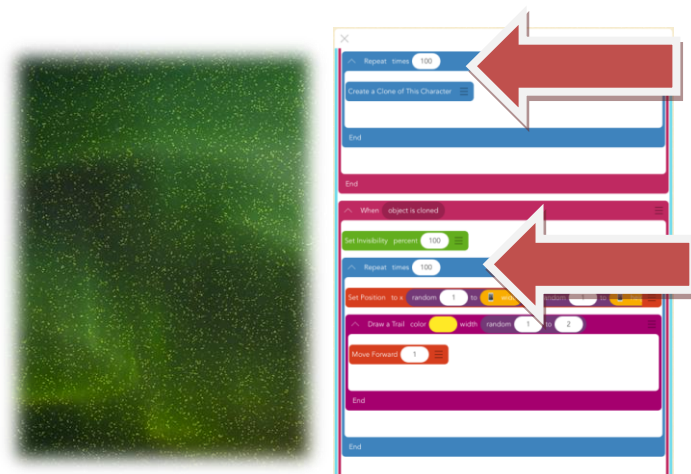
Live cameras provide the opportunity to observe what is happening in the world in real time. One can see images of nature, such as a nest of peregrine falcons, traffic on route 401 or sky for example, seen from several observatories in the world. It can be accessed at any time using the Internet. The Aurora Service website shows places where the Northern Lights are visible, in addition to giving a weather forecasting prediction of solar storms. Using a live camera, one can then draw the aurora borealis that one sees.



Name of the program : Aurore boréale : <https://c.gethopscotch.com/p/xuyhbf5z4>

Name of the program : Service Aurora <https://c.gethopscotch.com/p/yfgdii3qy>

Students with learning difficulties in mathematics will be more motivated when their work results are magnificent and not just problems on paper. Have you ever discussed this with your class?

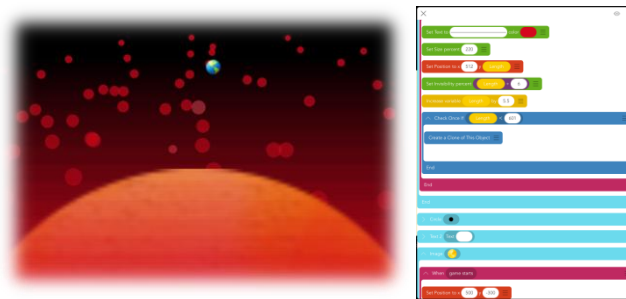


Name of the program : Nombres d'étoiles <https://c.gethopscotch.com/p/y9e8fumhr>

By using the Hopscotch code, one can visually and visually show the representation of a number and the visual result of a multiplication. The student is supported by showing him how to write the algorithms and how to read them. There are several ways to write an algorithm to have a similar result. In this case, we want to show 1,000 stars in the sky with the aurora borealis. One can draw 1000 points with a single object or we can draw 100 points with 100 objects by cloning our object. Here we see an application of multiplication where 100 clones draw 100 different objects. The result is 1,000 stars drawn in the sky. By adding the photo of the aurora borealis at the bottom, we obtain a quite spectacular picture of nature as a result of multiplication.

Game of the death of the sun

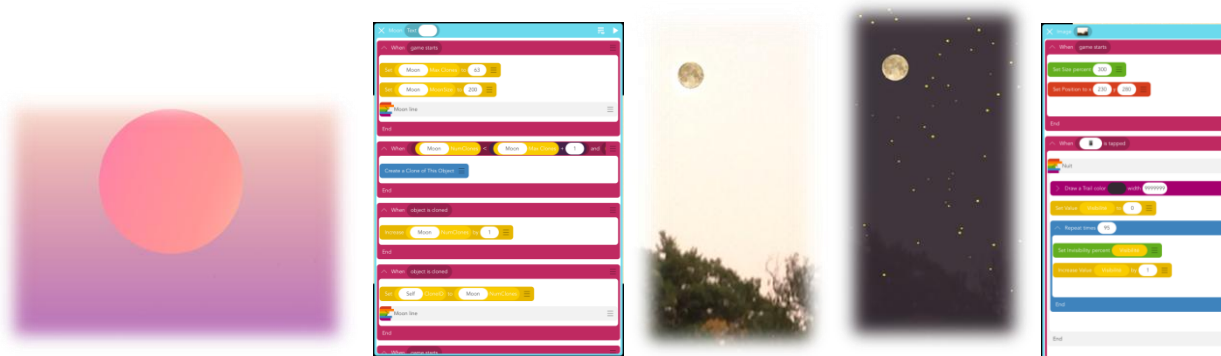
Space exploration will be necessary for humanity, not necessarily now, but certainly in the future if we want to keep humanity alive. The reason is the death of the sun. All life on Earth will be impossible in 500 million years because of the end of the life of the sun. Here we see a simulation of the death of the sun. If the sun dies, the Earth can still exist, but there would be no more photosynthesis to support plants. If the core of the Earth always gives heat, we could always survive on this planet become rogue, without its sun.



Name of the program : La mort du soleil <https://c.gethopscotch.com/p/ythssnate>

Games of the moon on the day

Many believe it is not possible to see the moon during the day. Can we take a picture of the moon during the day and build a mathematical model?



Name of the program : La lune <https://c.gethopscotch.com/p/yuhjramzv>

Name of the program : Lune jour et nuit <https://c.gethopscotch.com/p/yba5yld4i>

Hopscotch allows the inclusion of photos, here, a picture of the moon just before sunset. With this photo, we can build a model of the sunset. At the beginning of the simulation, the photo is present as it was taken by the camera. We gradually reduce the

visibility of the photo using variables and computational thinking. At the end, we have the night with the photo which is still a little visible, the moon that remained totally visible is the stars that are beginning to appear. This mathematical model of the moon makes it possible to discuss conceptual errors in science.

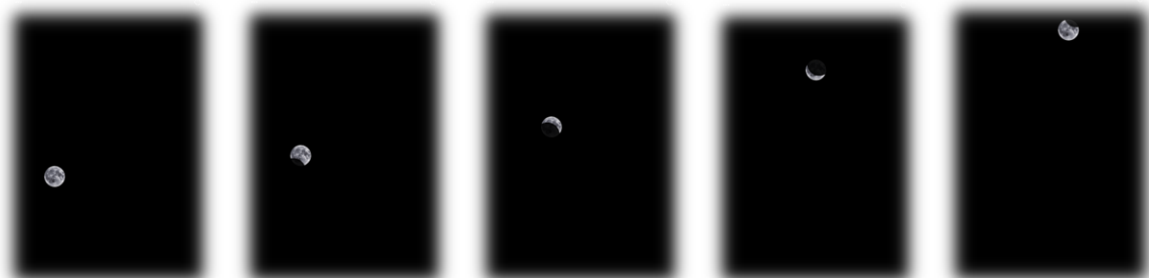
Games of moon shadows

For the Muslims, the moon is important since the lunar calendar based on the movements of the moon is still used in Islamic countries. A lunar year is 11 days shorter than the solar year. For example, the month of Ramadan during which Muslims make the young from dawn to sundown is every 11 days earlier than the year before. The lunar month begins at the new moon. The full moon is in the middle of the lunar month.



Nom des programmes : Ramadan: <https://c.gethopscotch.com/p/xoqit18qz>

The shadows of the lunar month are distinguished from those of an eclipse of the moon where the Earth passes between the sun and the moon creating shadows on the moon. Here we see a simulation of an eclipse of the full moon.

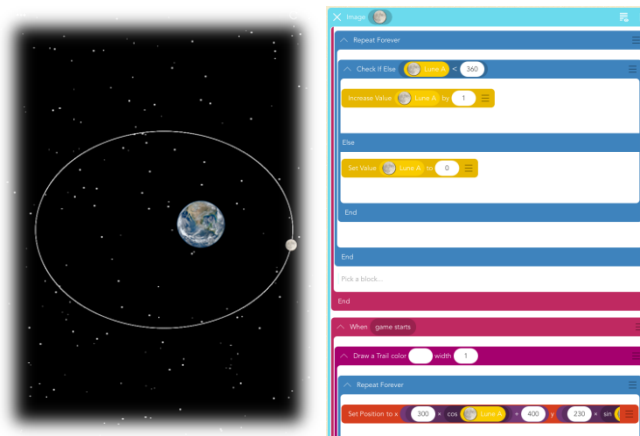




Nom du programme : Éclipse de la lune <https://c.gethopscotch.com/p/yw5fbejqn>

Games of the orbit and luminosity of the moon

Photographers can take magnificent photos during their travels, or observations in nature, that can be included in Hopscotch programs. At the so-called super moon, several amateur photographers took a photo of the moon. The moon appears bigger when it is closer to the Earth, at its perigee. They can then listen to a scientific analysis on Radio-Canada television on the program Discovery and code their understanding. Here we see the ellipse orbit of the moon and a simulation of a digital telescope that allows to adjust the size and brightness of the image.



Name of the program : Orbite de la lune + tracé orbite <https://c.gethopscotch.com/p/yf4wuj7u2>

Name of the program : Sine and cosine ellipse generator

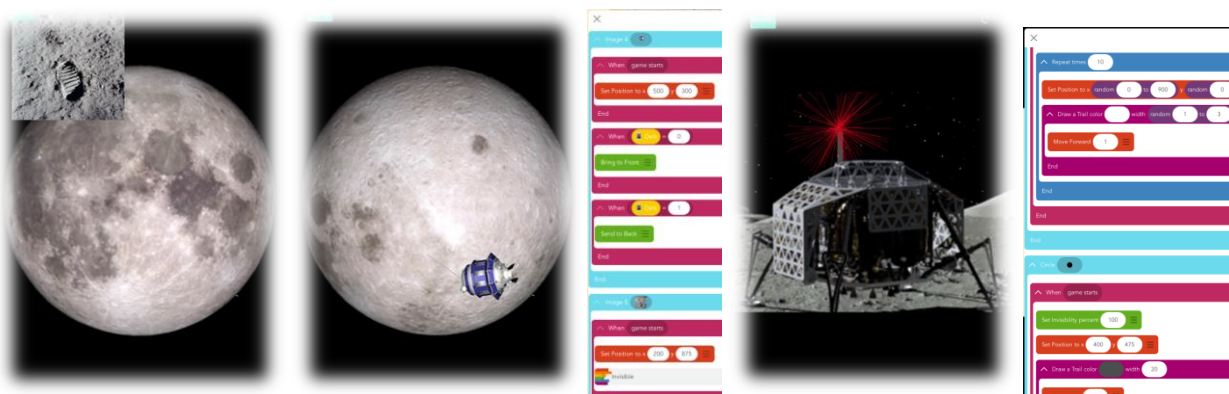
<https://c.gethopscotch.com/p/xl5bn30wt>



Name of the program : Super lune <https://c.gethopscotch.com/p/yf488paby>

Game of the exploration of the moon

From the Earth, we always see the same side of the moon because the moon rotates around the Earth synchronously. That is to say that the Moon makes exactly one turn on its axis every time it makes a tour of the Earth. This means that one can see only one side of the Moon with a terrestrial telescope. Thanks to the Soviet mission Luna 3 of October 1959, we saw for the first time the hidden face of the moon. It was only ten years later, in July 1969, that the American mission Apollo 11 would allow Neil Armstrong to take the first steps on the moon.



Name of the program : Exploration de la lune <https://c.gethopscotch.com/p/yocuthzdh>

Name of the program : Réseau 4G sur la lune <https://c.gethopscotch.com/p/yucj4tnv7>

A next mission to the moon in 2018 should allow the installation of a 4G relay antenna in the lunar valley of Taurus-Littrow in order to get a direct and immediate communication between the moon and the Earth (Science & Life, 06, 2017).

Mercury Project Game

Radio enthusiasts will have a lot of ideas for programming. For example, the death of John Glenn (RIP) was recently learned by listening to the radio. In search of more information on the Internet, one can discover the impact of this astronaut who in 1962 piloted the capsule Mercury, the first American capsule to orbit the Earth. He also had the chance to return to the space aboard Discovery in 1998. Seen from space, one can see the magnificent Earth of round or spherical form.

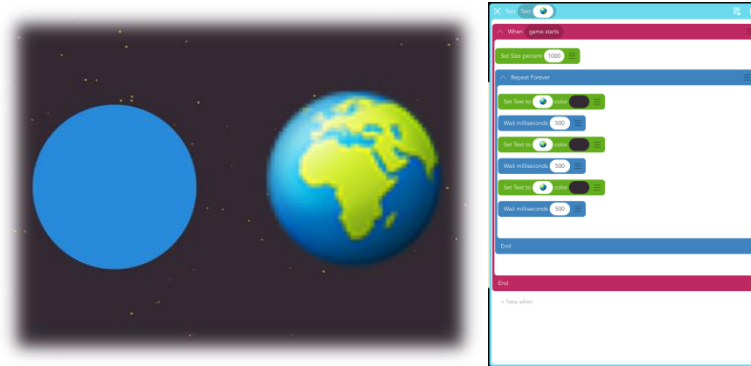


Name of the program : Project Mercury <https://c.gethopscotch.com/p/yeric8k6c>

Round and Round Earth Game

Faced with all the evidences that surround us, it is hard to understand why there are still people who believe that the Earth is flat. Most recently, there was a family dispute in Ontario that had to be dealt with by the police because the discussion became very heated (Radio Canada, 2016). One person said forcefully that the Earth was flat and the other that the Earth was round. With a scientific mind, this family dispute may not have taken place. One would only have to follow a scientific process and examine the evidence. For example, when looking at a boat on the horizon, the hull disappears first down to the bottom of the horizon and then the mast and the chimney. This returning

boat is not cast or fallen on the edge of a precipice. He only continued his way on the curved Earth. How can we interpret that there are still people who believe that the Earth is flat and do not have the growth mentality necessary to realize that the Earth is round?



Name of the program : Modèle de la Terre plate

<https://c.gethopscoth.com/p/yb9zoc457>

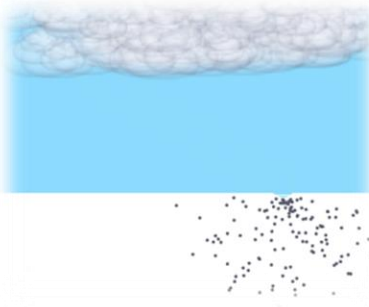
Games of the meteorite

Sometimes rocks fall from the sky. These meteorites are difficult to differentiate from land rocks only to look at them. They can be differentiated by their chemical compositions that are different from the rocks found on Earth. However, they can easily be recognized on snow. Meteorites have made major impacts in the past and have left enormous craters. Meteorites have left their mark in Arizona and Manicouagan in Quebec, for example. In 1981 Luis Alvarez made the theory that dinosaurs would have disappeared because of meteorites, 65 million years ago. The resulting dust, debris and forest fires would have destroyed much of life on Earth. In 1991, the Landsat satellite confirmed this theory by finding a 150 km wide crater formed by a 10 km wide meteorite. The force generated by this impact would have been 10 million atomic bombs (Science & Vie, 2.10.2015). Today, precautions are taken when observing the sky to detect potentially dangerous meteorites.



Name of the program : Météorite <https://c.gethopscotch.com/p/ythn9aeo9>

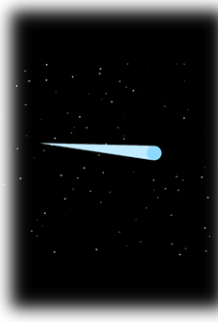
Name of the program : Pluie d'étoiles filantes <https://c.gethopscotch.com/p/ywmaedkkm>



Name of the program : Meteorite <https://c.gethopscotch.com/p/yopxvku7n>

Game of the Comet

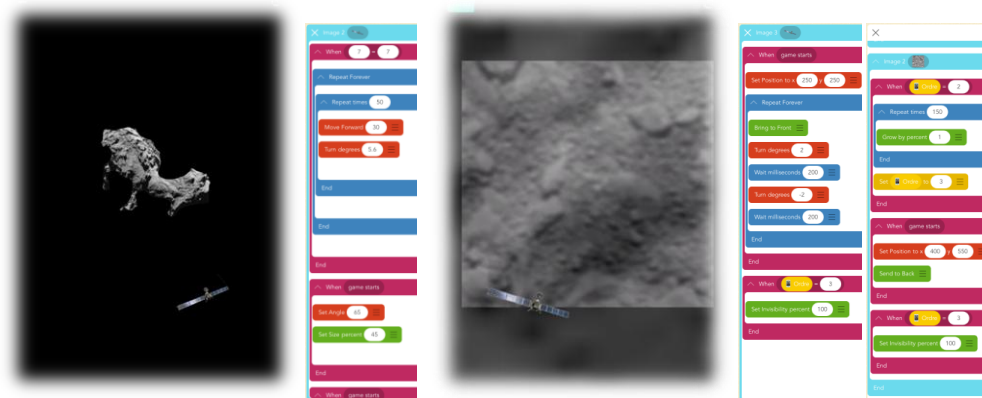
Comets are small pieces of ice that are mostly found in the belt of Kuiper. They become visible as they approach the sun and the ice begins to melt, leaving a very long tail that can measure up to 80 million kilometers.



Name of the program : Comet <https://c.gethopscotch.com/p/xogm3376t>

Rosetta spacecraft game

The European Space Agency's Rosetta Space Probe went to comet Tchouri, near Jupiter after 10 years of travel. It was the first time that humanity was so close to a comet. A comet like Tchouri formed at the very beginning of the solar system. The probe allowed to see its shape and its rock surface. The probe has also collected data of the chemical composition such as methane, ammonia, amino acids that make up living beings. This probe was able to collect data bringing us closer to the origins of life (25.03.1017, Science and Life). In her final hours, Rosetta sent a picture of close to the surface of the comet where she finally crashed.

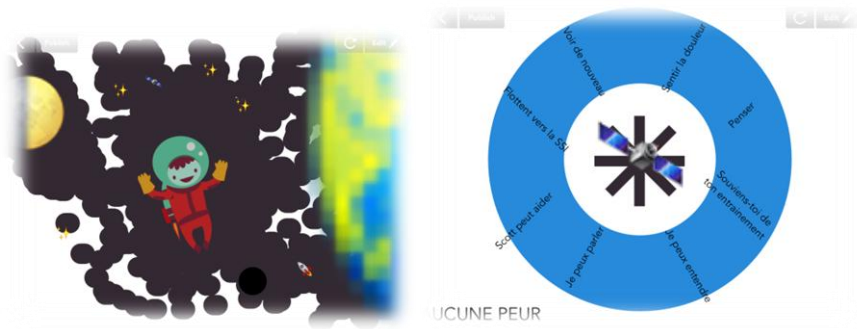


Name of the program : Rosetta Probe <https://c.gethopscoth.com/p/y9qyzkddu>

Name of the program : Dernier Jour de Rosetta <https://c.gethopsotch.com/p/ysc2ip2g3>

Games of emotional intelligence

One cannot become an astronaut, or an effective member of society without having superior emotional qualities. Chris Hadfield sets an example. In a walk in space, his tears did not flow normally and he lost sight. What were his options? What could he do, blind in space with his tools? To fear? Never. He could think, feel the pain, he could hear, talk, remember his training, float to the International Space Station. If nothing works, Scott can help. With the program Hopscotch, one presses on the iPad, the satellite turns and chooses a decision.

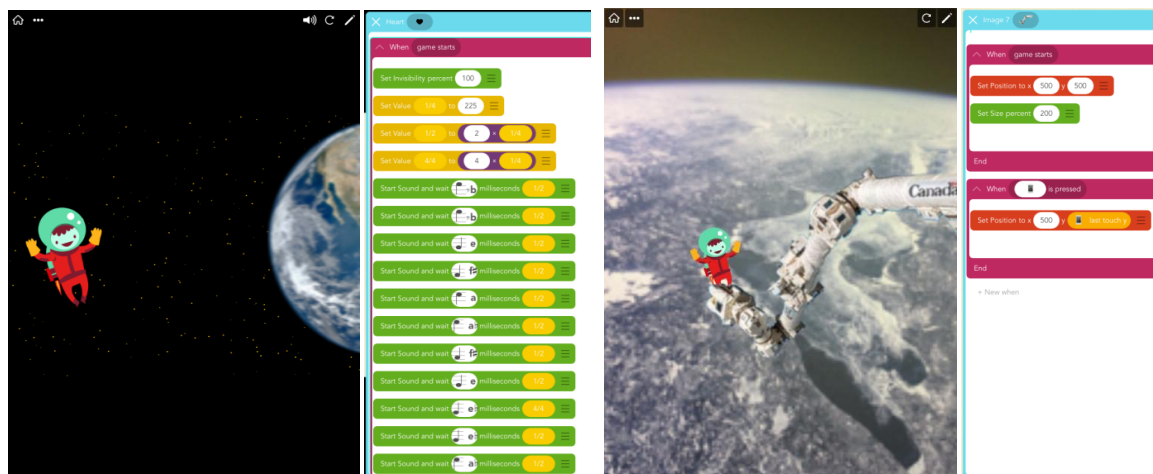


Name of the program : Face cachée : <https://c.gethopscotch.com/p/xnzbatje6>

Name of the program : Peur: <https://c.gethopscotch.com/p/xop5ffgn3>

International Space Station games

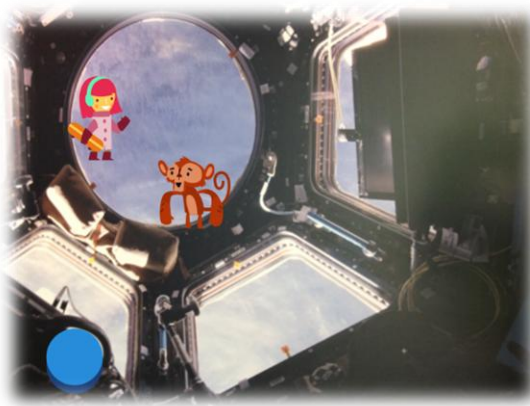
Astronaut Chris Hadfield made space exploration very popular among youth by writing messages on Twitter, giving several lectures and singing the Space Oddity song from the International Space Station.



Nom du programme: Space Oddity <https://c.gethopscotch.com/p/yca2j0urp>

Nom du programme : Canadarm <https://c.gethopscotch.com/p/yaf4ofgbe>

With Hopscotch, you can code the music of Chris Hadfield's song. We also see him in space, on the Canadarm, the Canadian robotic arm attached to the international space station.

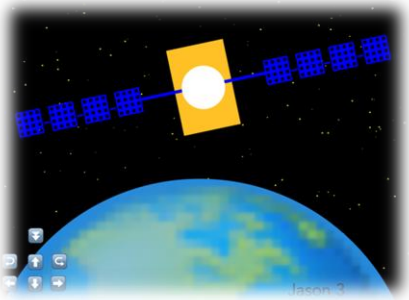


Name of the program : Stop motion ISS <https://c.gethopscotch.com/p/y8zokh8er>

Here we see a program that recreates a stop-motion simulation of astronauts in the international space station. The program is already written and the student has only to play. Astronauts move in space, and you take a picture at regular intervals by pressing the blue button. Once finished, the film is replayed and the astronauts always move in the same way it was recorded. By reading the code, we realize that this program uses variables, which record the position of the astronauts on each photo. Remembering the position of astronauts with the variables, the astronauts can be moved to the right place as many times as desired. One can see the possibilities, applications related to real situations in space and see that mathematics with Hopscotch is easily achievable.

Game of the Jason 3 satellite

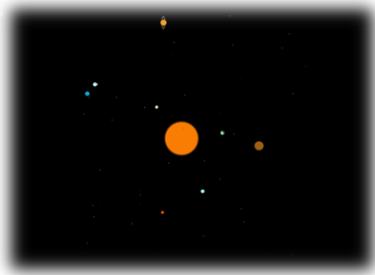
Can space technology help solve problems on Earth? The new Jason 3 satellite, launched in 2016, collects data on the height of the ocean surface and its topography (Al-Jazeera, 18.01.2016). He is also studying heat inside the oceans, which is the key to understanding the El Niño phenomenon and predicting climate change. The data provide critical information on global warming. For example, an iceberg the size of Prince Edward Island is about to detach from Antarctica (Quirks & Quarks, 16.06.2017). From space, it is possible to realize that a huge fissure on Larsen C Antarctic ice opens at an accelerated rate of 17 km in just 6 days (NASA, 2015). It may be that if this iceberg detaches and drifts offshore, all the rest of the Larsen C ice shelf is destabilized. Scientists working in Antarctica cannot get to work and those working in the region have to be evacuated.



Jason3: <https://c.gethopscotch.com/p/xp1hso9ej>

Solar System Game

When I went to school, the solar system had 9 planets. In 2006, the International Astronomical Union decided to remove Pluto from the number of planets and declassify it into a dwarf planet. Dwarf planets are intermediaries between planets and other smaller objects in the solar system. The criteria for a planet are now: a round celestial body, dominating its immediate environment and orbiting around the sun (Radio-Canada, 24.09.2006). The orbit of Pluto did not follow the same plan as the other planets. It was also necessary to decide the classification of the other celestial objects which had been discovered. We see here a recent example of the nature of science.

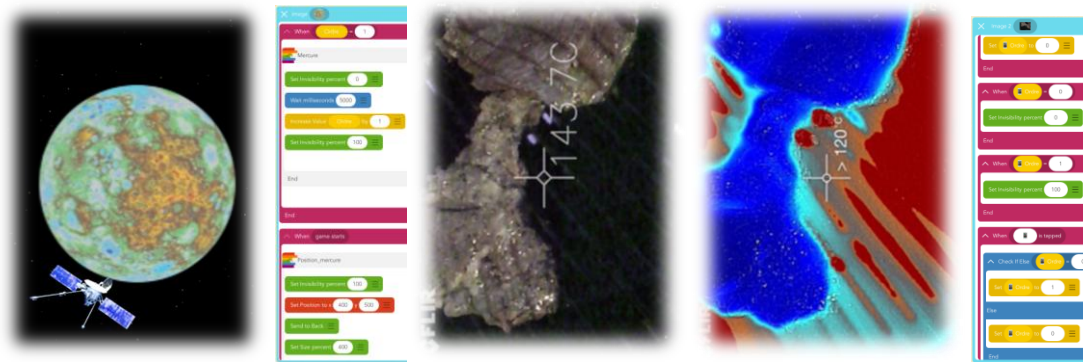


Name of the program : Solar System <https://c.gethopscotch.com/p/xzzru5mwu>

Game of the probe towards Mercury

Mercury is the planet closest to the sun and slightly larger than the moon. The Messenger probe that approached the planet Mercury is no more. Running out of fuel,

she crashed on the planet Mercury. Before the Messenger probe, we did not have much information about Mercury. It has taught us that Mercury consists of an iron core. Mercury almost certainly also has a liquid core, which produces a magnetic field as on Earth. The surface of Mercury could be seen in a very detailed way that is covered with crater caused by the collision of asteroids and meteorites. The temperature at its surface varies between -170 and 420 degrees. There is also lava and ice covered with mysterious black matter at the mercury poles that could be organic. The next mission to Mercury will be in 2024 (Al-Jazeera, 30.04.2015).



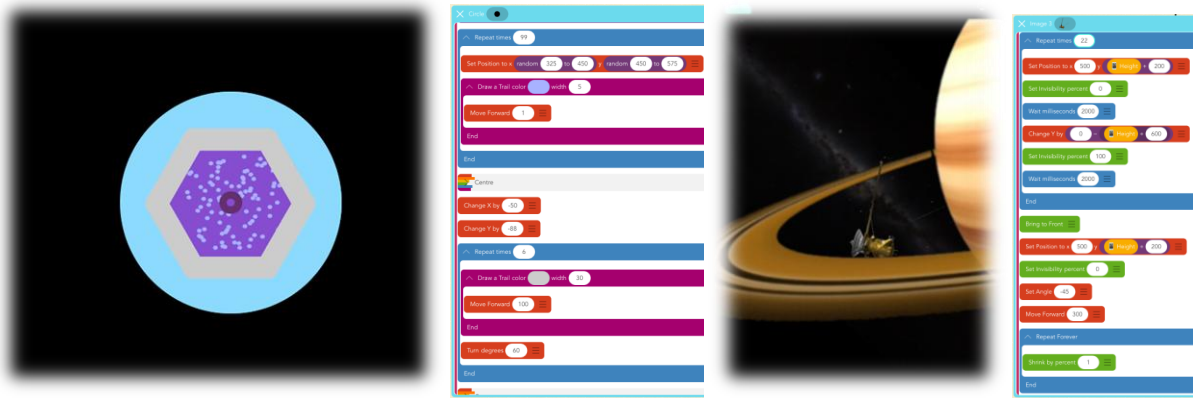
Name of the program: Mercure <https://c.gethopscotch.com/p/y9lrh6xh2>

Name of the program : Température dans l'espace <https://c.gethopscotch.com/p/yv3345as9>

The temperature is measured by observing the heat generated by the thermal agitation of the molecules. The temperature of the surfaces in space can be measured with the aid of an infrared sensor which allows, as shown here, to distinguish the temperature variations above a BBQ.

Cassini Mission Games

Here we see a spectacular view of the planet Saturn seen from its North Pole since the Cassini mission. The rings of Saturn are thousands of kilometers in diameter, but only 90 km deep. Saturn has 60 moons and Cassini has discovered that some are propitious to life. The moon Enceladus for example, could bear the life of microbes. Cassini has almost no fuel. In April 2017, the Cassini spacecraft began a bold series of orbits, the final mission of Cassini. The spacecraft will climb several times over the North Pole of Saturn. Cassini will sound the active geysers of the Enceladus moon, then dive between the planet and the inner ring 22 times to finally crash into Saturn. Cassini will complete his mission in September 2017 and will settle on the planet (Al-Jazeera 26.04.2017).

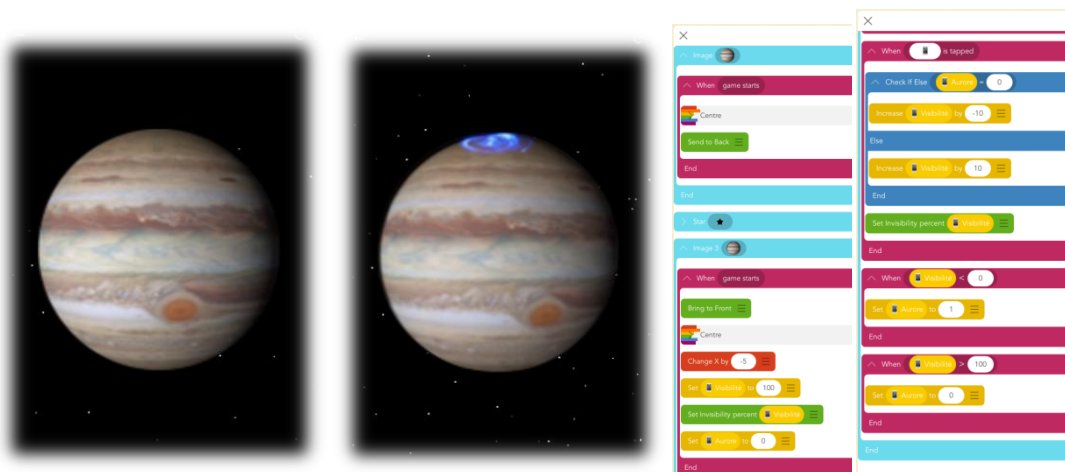


Name of the program : Saturne vu de Cassini <https://c.gethopscotch.com/p/yonw0v7if>

Name of the program : Cassini Mission finale <https://c.gethopscotch.com/p/yoy86zm12>

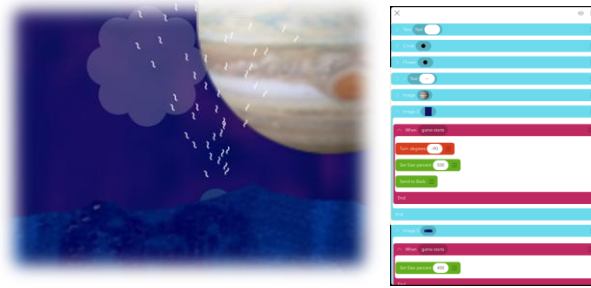
Games of Jupiter

The Earth offers spectacular aurora borealis. These auroras are also visible on other planets including Jupiter. Jupiter possesses, like the Earth, particles of high energy. They are almost permanent on Jupiter, but we must observe them using X-rays with the Chandra space telescope or in ultraviolet with the Hubble space telescope (Lequeux, 2016).



Name of the program : Jupiter aurore <https://c.gethopscotch.com/p/yr6sl83rm>

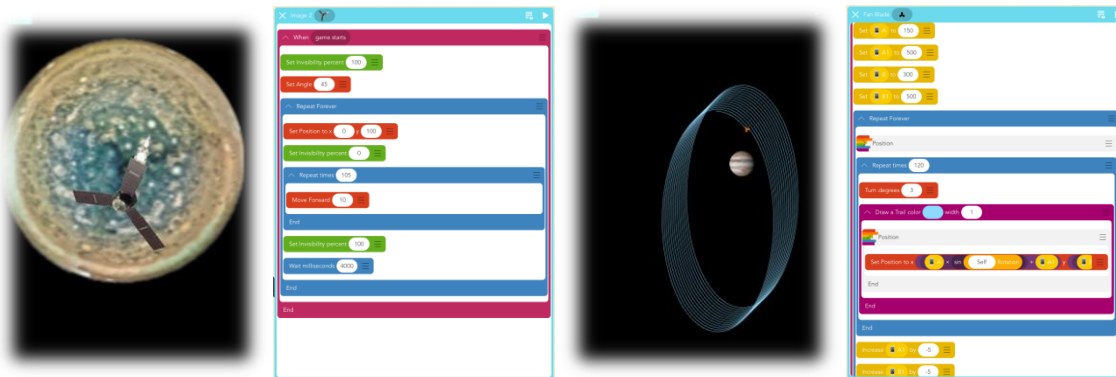
Jupiter has at least 69 moons, including 4 moons discovered by Galileo in 1610. The moon Io possesses nine volcanoes erupting while the surface of the moon Europe has jets of water vapor on its surface.



Name of the program : Jets de vapeur sur Europe <https://c.gethopscotch.com/p/yu7t6p37t>

Juno Probe Games

The Juno probe was launched in 2011 and orbited around Jupiter in 2016. Since then, the Juno probe has communicated captivating images of Jupiter. Here we see one of the poles of Jupiter. Every two months, she approaches the planet of Jupiter, according to her current orbit of 53 days and takes more and more photos showing the secrets of Jupiter. Juno is approaching nearly 5000 km from the surface of Jupiter (Sciences & Vie, 21.02.2017).



Name of the program : Pole de Jupiter <https://c.gethopscotch.com/p/yshkecdun>

Name of the program : Orbite de Juno <https://c.gethopscotch.com/p/yshknl62j>

The Juno probe recently gives very accurate and captivating images of the large red spot on Jupiter (Radio Canada, 2017) that is much larger than the Earth. Unlike the Earth which is a rocky planet, Jupiter is a gaseous planet. Scientists consider this red spot a mystery of the solar system, a storm over Jupiter that has lasted for more than 300 years. From 1648 to 1669, Jean-Dominique Cassini watched the sky with his telescope and noticed this great spot on Jupiter. The spot changes shape over the years. It is shrinking now and could possibly disappear in a few years. Scientists are wondering

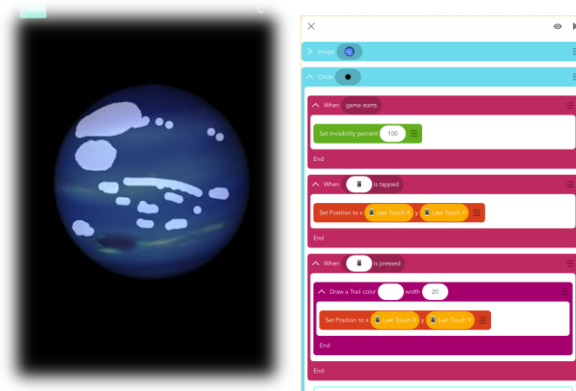
whether the spot is only on the surface or a phenomenon deeply rooted inside Jupiter. Scientists will probe the inside of the spot with the Cassini probe instruments. Instruments measure the planet's magnetic field, the planet's gravitational field, microwave antennas look at the brightness of the planet that would detect Jupiter's deep water and the deep movements at the heart of the planet. the planet. Finally, using infrared, Juno will detect the movement of the clouds of the large red spot. NASA scientists encourage the general public to view live images when they are received in order to analyze them and help scientists. The public can vote on the targets that Juno can observe.



Name of the program : La tache de Jupiter <https://c.gethopscotch.com/p/yumxqymc0>

Game of clouds on Neptune

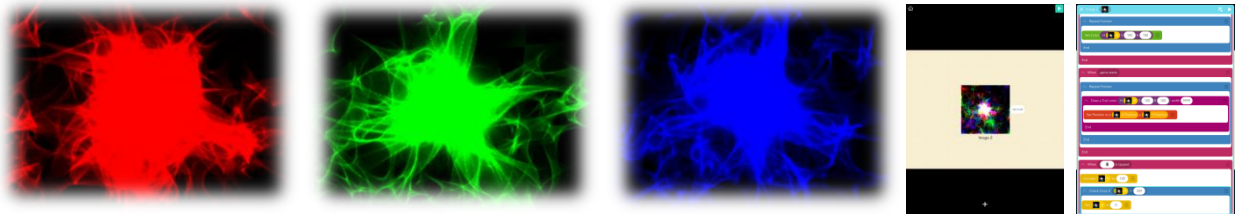
In 2016, the Hubble telescope found clouds on Neptune 9,000 km in diameter, the size of the United States. It is the location where the spot is located that intrigues astronomers. Understanding Neptune's meteorological systems will help understanding exoplanets.



Name of the program : Nuages sur Neptune <https://c.gethopscotch.com/p/ywd02ttad>

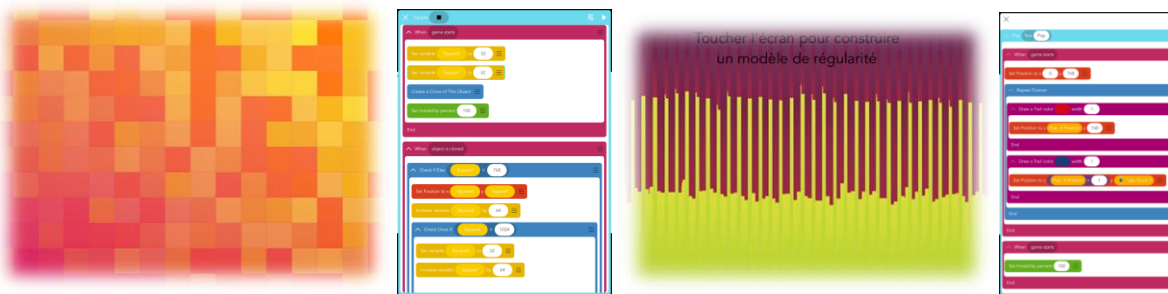
Games of the astronomical photo

Astronomical images are taken using sensitive sensors at different electromagnetic wavelengths. Here we see different filters used on the same part of the space. The resulting image of the same phenomenon is very different, depending on the filter used.



Name of the program : Image composite de galaxie <https://c.gethopscotch.com/p/yu7dxo6h0>

Each digital image consists of a set of pixels arranged in rows and columns. The smaller the pixel, the more precise the image. Here we see pixels of the red spot of Jupiter and an image of wavelengths processed by computer.



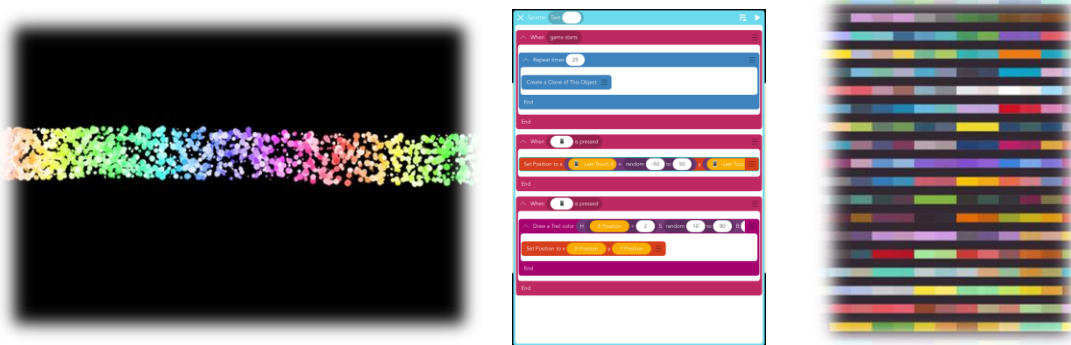
Name of the program : Ensemble de pixels carrés <https://c.gethopscotch.com/p/yumwc4xt2>

Name of the program : Détecteur thermique <https://c.gethopscotch.com/p/ythor9d6w>

Once filtered, the wavelengths are processed by computer to create a digital photo. Photography is an indispensable tool for inventorying and analyzing celestial objects including planets, stars, galaxies and the whole cosmos in general. Being able to see space in all forms of light has been a major technical advance of the twentieth century since 90% of the information that scientists use to understand our cosmos comes from the instruments of the invisible.

Games of spectroscopy

Spectroscopy is another indispensable discovery for the analysis of space. Spectroscopy allows to analyze the light of the stars in order to know their chemical composition. One can observe the beauty of the effect of water drops that decompose the sunlight to give a rainbow. Similarly, the spectrum of light from the deeper space can be observed. The spectrum of light from the stars contains small black stripes. The position and number of these scratches are unique for each star. Each chemical element emits a specific wavelength of light. By studying this wavelength of light and by comparing with the known luminous signatures one learns about the chemical composition of the star.



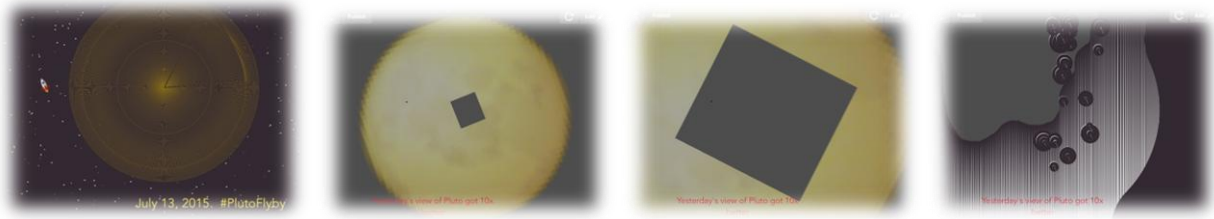
Name of the program: Émission du spectre de la lumière <https://c.gethopscotch.com/p/ytkmthdkm>

Name of the program: Spectre <https://c.gethopscotch.com/p/yv2fs1grl>

Pluto Games

Pluto was considered for more than 75 years as the 9th planet of the solar system. It lost its planet classification in 2006 and reclassified as a dwarf planet because it is one of the largest objects in the Keiper belt.

NASA's New Horizons spacecraft passed near Pluto in 2015, after a nine-year journey where it was able to take pictures of Pluto for a 30-minute period in order to measure Pluto, analyze its atmosphere and its moons. It took 4 hours for the data to travel to Earth and 16 months for all the data to be transmitted to the Earth.



Name of the program : Pluto flyby <https://c.gethopscotch.com/p/xdrl7yomw>

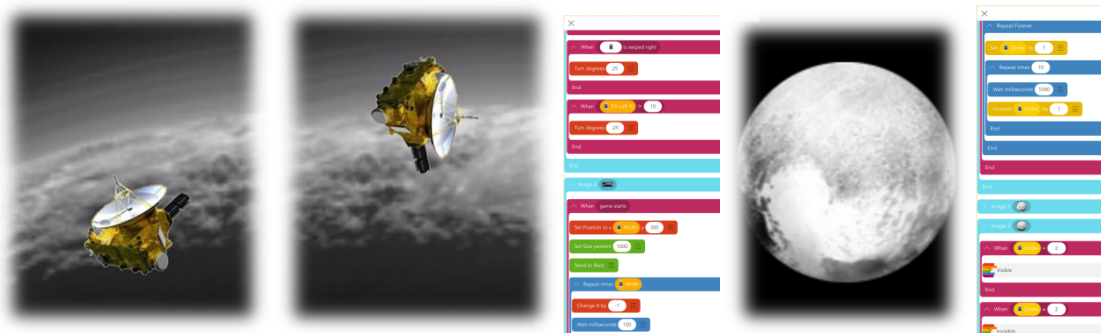
Name of the program : Pluto flyby <https://c.gethopscotch.com/p/xes22pw5x>

Overnight, the image we had of Pluto has improved tremendously.



Name of the program : New Horizons <https://c.gethopscotch.com/p/yuif7ycuo>

Here we see in a simulation the New Horizons probe near Pluto. It is also noted that Pluto has a clear heart-shaped spot on its surface. The simulation shows the whole planet turning on itself.



Name of the program : Pluton Flyby <https://c.gethopscotch.com/p/yuhzhlttm>

Name of the program : Un jour de Pluton <https://c.gethopscotch.com/p/yuhy2bwgm>

Night sky game

Three quarters of people in Canada cannot see the Milky Way (Quirks & Quarks, 2016). They have to travel far, out of town or go to a planetarium, to see the Milky Way.

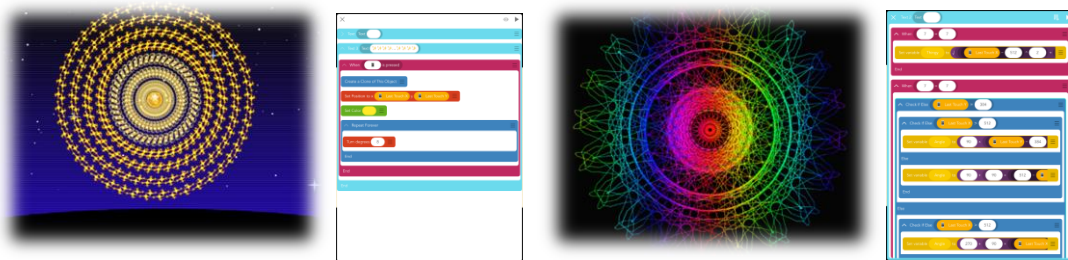
The goal of the game is to create the night sky of your city as seen from the International Space Station at the touch of a finger. We create a black background and gray lines showing the light in the area. The yellow rooms indicate the area where the light is most intense in the city of Montreal. As the students touch the screen, a yellowish light appears at his fingertips.



Name of the program : Ville de la SSI : <https://c.gethopscotch.com/p/xyn5p7q8a>

Games of the Stars

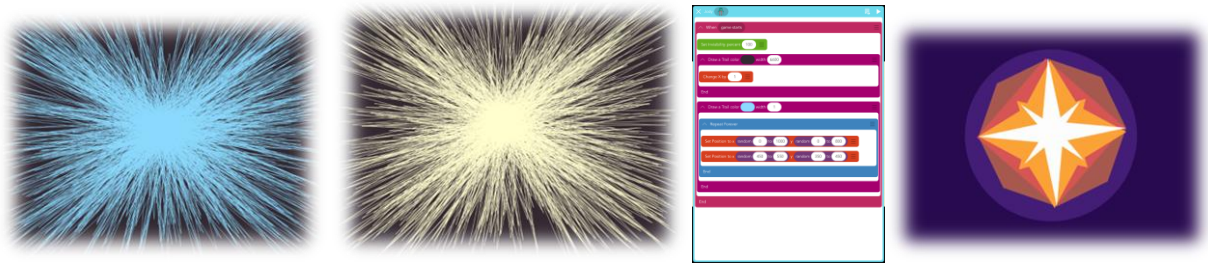
From the Earth, we can observe billions of stars. Only one, Polaris, appears to us motionless, from an observer on Earth. Here we see a simulation of a long exposure photography. Its immovable appearance comes from being approximately in the axis of rotation of the Earth while the other stars are perceived as making a circular motion around Polaris.



Name of the program : Photographier l'étoile polaire <https://c.gethopscotch.com/p/yu7s0etnk>

Name of the program : La plus belle étoile <https://c.gethopscotch.com/p/yuxvkw6m>

By looking quickly, you can think that the stars are white. Looking carefully with a small telescope, one can realize that one finds blue, white, red and even golden stars. The difference in temperature of each star produces the difference in color. A red star is colder than a white star and a white star is colder than a blue star.



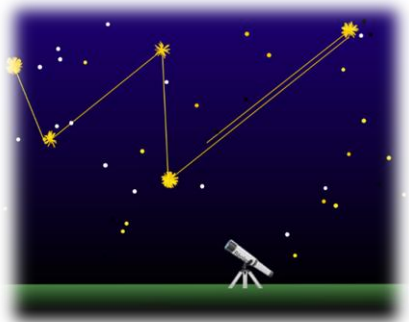
Name of the program : Etoile bleue <https://c.gethopscotch.com/p/yti5pkygy>

Name of the program : Etoile jaune <https://c.gethopscotch.com/p/ythts1b8p>

Name of the program : Etoile <https://c.gethopscotch.com/p/ytg7a91x2>

Game of constellations

The constellations make models in the sky. The stars of the constellation are not all in the same region of space, but the model goes according to the perceived position of the Earth. These stars are not fixed; They move slightly because of the expansion of the universe. Today, there are 88 different constellations. This game allows to draw constellations in the sky.



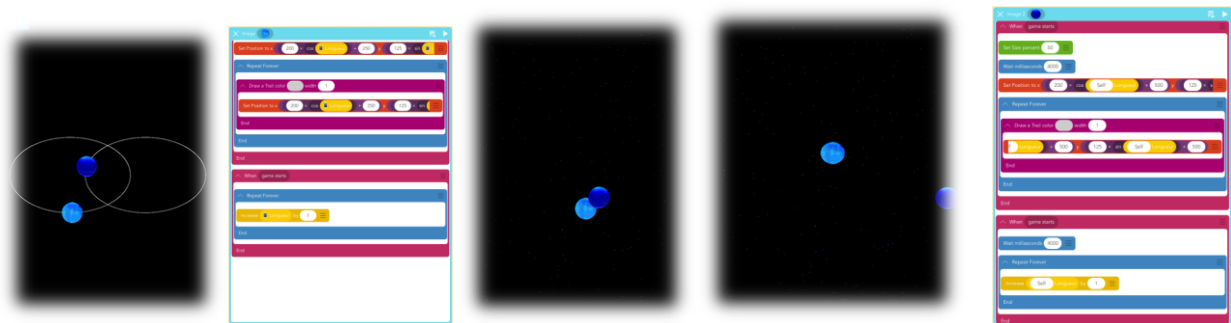
Name of the program : Créateur de constellations <https://c.gethopscotch.com/p/ytcacjzgc>

Games of the binary stars

The STAR WALK application is very useful for identifying objects in the sky. It identifies more than 200,000 celestial objects including stars, planets, constellations, and satellites.

We observe the sky in real time, and what is before us, with the movement of the iPad. Here we see Alcor and Mizar, in the constellation of the Great Bear.

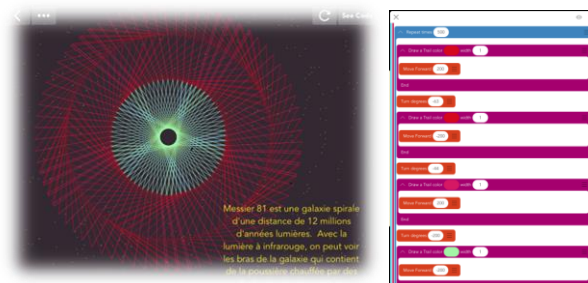
About half of the stars are binary stars. The sun is not, however, a binary star, there is only one. Binary stars are identified not because they appear optically close to one another, seen from the Earth, but because they orbit each other. We see here two simulations of binary stars, one with the trajectory drawn in its passage and the other showing its dynamic beauty.



Name of the program : Simulation étoile double <https://c.gethopscotch.com/p/yod0u7uks>

Name of the program : Etoile double <https://c.gethopscotch.com/p/yod06yui6>

Game of the Messier galaxy



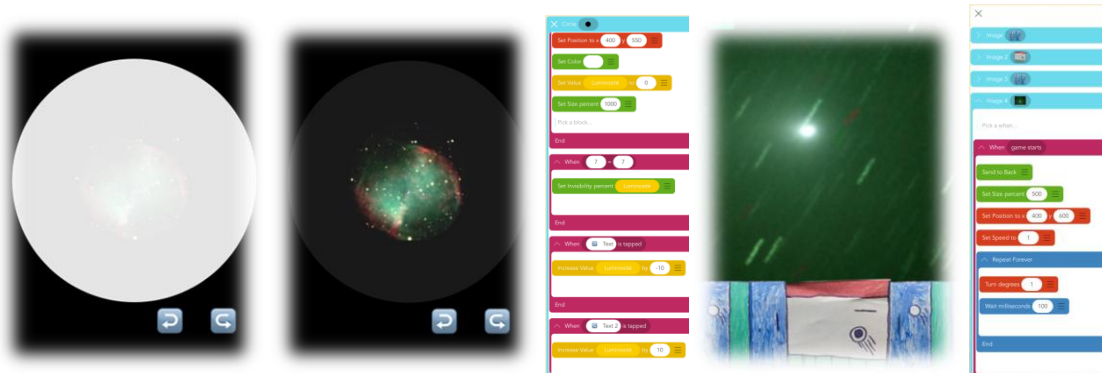
Name of the program : Messier 81 Galaxie <https://c.gethopscotch.com/p/xkja5hjab>

The Internet and the NASA site offers us many outstanding images and scientific information about space exploration. In order to see in space, we need several tools. A technology like infrared technology, for example, allows us to detect different aspects of the cosmos than those seen in conventional light, thanks to heat. We can see here a

simulation of the spiral galaxy, Messier 81, at a distance of 12 million light-years seen at the infrared. Infrared allows us to see the heated dust not from the young massive stars.

Games of the telescope

It is possible to take wonderful pictures with a telescope. The book *Turn Left at Orion* gives detailed instructions to easily find many space objects to help beginners in astronomy. It is also possible to use the York University telescope which offers weekly sessions with scientists and allows to see the sky with their telescope. The meeting is done online using the Internet. In the next two examples, images from the York University telescope were used. A digital focus button is programmed to view the Dumbbell nebula. We also see the rotation of the sky, seen from the Earth using the image of comet Hartley and a drawing of a pupil.

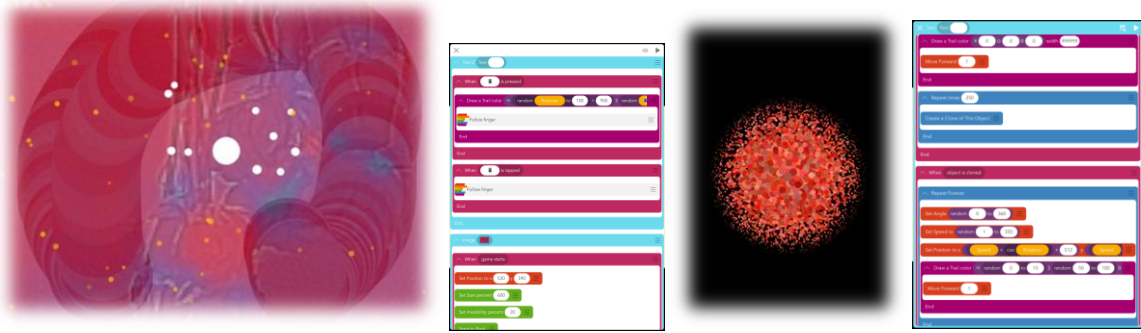


Name of the program : Télescope focus <https://c.gethopscoth.com/p/yfgg8r2ra>

Name of the program : Rotation du ciel <https://c.gethopscotch.com/p/yfgjkg7h>

Games of the globular cluster

The globular cluster is a very concentrated assembly of stars. They contain hundreds of thousands of stars. These stellar clusters consist mainly of red giants. The first observations of globular clusters were made in 1665 by a passionate amateur astronomer: Johann Ihle. He observed the globular cluster known today as M22. There are now more than 150 globular clusters in our Milky Way. Harlow Shapley used these globular clusters to measure the position of the Sun in the Milky Way.



Name of the program : Amas d'étoiles RCW38 <https://c.gethopscotch.com/p/yu02jx762>

Name of the program : Amas globulaire <https://c.gethopscotch.com/p/ytiy9kdi>

Game of the Orion Nebula

The Orion nebula is one of the most studied nebulae. Located in the Orion constellation, it is visible to the naked eye of the Earth. The best images of the nebula are obtained with infrared telescopes such as the European Southern Observatory (ESO) Very Large Telescope in Chile. One can see enormous clouds of gas and numerous stars dotted in the cloud. The brightest stars glisten here with Hopscotch.

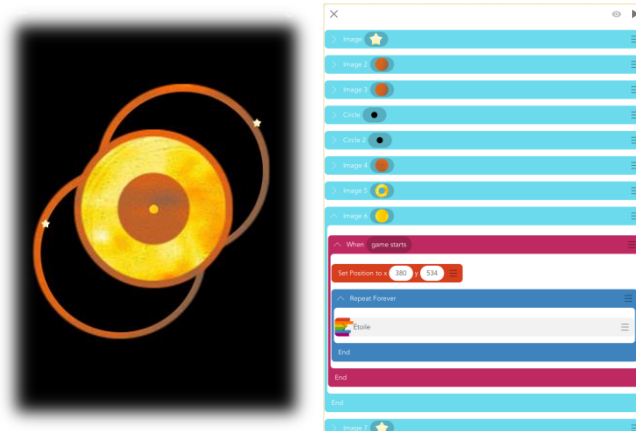


Name of the program : Nébuleuse Orion <https://c.gethopscotch.com/p/yqvrmdgb>

Game of the wave of matter

Where does the solar system come from? By analyzing the old meteorites of the solar system, scientists believe that the heavy elements that form the planet's soil come from star explosions at the end of their lives. The old stars no longer have hydrogen fuel that

they transform with nuclear fission in helium. The remaining helium is transformed into carbon, oxygen and nitrogen. The explosion of the star, the supernova, ejects the heavy elements that will form other stars and planets in other places. Such a supernova was observed in the Magellanic cloud (Forget, 2006).



Name of the program : Onde de matière <https://c.gethopscotch.com/p/yqw8jw6ky>

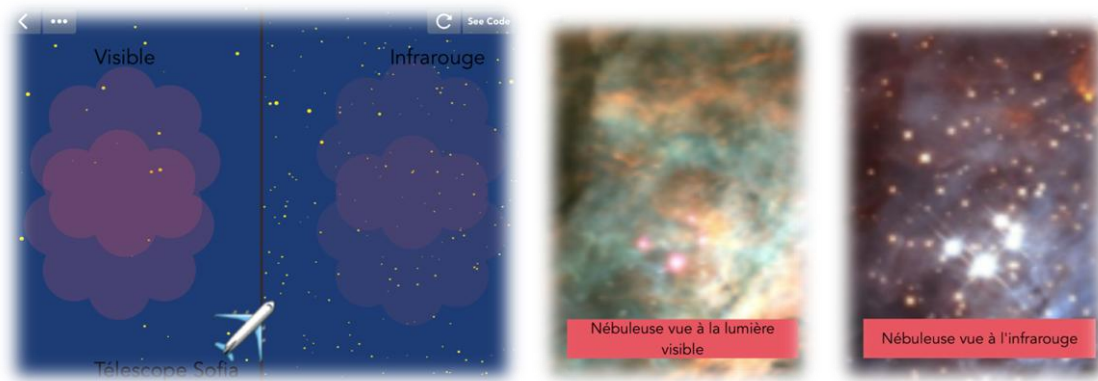
Games of the Sofia telescope

NASA's Sofia telescope, mounted on a Boeing 747 aircraft, was designed to study space with the aid of infrared technology to see objects that are difficult to see in the visible spectrum. Scientists gather information while traveling on the plane. The infrared telescope can study nebulae, black holes and other objects. NASA scientists also document the expansion of the Universe. Einstein's theory makes his understanding possible. They take pictures of distant galaxies over several years to see the distance between galaxies and the expansion of the universe.



Name of the program : Télescope Sofia <https://c.gethopscotch.com/p/you6xqhtim>

Infrared allows us to see the invisible. The simulations below allow us to see the difference between the vision of the cosmos with visible and infrared light. Infrared allows us to see more deeply in the cosmos and also allows us to see beyond the dust present in the universe.



Name of the program : Infrarouge : <https://c.gethopscotch.com/p/xmqig22om>

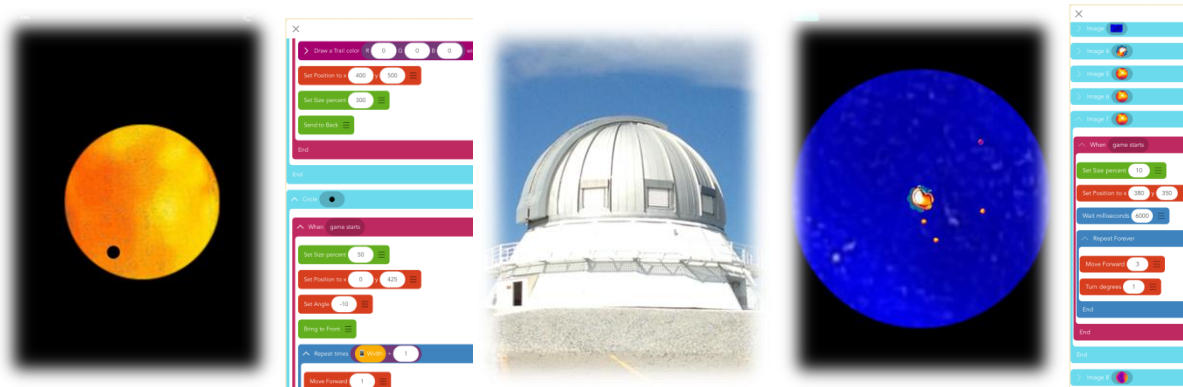
Name of the program : Contraste infrarouge visible nebuleuse <https://c.gethopscotch.com/p/yy7y8y9ve>

The Sofia telescope is more powerful than terrestrial telescopes because of its elevation. The vast majority of the electromagnetic spectrum is blocked by the Earth's atmosphere and must be observed at high altitude or space.

Games of the detection of exoplanets

It was at the Mont Mégantic observatory in Quebec that the technique of photography was developed which allowed to photograph directly a exo gaseous planet (Luminet, Reeves, 2016). Exo planets are typically observed with the transit method. When a planet passes in front of its star, there is a fluctuation of the light emitted by the star since the planet blocks some of this light as it passes in front of the star. The transit method has some limitations. The planets that are farther from their star have a longer rotation period and require several years of observation so that the observed results can be observed again. If it takes 10 years for a planet to return to the same place in its orbit, it will take 10 years for the observations to be repeated in order to confirm the presence of the planet. With the direct photography method, one can see the planets right away.

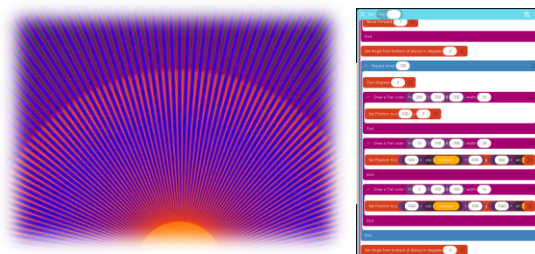
Since the Earth turns on itself, what we observe in the sky appears to us to turn as well. In order to take a good picture, the telescopes must 'immobilize' the sky by changing their position at the same speed as the rotation of the Earth, in the opposite direction.



Name of the program : Planète devant un astre <https://c.gethopscotch.com/p/yus5mgxcc>

Name of the program : Etoile HRS799 <https://c.gethopscotch.com/p/yucs6wrjg>

Christian Marois at Mont Mégantic had the idea to take a photo of the sky, and to stop the rotation of the telescope in order to take a second picture, for an hour. We then take the two photos and mathematically subtract the light from the star. The light that remains, if any, is the brightness of a planet around the star. The light of the star in the first photograph is so intense that it does not allow to see the planet. By subtracting this intensity by using the two photos, one can directly see the other objects around the star. This new technique of photography was developed with a small terrestrial telescope and adapted by larger telescopes. The Mont Mégantic Observatory was the first to find 3 exoplanets in the HRS799 system. With a more powerful telescope, we could find a fourth planet in the system. We see in the second game, a simulation of four planets in orbit around HRS799.

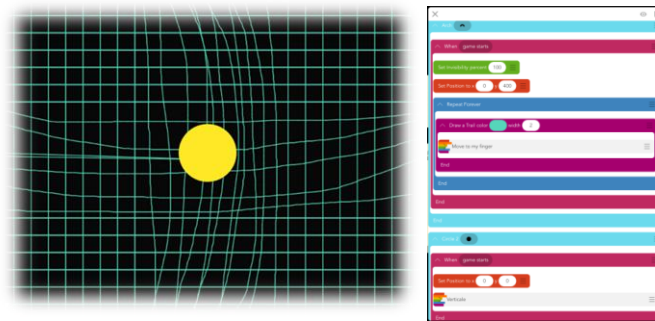


Name of the program : TW Hydrae <https://c.gethopscotch.com/p/yo064hjeo>

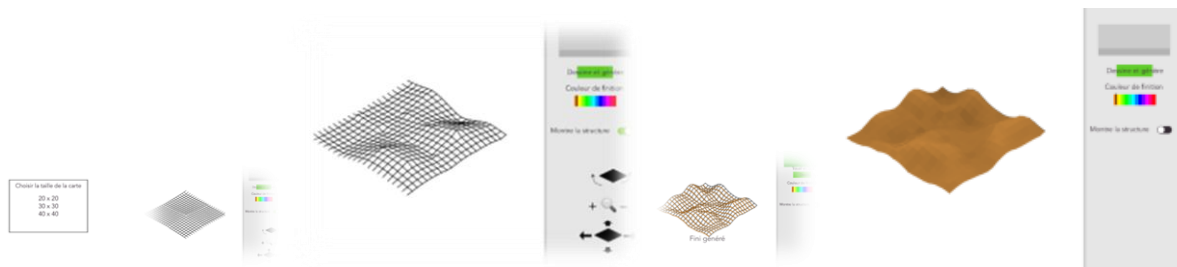
In the TW Hydrae game, we see rings and holes around the star, indicating that planets are forming around this star.

Games of the Einstein theory

In 1915, Einstein developed the theory of relativity. In the theory of relativity, space-time is curved like a fabric. When the fabric curls, everything around is going to be bent too. The orbit of the celestial bodies responds to the space-time curvature of the surroundings. The curve affects the movement of the masses and the distribution of the masses affects the curvature. According to the theory of relativity, gravity can lead to delays in time.



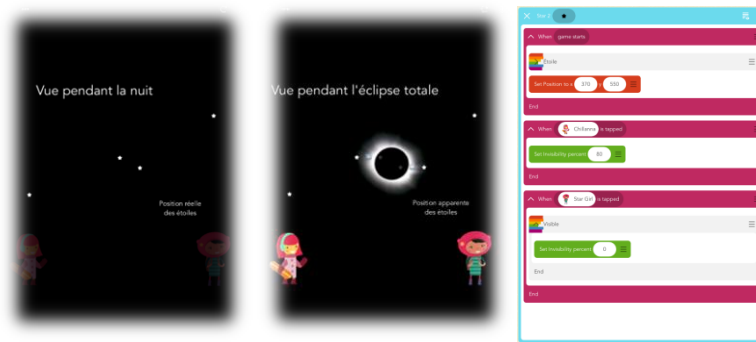
Name of the program : Einstein remix <https://c.gethopscotch.com/p/ysxda24rp>



Name of the program : Théorie d'Einstein <https://c.gethopscotch.com/p/ysxda24rp>

Gott (2017) explains the theory of relativity by giving an example. To travel between Toronto and Tokyo on the straightest path, an aircraft must pass through northern Alaska and not use the straight path seen on a 2-dimensional map. The passage to the north is the shortest and the most straight. In the same way, with Einstein's theory, particles in the cosmos move in the curved universe as straight as possible.

Einstein had calculated the trajectories of the planets of the solar system with his new theory and had noticed that the orbit of Mercury had an anomaly which Newton's theory of gravity could not explain. Einstein's theory also predicted that the light of the stars passing near the Sun would be bent by gravity. Einstein's new theory was used to explain this anomaly which was tested by Eddington.



Nom du programme : Confirmer théorie Einstein
<https://c.gethopscotch.com/p/yvvgjzkuu>

Eddington took a picture of stars at night and during a total eclipse of the sun. The total eclipse of the sun allowed to see and to photograph the stars behind the sun. By comparing the two images, it was possible to confirm the movement of light under the influence of a massive object like the sun.

Space elevator game

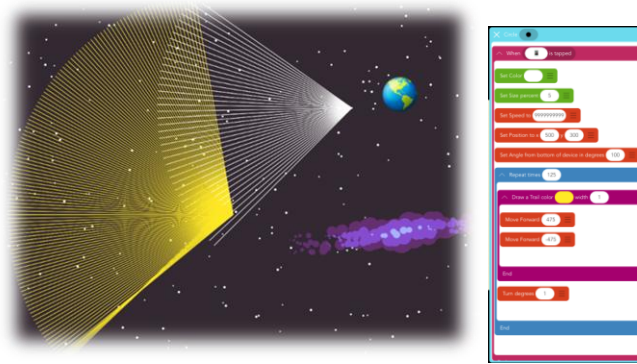
What is the future of space exploration? In the film *The mysteries of the invisible world*, we talk about nanotechnology and how carbon nanotubes can be used to build really solid materials. These solid materials could be used to make a space elevator. This space elevator could make enormous savings on traveling beyond the atmosphere.



Space elevator: <https://c.gethopscotch.com/p/xxe9ws9ml>

Game of the ship NANO

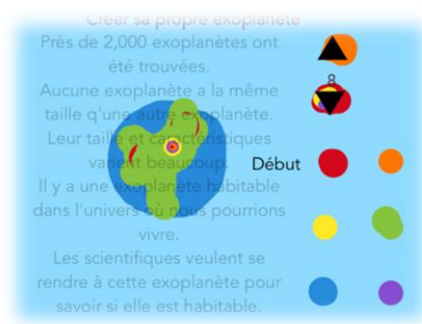
There is a new project, led by the billionaire Yuri Milner, who proposes to send a tiny vessel to the alpha system of the Centaur. He proposes to send a NANO ship, which can be held between two fingers. It may take 20 years to develop this radically different technology. A normal ship would take 30,000 years to travel the distance of 4.37 light-years. But the StarShip ship could go to Alpha Centaur in just 20 years. It was Carl Sagan who in 1976 proposed the idea of solar sail. Nature lovers are not waiting for the government to build their dream. They do it themselves.



Name of the program : Nanocraft <https://c.gethopscotch.com/p/xxf409g7k>

Game of an exoplanet

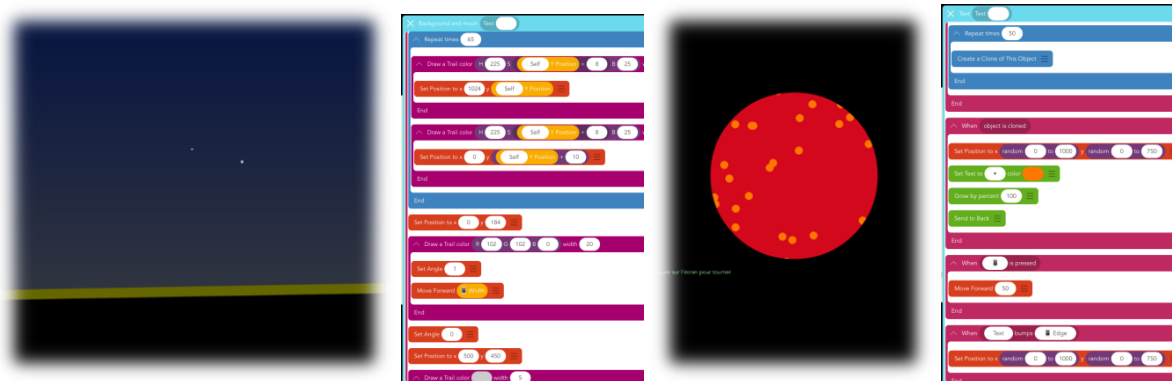
There are also planets outside the solar system. The Kepler satellite launched in Earth orbit in 2009, has found more than 4,000 in four years of operation and finds others every day. At this time, we cannot see them directly, the exoplanets are detected indirectly. Certain chemical elements present on the detected planets and their size can be detected. The game of an exoplanet makes it possible to imagine what the exoplanet looks like that is observed using the facts we know. Summers and Trefil (2017) indicate that there are at least six categories of exoplanets. There are the Super Lands that are rocky planets several times the size of the earth. There are the polystyrene worlds which are excessively light planets. There are diamond planets whose surface is composed of pure carbon. There are multiple star worlds where a planet revolves around several stars. There are hot lands, the worlds where the planet is so close to its star that its surface is steam rocks. Finally, there are the rogue planets that travel in the cosmos without being attached to any planet. Free to visualize these planets.



Name of the program : Créer votre propre exoplanète <https://c.gethopscotch.com/p/yszpgayrx>

Game of Mars of the Earth

It's in our DNA. Many people dream of going to Mars, only because they are capable of it. Where is she? There are several magazines including SkyNews, Astronomy, Sky & Telescope and websites including StarMap which offer a starry sky view at sunset and during the night, during the whole year. This makes it easy to identify planets, constellations and other objects in the sky. These Hopscotch programs show us a view of Mars at sunset, with the naked eye, and an artistic view of Mars.



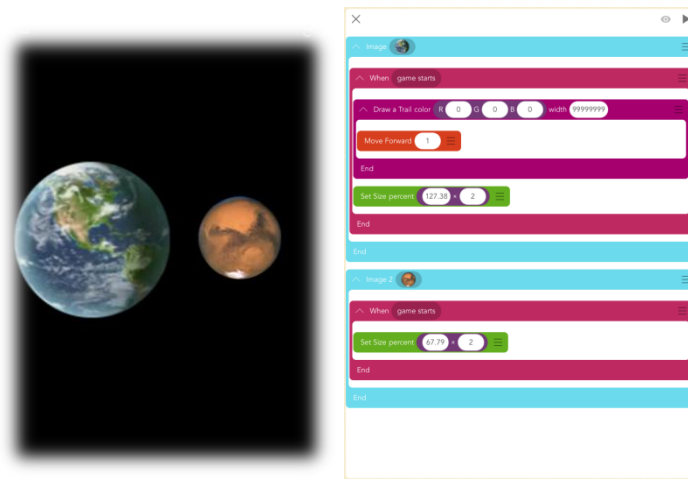
Name of the program : Mars de la Terre <https://c.gethopscotch.com/p/yr0vilebi>

Name of the program : Mars <https://c.gethopscotch.com/p/yszlnnyes>

Game of the size of Mars

What do we know about Mars? We can see its surface much better with the Hubble telescope. It is the fourth planet of the solar system at about 228 million kilometers from the sun. It is about half the size of the Earth. However, there are no oceans on Mars. Earth and Mars have about the same amount of land surface. Mars also has two moons,

Phobos and Deimos, shaped like potatoes, instead of being circular like the moon of the Earth.



Name of the program : Taille terre mars <https://c.gethopscotch.com/p/yr3cdv6zk>

Game of the rotation of Mars

Mars rotates on itself. It is therefore possible to see its entire surface through the telescope. One day on Mars, a ground, lasts 24.5 hours terrestrial. Mars has an atmosphere composed of carbon dioxide and not oxygen. Temperatures on the surface of Mars vary between 25 degrees Celcius and -125 degrees Celcius. Looking carefully, one can realize that half of Mars has many craters and that the other half has almost no craters. With this information, scientists have divided the history of Mars into three eras. In the southern hemisphere of Mars, where a great number of craters are concentrated, we have the Noachian era, the oldest era. In the southern hemisphere there is also a less marked area of craters. This is the Hesperian era. In the north of Mars, there is a much younger region, a dusty and deserted plain, the Amazonian era. The tectonics of the plates that are found on Earth constantly renew the surface of the Earth. There is no plate tectonics on Mars. Mars was able to keep traces of its distant past. It thus retains the memory of a very distant past and could thus tell the emergence of life in order to understand our origins.

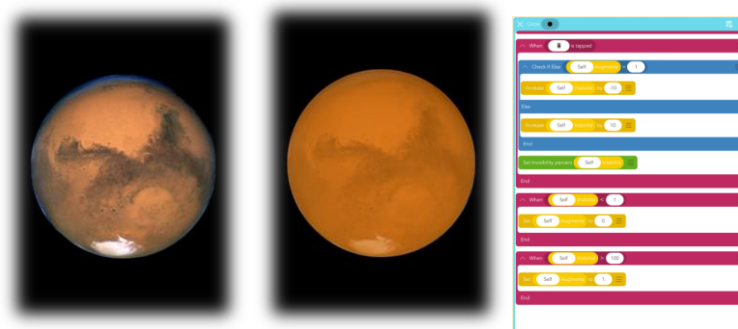
The North Pole of Mars is covered with an ice cap mainly composed of frozen carbon dioxide, but also contains ice water. Scientists hope that the water from the ice cap is a sign that Mars still contains other water that could bear life.



Name of the program : Mars rotation <https://c.gethopscotch.com/p/yr8xd95kg>

Dust cycle play

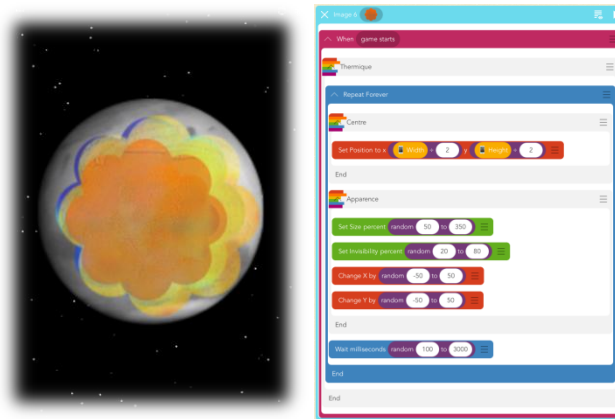
Why is Mars called the Red Planet? The soil of Mars is orange. It is the color of oxidized iron, rust. Mars is covered with iron oxide dust over its entire surface. The atmosphere of Mars also contains a large amount of dust suspended in the air. Every day there are many dust storms on Mars during atmospheric depressions. During the spring and summer, the clear season, there are few storms and also little dust in the air. During the autumn and winter, the dust season, there are many storms and a lot of dust suspended in the atmosphere. Some of these storms can become global and encircle everything from the Martian globe, as seen in this game of the dust cycle. Global storms can last for several months.



Name of the program : Mars cycle de poussière <https://c.gethopscotch.com/p/yr69m6lsw>

Set of thermal emission

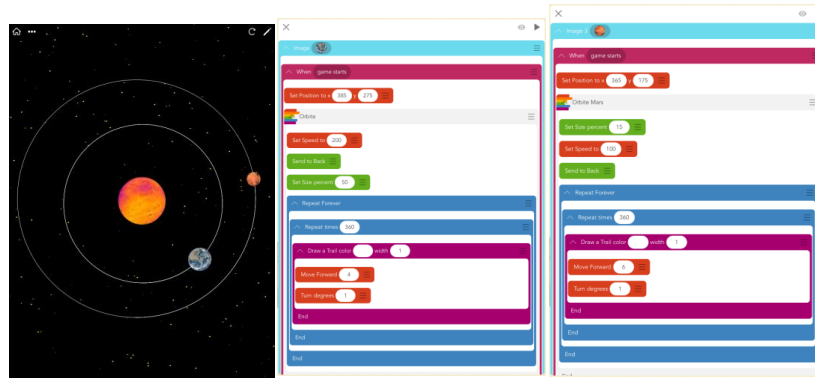
Infrared spectrometers on board Martian satellites measure the temperature variations on Mars. A very clear atmosphere appears in purple. A very dusty atmosphere appears on the opposite side, in red. These data allow to observe the local and global storms on Mars. Scientists observed many global storms in the 1970s, but few during the next 20 years. Dust storms greatly change the Martian weather. Scientists are busy understanding the Martian atmosphere.



Name of the program : Mars émission thermique <https://c.gethopscotch.com/p/yrzh5big0>

Game of Earth Mars Orbit

A year on Mars lasts 687 Earth days. Earth and Mars both have an almost circular orbit. The different orbits mean that the distance between the two planets changes constantly. Sometimes the Earth and Mars are on the opposite side of the sun, 401 million kilometers away. Sometimes the two planets are relatively next to each other, 54 million kilometers apart. Every two years, a window opens and the two planets are close to one another, allowing space probes to be launched to Mars from Earth, during which time the distance between the two planets is smaller.

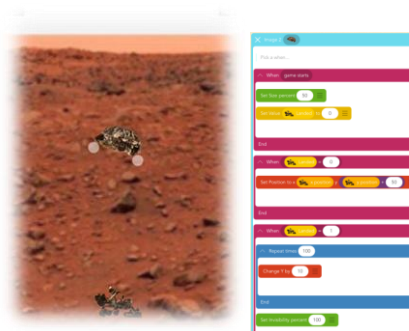


Name of the program : Orbite Terre et Mars Remix

<https://c.gethopscoth.com/p/ysc48b64z>

Game of the rover on Mars

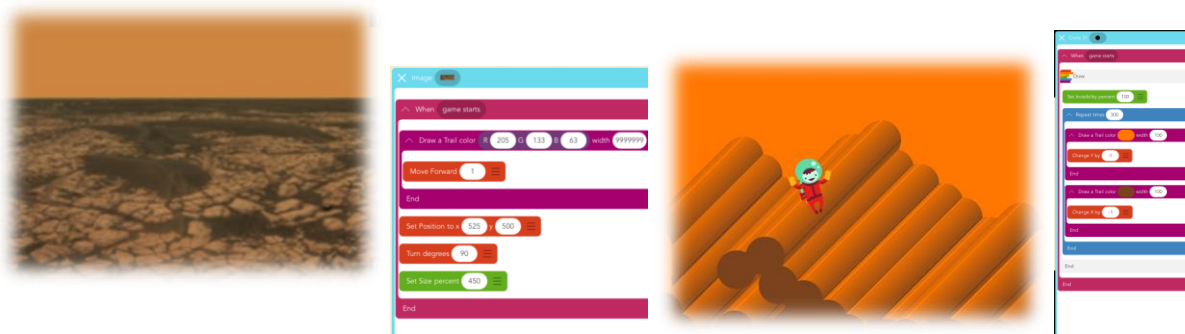
NASA scientists in America took 10 years to prepare the Curiosity mission that landed on Mars. Its mission is to analyze the surface of Mars in order to know if there is life on Mars and to search for habitable environments. Curiosity is equipped with an extraordinary scientific laboratory and a self-propelled engine which allowed it to go to Mars and land there. After a journey of 60 million km from Earth, the rover sends us images of the surface of Mars. The mobile laboratory analyzes the Martian soil. There was evidence that water existed on Mars. We have also found evidence that Mars has already been able to endure life. Martian soil analysis has identified carbon, hydrogen, oxygen, phosphorus, and sulfur, the molecules that form the basis of life (Al-Jazeera, 5.08.2013).



Name of the program : Atterissage sur mars <https://c.gethopscoth.com/p/y9mwdsa4t>

Game of the landscape of Mars

The landscapes are magnificent on Mars. NASA images are available on the Internet. They can be included for free in any Hopscotch program. All color varieties can be programmed with the RGB color code.



Name of the program : Mars paysage <https://c.gethopscotch.com/p/yqvdr6flq>

Name of the program : Surface de Mars <https://c.gethopscotch.com/p/ythmnydix>

Thermal Shield Game

More than a year after its landing, Opportunity regained its thermal shield on the surface of Mars (Forget, 2006). It was the shield that protected it when it entered the atmosphere of Mars. Opportunity dismantled its shield just before landing.



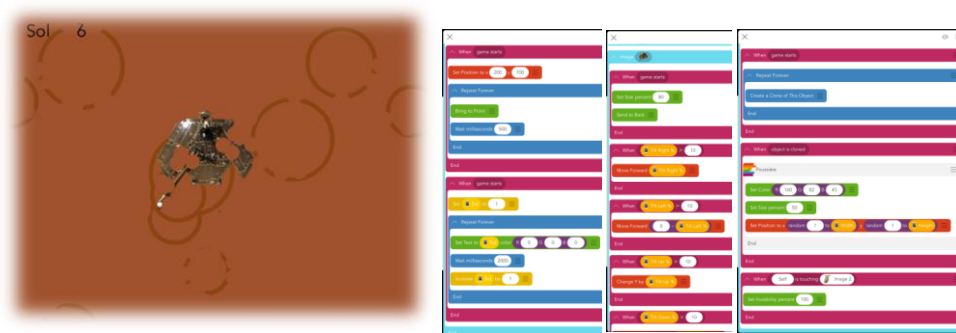
Name of the program : Bouclier du rover martien <https://c.gethopscotch.com/p/ythoy2pms>

Name of the program : Mars bouclier thermique <https://c.gethopscotch.com/p/yqvbqqa9>

Dust on the Rover

The Rovers who are on Mars are moving on the surface of the planet using the energy they receive from the sun using their solar panels. There was Pathfinder, Sojourner, Opportunity and Spirit. The Spirit rover is no longer in service due to the accumulation of particles on its solar panels. He can no longer receive the sunlight. The atmosphere of Mars is full of dust particles. On Earth, we have rain that removes particles from the atmosphere, but not on Mars.

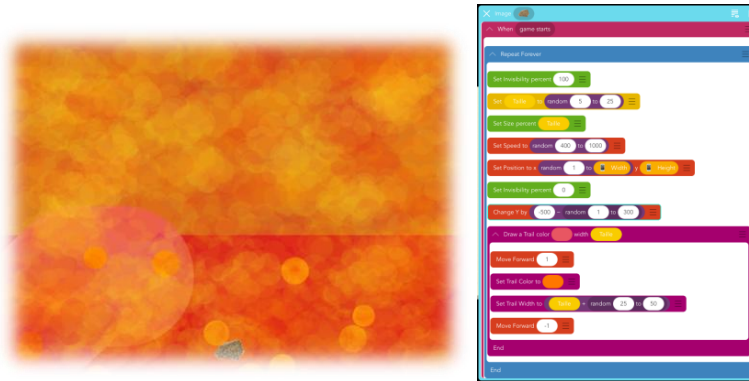
The Curiosity and Opportunity rovers are still active. Opportunity rental allowed wind storms on Mars to dislodge particles that accumulate on their solar panels. The Curiosity rover is not as dependent on the Martian temperature, because it is powered by a nuclear engine. Here we see the accumulation of particles on one of the rovers and a storm on Mars that dislodges the sand accumulated on the Rover.



Name of the program : Mars rover poussière <https://c.gethopscotch.com/p/yr63a6q8k>

Game of the Craters of Mars

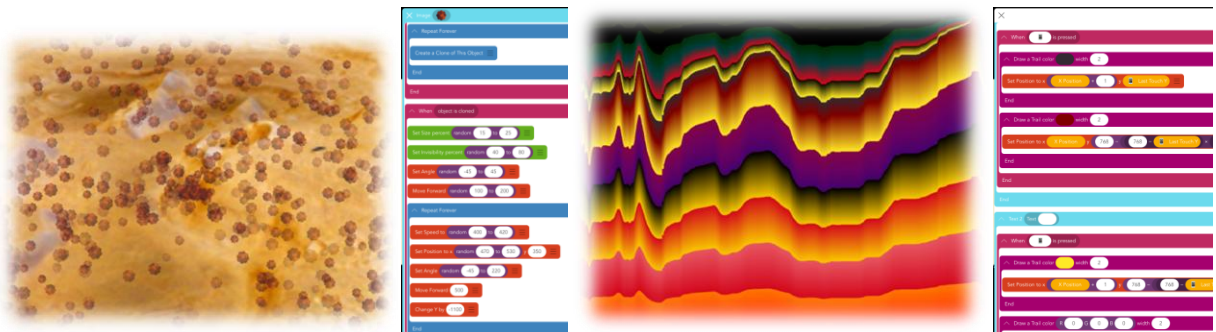
It is possible to date the surface of Mars by the amount of craters observed there. It can also be observed that Mars always receives space meteorites that can form new craters when they impact the surface of Mars (NASA, 2009). The surface of Mars is changing. We see here a simulation of the impact of meteorites on Mars, forming the craters.



Name of the program : Mars cratères <https://c.gethopscotch.com/p/yqvflxtsf>

Game of the volcano on Mars

The planet Mars is half the size of planet Earth. A Martian day lasts 24 hours 37 minutes and 22 earth seconds and a Martian year is 669 Martian days or 687 Earth days. Its temperature varies between -133 and 27 degrees Celcius. Its atmosphere is not breathable since it has little oxygen. On the surface of Mars, however, there is a lot of water and carbon dioxide. Mars possesses the highest volcano of the whole solar system and also two moons (Al-Jazeera, 20.08.2003). Volcanoes on Mars are 100 bigger than those on Earth.



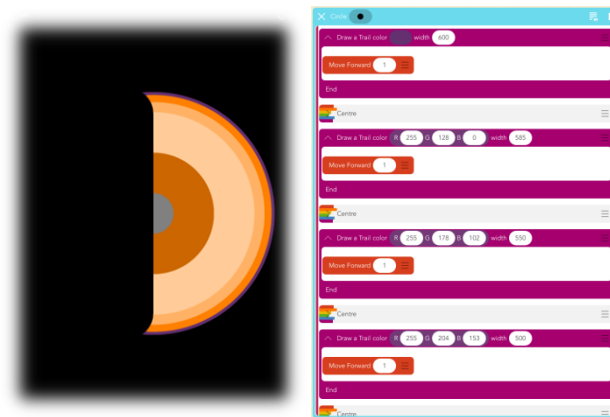
Name of the program : Volcan sur mars <https://c.gethopscotch.com/p/yocyeqf0q>

Name of the program : Apparition de la vie sur Terre <https://c.gethopscotch.com/p/ythrdokju>

We can see layers of lava several kilometers thick which testifies to a volcanism that has already been very active on Mars.

Game of the kernel of Mars

The impacts of large meteorites on Mars form craters on Mars and the Martian rocks dislodge themselves in turn to travel in space and sometimes find themselves on Earth, the star nearest to March. One of the fragments of Mars, the Chassigny meteorite, fell on Earth in 1815. The analysis of these Martian meteorites found on earth and a comparison with what is known about the Earth's nucleus informs scientists about the composition of Core of Mars. 70% to 80% of the Martian nucleus would consist of iron. Nickel (8%) and sulfur (14%) are also found. With sulfur, scientists believe that the Martian nucleus could still be liquid (Forget, 2006).



Name of the program : Mars. Noyau <https://c.gethopscoth.com/p/yr0sf7eau>

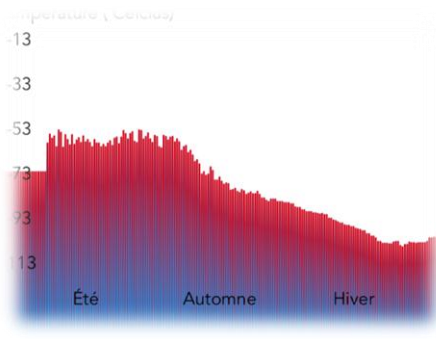
Game of the river on Mars

Liquid water was not observed on Mars. There are signs, however, that there has already been liquid water on Mars. In the north of Mars, frozen dew covers the Martian soil in the morning. There are also ravines in which liquid flows. This liquid water would come from a groundwater deposit or perhaps from a frost-related process (Harrison, 2017).

[illegible]

Game of the temperature on Mars

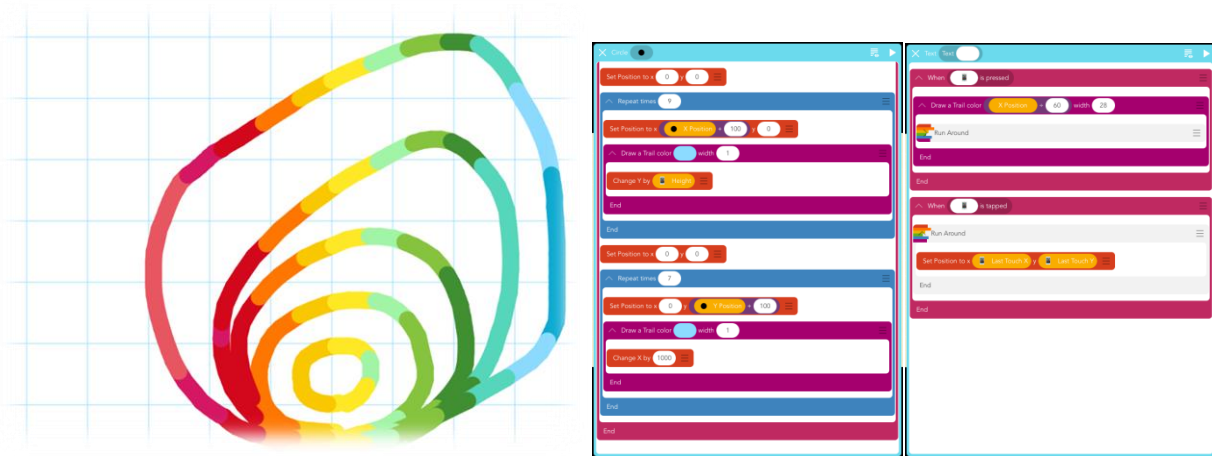
Viking 1 was the first alien meteorological station. Since 1976, scientists are taking the temperature of the planet Mars every day. At night, the temperature can drop to -100 degrees Celsius and the maximum observed temperature at night is -75 degrees Celsius. During the day, the maximum temperature observed is -23 degrees Celsius and the minimum temperature observed is -75 degrees Celsius during the winter. The following diagram shows the average temperature on Mars during the course of a full year (Forget, 2006).



The screenshot shows the Scratch 'Repeat' block interface. The 'Repeat' block is set to 'Repeat 10 times'. The 'Do this many times' field is set to 10. The 'Loop' section is set to 'Loop until the end of the loop'. The 'When green flag clicked' event is selected. The 'Say Hello! for 2 secs' block is added to the loop.

Game of the Wind on Mars

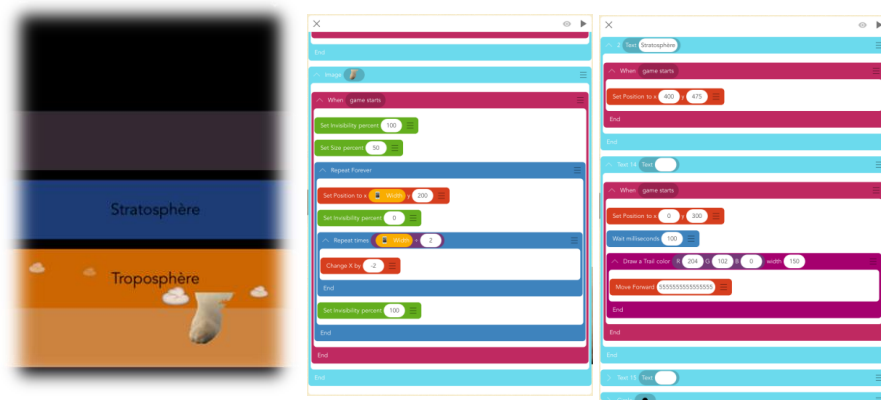
Meteorologists also observe the Martian winds which are formed by thermal contrasts and rotation of Mars. Solar radiation causes the particles to move in the atmosphere by creating contrasts in temperature. There are differences in pressure at different altitudes. The movements of the Martian air are also affected by the rotation of Mars on itself. The air circulation on Mars resembles the air circulation on Earth, except the influence of the oceans that are absent on Mars. At high altitudes, air from hot regions is pushed to cold regions where it cools and re-descends to the surface. This phenomenon is called the Hadley circulation (Forget, 2006).



Name of the program : Vent sur mars <https://c.gethopscotch.com/p/yr3mtxgj7>

Game of the atmosphere of Mars

The dust tornadoes are a reality of the planet Mars. They are present in all seasons. They were nicknamed the "dust devils". They can be up to 10 km high and hundreds of meters in diameter. These tornadoes of wind raise a lot of dust. Where the devils of dust pass, traces of graffiti are seen (Forget, 2006). The atmosphere of Mars has less than 1% the density of the earth's atmosphere. Although we speak of tornadoes, the Martian winds are not very strong. If you've seen the movie *The Martian* (2015), the winds are not strong enough to push actor Matt Damon, as we saw in the movie. This initial atmospheric situation which caused the abandonment of the astronaut on Mars is scientifically impossible and totally a work of fiction (Moore, 2017).



Name of the program : Mars atmosphère <https://c.gethopscoth.com/p/yr3fsl7a7>

Game of the drone

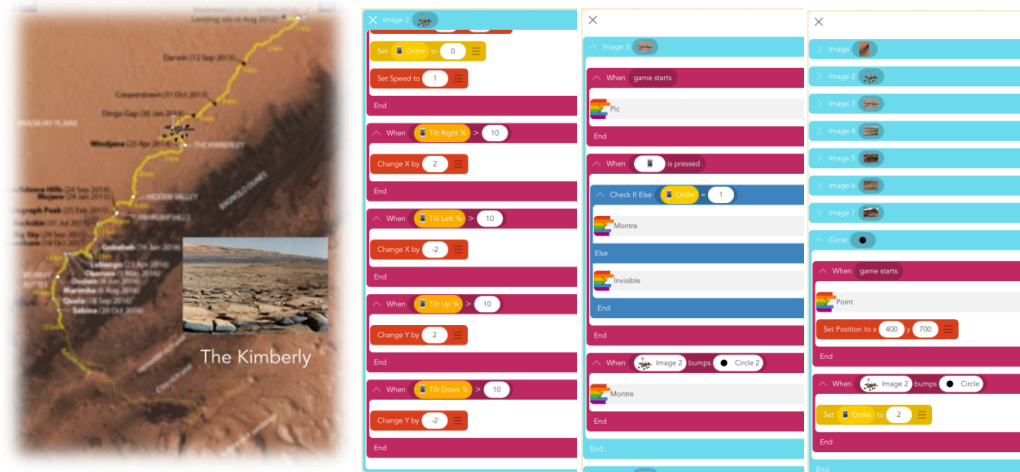
Although the atmosphere of Mars is 1% that of the Earth, the gravity is one third of the Earth's gravity. This does not allow planes to fly on Mars, but a small helicopter, a drone would be able to fly on Mars in order to take very detailed photos of the surface of Mars. A drone equipped with a camera with the power of a smart phone, communicating with a rover, could take images ten times better resolution than satellites orbiting the planet. A drone could fly over the terrain where the rover must go, in order to maximize its effectiveness (Astronomy, 07.2017).



Name of the program : Drone sur mars <https://c.gethopscoth.com/p/yrzhekhqt>

Google Play Mars

The Curiosity rover is the most complex laboratory sent on Mars, among the more than 55 space missions sent to Mars since 1960 by the Soviet Union, the United States, Europe, Russia, China, India. The mission of Curiosity is to find out if Mars had the necessary environment to support the life of small germs. He travels on Mars where scientists think life could have existed because fossil traces that date back millions of years are still available. To support microbial life, we need liquid water to facilitate chemical reactions, a source of energy and long-term stability for life to develop and thrive. Scientists believe that Mars has everything to support life (Lakdawalla, 2017). In this game Google Mars, we see the route that took Curiosity on Mars and the pictures that Curiosity sent from each place visited.

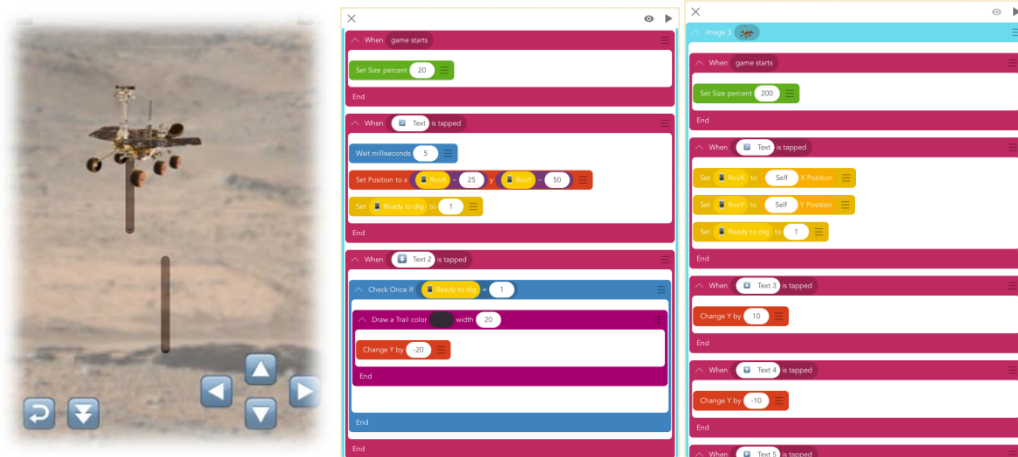


Name of the program : Google Mars <https://c.gethopscotch.com/p/yrzxf38e>

Game of the Martian laboratory

Scientists believe that the place where to look for the evidence of the existence of life on Mars is in the oldest rocks, in the clay minerals, and that under the Earth, far from the cosmic radiations. Curiosity has several instruments to analyze the soil it harvests from the surface and subsoil of Mars. Curiosity has 17 cameras to take pictures from near or far. It also has hammers to reach rocks that are not visible from the surface. It also has a drill that sprays the rock and collects dust for analysis. Drilling the surface of Mars is very dangerous. It is a delicate and precise operation. If the rover moves a bit during drilling, it could damage the drill or rover arm, eliminating all future drill testing. The rover has

extracted gray dust during drilling indicating that Mars is not only made of rust. Looking deeper, we could find life. Small bacteria could live in these rocks.



Name of the program : Sam laboratoire Martien <https://c.gethopscotch.com/p/yrzm2b5bs>

Game of mineral composition

The rover analyzes the dust collected during on-site drilling. Scientists who interact continuously with the rover take a lot of precautions when analyzing the data sent by the rover. It must be ensured, for example, that there is no contamination of the Earth from the instruments of the rover or its chemical compounds which are on board. The mineral composition of the Mars surface differs greatly depending on where the samples are harvested. They contain feldspar, mafic fire retardant minerals, magnetite, hematite, clay minerals, silica, jarosite, flourapatite, and calcium sulphate. The percentage of each mineral is shown in the graph (Lakdawalla, 2017).



Name of the program : Composition minérale mars <https://c.gethopscotch.com/p/yrztrjj7o>

Game of water on Mars

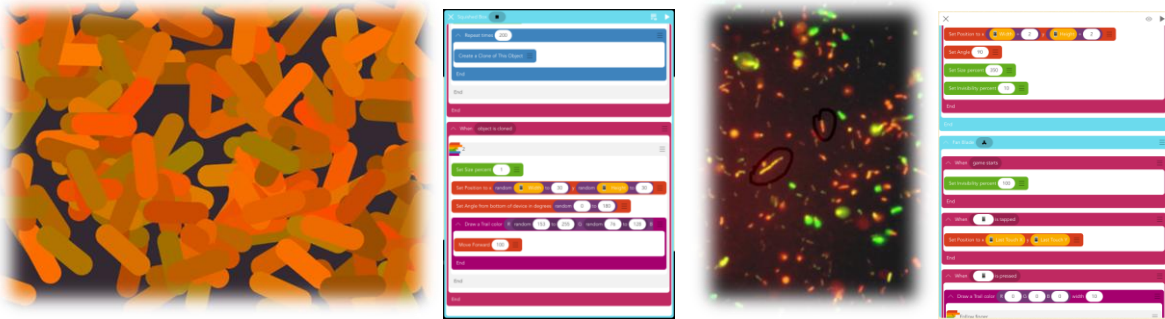
Spectrometers aboard Mars Odyssey were used to map the locations of water on Mars as a whole. The spectrometer checks the presence of hydrogen by measuring the change of neutrons from the soil surface. A positive hydrogen indicator, seen in blue, consists of the presence of solid water on the surface of Mars (NASA, 2003).



Name of the program : Eau sur mars <https://c.gethopscotch.com/p/yszqgpqex>

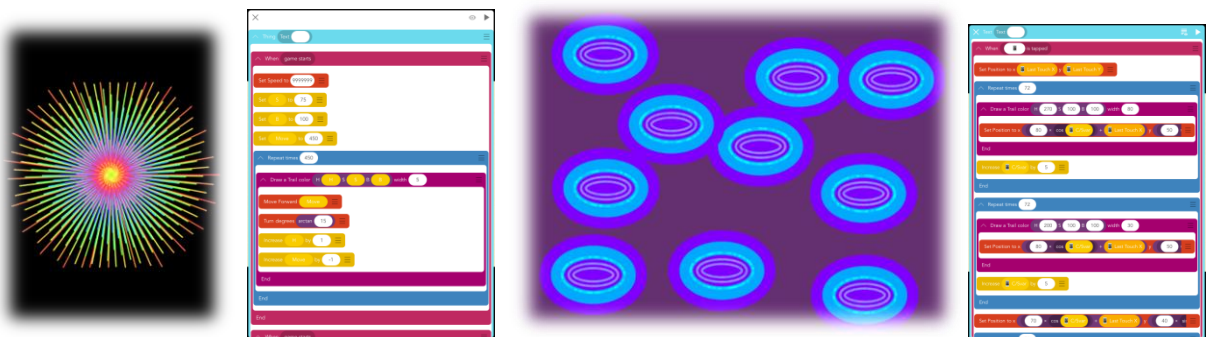
Life Games on Mars

Curiosity verified the presence of water on Mars. He analyzed the geological composition of numbers of locations on the surface of Mars. He continues his mission. The mission of the exploration of Mars is still continuing. Is there life on Mars? Will we be able to find life on Mars, fossil microbes or still alive in the rock? We compare life in extreme conditions on Earth to extrapolate and understand that life is possible on Mars. For example, scientists are looking for bacteria in ice caves from the intense cold of Antarctica. These bacteria on Earth offer clues to what life could be about Mars.



Name of the program : Vie sur mars <https://c.gethopscotch.com/p/yrzxa9myw>

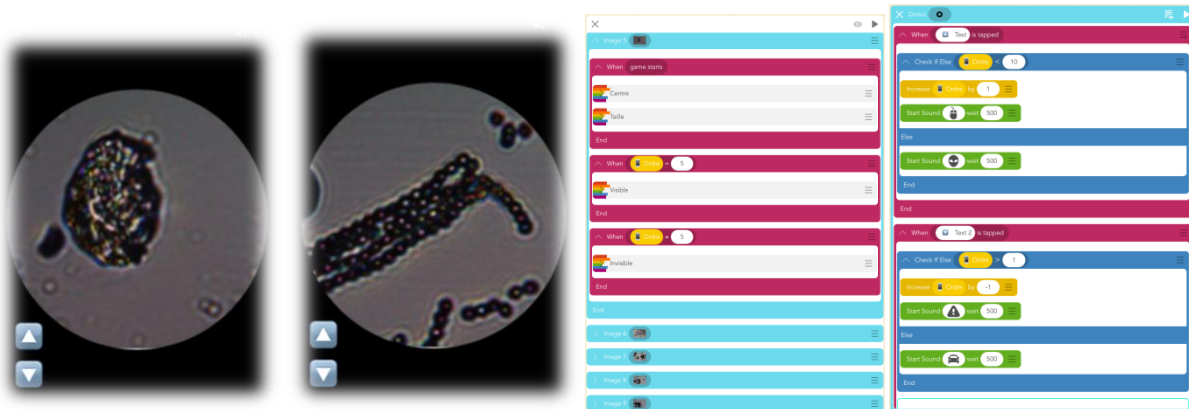
Name of the program : Bactérie extrêmophile <https://c.gethopscotch.com/p/yuf9f4ru2>



Name of the program : Bactérie extrêmophile <https://c.gethopscotch.com/p/yucry1u1r>

Name of the program : Bactéries extrêmophiles <https://c.gethopscotch.com/p/yuhk2dlx5>

We also know that life is possible in the depths of the oceans where there is no sun. Life is thriving thanks to the very hot cores of the Earth which gives a source of energy for life without sun.

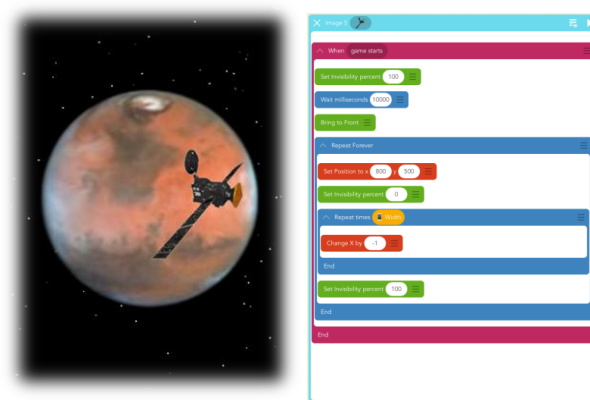


Name of the program : Télescope martien <https://c.gethopscotch.com/p/ytkxxdory>

It will not be until after the launch of the ExoMars mission in 2020 that we can dig up to 2 meters deep to see if there are bacteria or traces of bacteria in the Martian subsoil.

ExoMars Mission Game

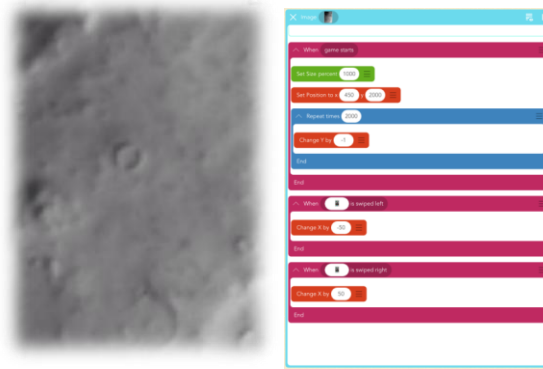
NASA is not alone in wanting to explore Mars. There are probes sent by several other countries, including the probe of the ExoMars European Space Agency. The aim of the ExoMars mission is to analyze the Martian atmosphere. We want to know the history of the Mars atmosphere. For example, methane was found on Mars. Where does this methane come from? Are they volcanoes? Is it life formerly or now on Mars? The ExoMars probe arrived in Mars orbit, but scientists are not yet ready to analyze the data.



Name of the program : ExoMars mission <https://c.gethopscotch.com/p/ys22vof6m>

Play CaSSIS

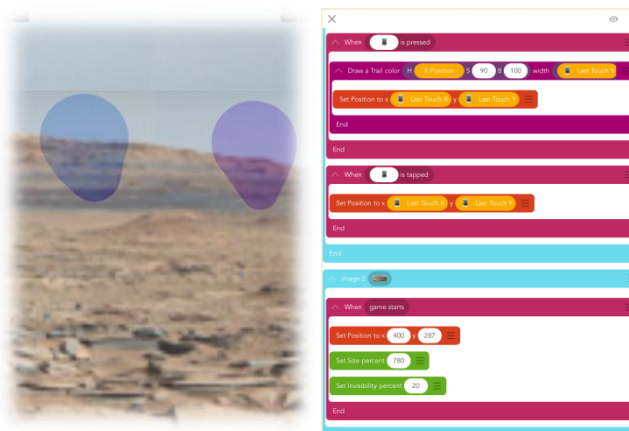
Instruments on board ExoMars must first be calibrated. Here we see an initial infrared image of the surface of Mars. Scientists use these images to detect the presence of different chemicals in the atmosphere of Mars. Methane is of particular interest to scientists. Methane is one of the chemicals present on Mars and is formed by microorganisms or by active volcanoes. Neither one has yet been detected on Mars. Where does this methane come from?



Name of the program : Mars avec CaSSIS <https://c.gethopscotch.com/p/ys2uswzfb>

Balloon game on Mars

Scientists are thinking of developing other instruments that could be used on Mars. Many instruments are very expensive. There are less expensive instruments like balloons that could be deployed to make analyzes of the planet with a much smaller budget than other similar instruments.

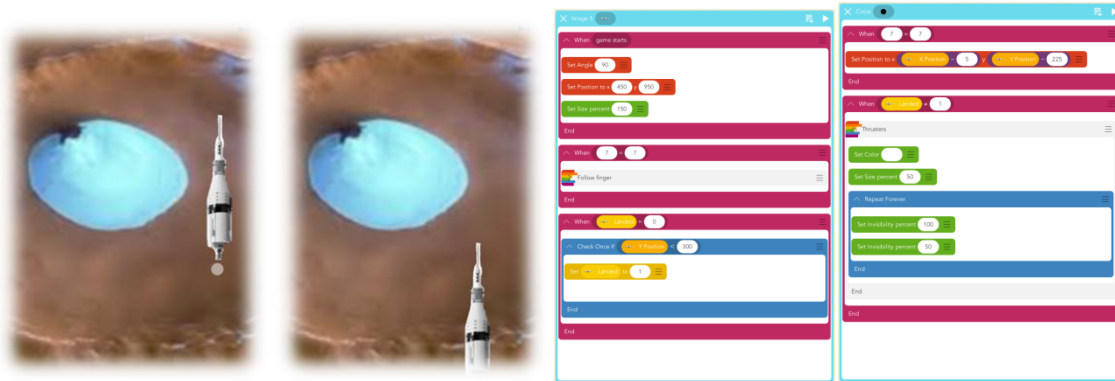


Name of the program: Ballons sur mars <https://c.gethopscotch.com/p/ysefb119g>

Game of the landing on Mars

NASA and private groups including Elon Musk's Space X, plan future and inhabited missions on Mars. The construction of a rocket and engines to bring a group of astronauts to Mars is still to be done. We saw missions going to Mars. We have never

seen a mission go to the surface of Mars and return to Earth. It will take many years of hard work to build all the technology to accomplish a mission of this kind. Private companies, including Space X, believe they can do so before NASA.



Name of the program : Mars astronaute atterrissage

<https://c.gethopscotch.com/p/ys9968xcz>

Game of Face Recognition

NASA astronauts have already walked on the moon. Mars is 140 times farther away. To go to Mars, the astronauts will face 520 days of isolation. They will also face cosmic radiation from the sun. They will have to cope with galactic radiation from particles ejected from supernovae. They will have to thwart microgravity. All these long-term challenges will put enormous psychological pressures on the astronauts. The biggest challenge will be psychological. The vitality of each of the astronauts is crucial to mission in space. If one of the astronauts cannot accomplish his mission, it could endanger the lives of other astronauts and cause the mission to fail. Face recognition software could help controllers reveal how the astronaut really feels. With the recognition of faces, one can identify the degree of concentration of the astronaut. Is it alert or asleep? Changes in the eyes also indicate what emotions they feel. This information makes it possible to adjust the conditions on board the shuttle in order to maximize the environment of the capsule in order to help the entire mission (Découverte, 2015).

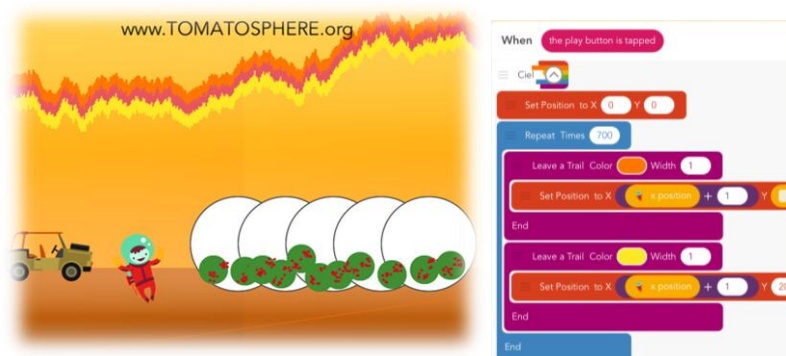


Name of the program : Reconnaissance des visages <https://c.gethopscotch.com/p/ysmo737lo>

Game of agriculture on Mars

Companies like Space X by Elon Musk are developing technology to send astronauts to other planets. March 1 of the Netherlands plans to send four astronauts towards Mars in 2031 in one go without return, in order to colonize it. Several astronauts volunteered including Australian and engineer Josh Richards (Al-Jazeera, 24.04.2017).

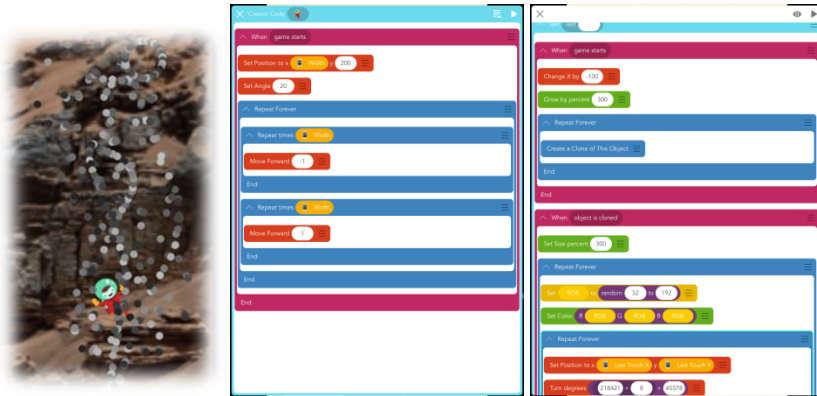
The Canadian Space Agency's tomatoes program uses tomato seeds from space to study the effects of the space environment on their germination. Students are taught the processes of scientific research. You can stimulate students' imagination while making connections with mathematics. Marc Garneau is the first astronaut who brought tomato seeds into space for school study.



Name of the program : Agriculture on Mars <https://c.gethopscotch.com/p/yav27w55z>

Game of march on Mars

It is the dream of many people to go to Mars to take a walk and take pictures.



Name of the program : Marcher sur mars <https://c.gethopscotch.com/p/ys2vdi1dz>

Game of the album of Mars

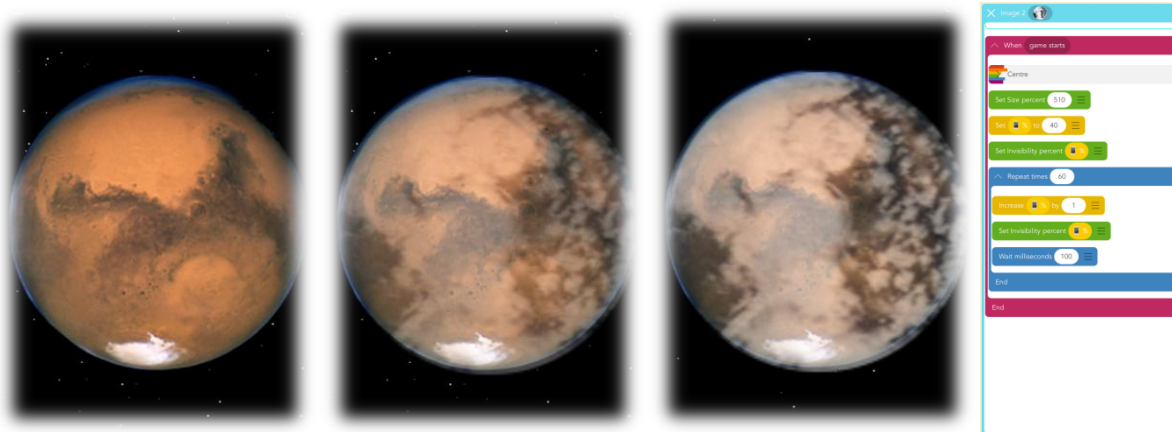
It is true that Mars is magnificent. In this photo album, we can see twelve different sites of the planet, obtained from various Martian missions.



Name of the program: Album Mars <https://c.gethopscotch.com/p/ysmkoo3xh>

Mars game with clouds

Some groups think of terraforming the planet Mars. Terraforming Mars will be much more difficult than science fiction suggests. Mars no longer has a global magnetic field as one finds on Earth, allowing to keep the atmosphere intact. Mars has only 1% Earth's atmosphere. Some scientists will still try.



Name of the program : Mars avec nuages <https://c.gethopscotch.com/p/ys4a7mrbb>

Connections to mathematics

Learning mathematics does not just consist of memorizing mathematical facts or multiplication tables. One must think of a high level in order to solve real life problems. Research indicates that many teachers believe that it is impossible to do mathematics using technology (Fievez, 2013). The Hopscotch application allows you to learn mathematics at a high level, while having fun.

The Hopscotch application gives all users the tools to learn how to code while using all the concepts of mathematics. Students can learn for themselves by listening to the videos on the app, or by consulting other programs available in the Hopscotch community. Hopscotch also provides an assessment of learning by suggesting other programs to learn, after a student completes and publishes a program.

The Ontario mathematics curriculum discusses the mathematical processes that students use to understand mathematics effectively. The use of Hopscotch makes it possible to use all these processes in order to have a good mathematical training.

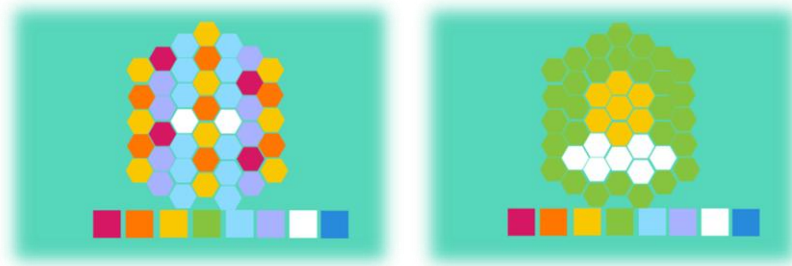
Problem solving helps to make connections between the world around it and mathematics. The student can understand how mathematics can be used to develop technology and get a job in the future. The student solves problems in all spheres of his life. With **communication**, the student studies, explores and illustrates ideas in mathematical language. Hopscotch allows to develop a mathematical language used every day by engineers, and programmers. Mathematical concepts are used in the context of technology. One can also use Hopscotch with another app, like ExplainEverything, in order to explain the mathematical concept and its reasoning.

Students **demonstrate their thinking** by sharing their experiences and strategies. Hopscotch allows you to share all programs with the Hopscotch community or social networks, if parents allow. Students can share their analyzes with other class students by speaking, and also by posting their explanations on the Internet with ExplainEverything for the world if permitted by parents. **Reasoning** gives meaning to mathematics. It is impossible to write an algorithm that works with Hopscotch without making its reasoning visible. Hopscotch adds the element of fun to reasoning. When we develop a program using our reasoning, we see objects that move, drawings that appear, games that are developed. The result is really very motivating for the students. By making connections, one sees the usefulness of mathematics in the study of other subjects. It is

possible to write programs and make links with all the subjects of the curriculum and the life of the child. Hopscotch is a technological tool to illustrate the mathematical concepts that students need. Hopscotch also allows to model, student understanding visually. Hopscotch also illustrates his mathematical understanding in each of the 5 domains of mathematics.

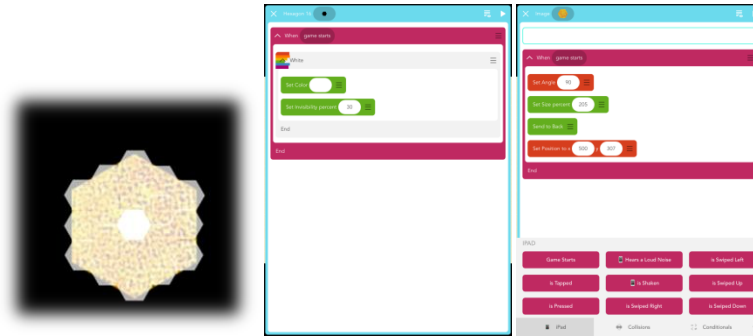
Visual element

In the book *Les maths par l'image*, Marian Small advocates the strategy of using visual elements to differentiate teaching and to understand mathematical concepts in depth. Students can start with visual elements already provided in the book and can continue to create and question their own visual elements. One can see for instance how, with a Hopscotch game, students can express their understanding of regularity. There are elements that form and repeat themselves, like the hexagons of alternating yellow and orange colors. It may also be noted that these hexagons resemble flowers or the structure of the honeycombs. The structure also resembles the mirror of the James Webb telescope that will be launched in 2018.



Name of the program : Patterns <https://c.gethopscotch.com/p/yvdedg9qe>

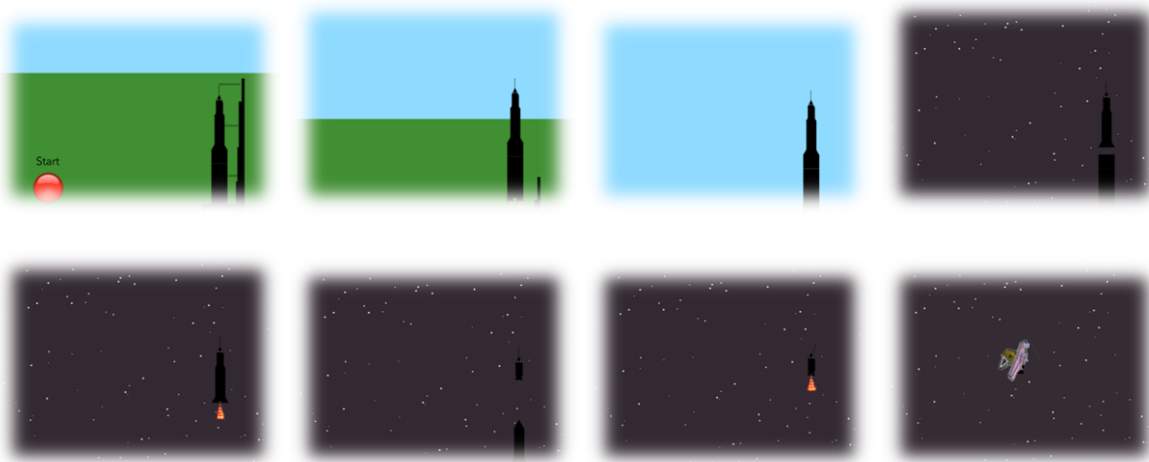
As a second step, instead of playing an already prepared game, the student can create a first Hopscotch program that integrates regularity elements and other mathematical notions including measurement, percentages, angles, and graphic coordinates. Making connections to the most recent science.



Name of the program : Miroir du télescope James Webb

<https://c.gethopscotch.com/p/yo0pmqrx>

Third, the student can study programs already written by the Hopscotch community and modify them while learning how they work. Here we see a remixed program where we can see the trajectory of the rocket that will take off from the Earth in order to take the James Webb telescope into space for its deployment. This makes it possible to make a connection with artificial intelligence.



Name of the program : Rocket Launch James Webb <https://c.gethopscotch.com/p/yvhvdmrso>

Indeed, we see here an example of autonomous learning of artificial intelligence. Autonomous learning combines the efforts of deep learning and reinforcement learning. It is no longer enough to understand one's environment. You also need to be able to apply control and choose a trajectory. When launching the rocket, it is no longer the controllers on Earth that drive the rocket, but artificial intelligence. The AI is used to

establish the trajectory of the rocket and to correct it if necessary in order to ensure the launching of the telescope.

Start the year by showing that you are concerned

At the beginning of the year, students can be asked what mathematical strategies they like and which does not help. The purpose of this exercise is to encourage positive experiences related to the school. Some schools do not have enough equipment for all students. This does not prevent the teaching of computational thinking. One can use paper, art, repetitive routines like planting seeds or simply images of the lines of codes in order to introduce computational thinking. An example of a positive experience can be seen. Can we deduce by reading these lines of code, what algorithm will draw a square, which will draw a circle or a hexagon? The angles, the number of repetitions are surely hints.

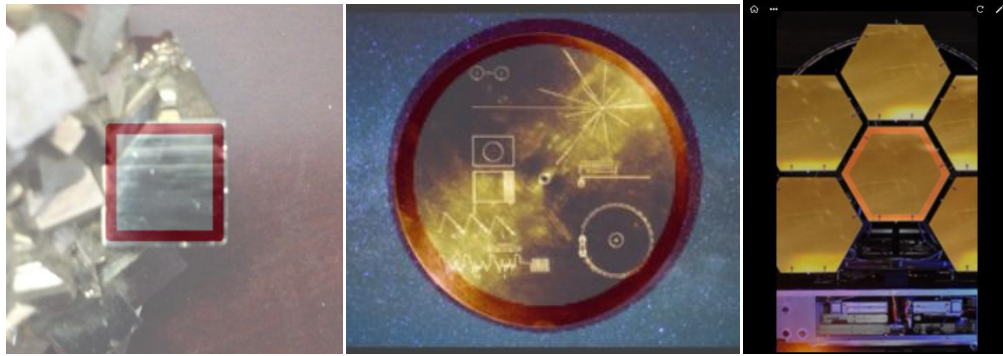


Nom du programme : Circle <https://c.gethopscotch.com/p/y96opn250>

Nom du programme : Square <https://c.gethopscotch.com/p/y96nf510u>

Nom du programme : Hexagone <https://c.gethopscotch.com/p/yvvvd7l6p>

Even if the school does not have enough equipment, some teachers allow students to bring their own equipment to the classroom. Those who have been fortunate enough to have teacher open to technology can share their positive experience by showing geometric shapes drawn with the Hopscotch code.



In my personal case, the school I went to had only one computer for the entire school. The mathematics teacher therefore established an after-school computer club where students could go and learn to code. This is how I personally made my debut by learning the connections between mathematics and computer science, after school, because it was fascinating.

Involving parents

Many students have a negative attitude towards math. Mathematics is often taught with worksheets, without making deep connections to the real world. Students do not have the means to develop their real potential. Moreover, popular culture shows that it is acceptable to hate mathematics.

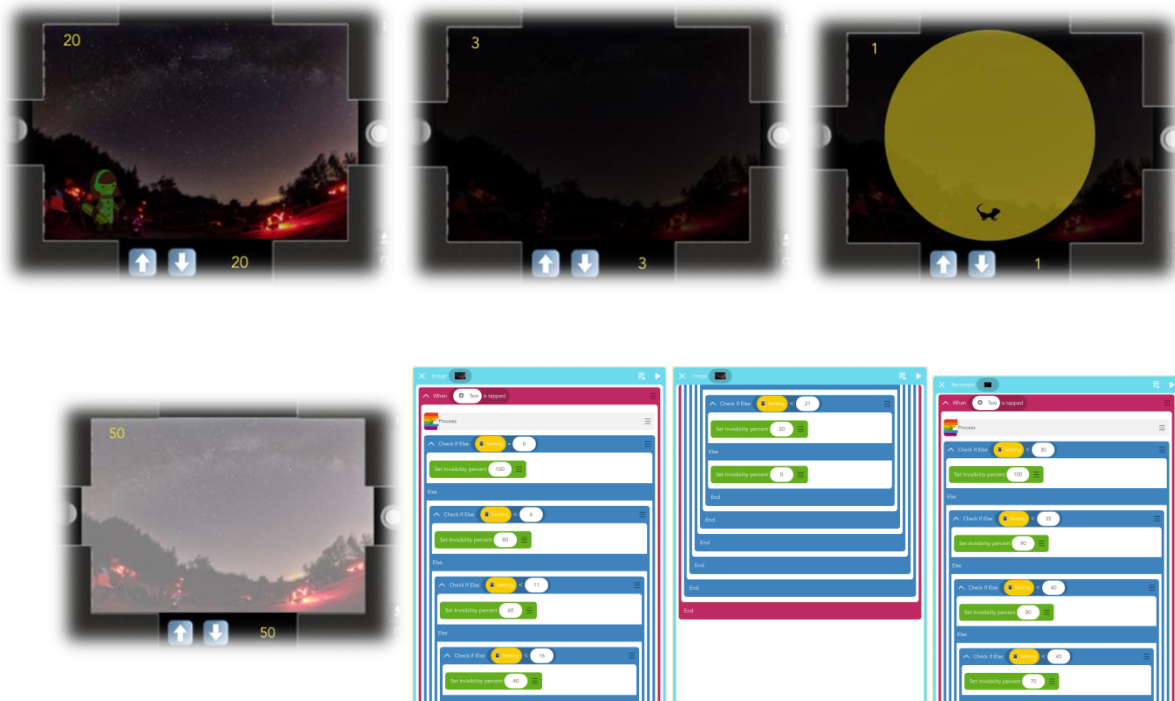
Under these conditions, teachers must redouble their efforts to develop a positive attitude toward math. In her book "Learning to love math", Judy Willis, suggests strategies based on brain research to improve students' attitudes toward mathematics. For example, parents can be involved.

Where can we get help? Since much of the child's brain development takes place at home, it is very important to involve parents and to link the mathematical success to the child's growth mindset. Mathematical success is not only demonstrated with good grades on the report card, but also with a positive attitude. It is very conceivable that a gifted student with a negative attitude develops his mathematical skills more slowly than a student with learning difficulties but with a positive attitude. It is also very conceivable that a student is very stressed because of the enormous pressure exerted by the parents to demonstrate by means of tests that his child is gifted. This stress affects

the development of the child. Establishing an environment in the classroom and at home where the student can develop a growth mindset becomes paramount.

For example, throughout the school year, the RASC organization organizes star observation sessions across Canada. At the Long Sault Conservation Center near Bowmanville, Jeff Booth shows objects from the night sky with his telescope, away from the light pollution of the Greater Toronto Area. Parents can easily get there with their children and see the Milky Way, the moon, the planets, and galaxies. One sees the use and images of a Schmidt-Cassegrains 8-inch telescope mounted with a camera. One can compare with the instruments of other RASC members who are present. There is plenty of mathematics involved in astronomy, without realizing that this is mathematics. Children and parents have fun while learning. These concepts can then be coded.

The camera allows you to take pictures of the Milky Way, with or without a telescope. In Long Sault, the sky is dark enough to see the Milky Way, which is not possible in the city. One must learn to use the camera. A lens with a wide angle is used to see the entire horizon. Jeff Booth graciously gave the photos used to write the Hopscotch programs of this section while the infrared photos were taken at Long Sault with my infrared camera.





Name of the program : Caméra long exposure <https://c.gethopscotch.com/p/yvdu2623v>

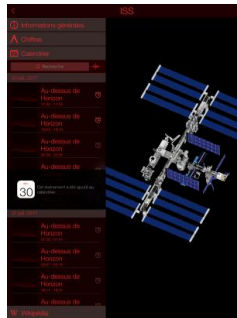
The *long exposure camera* program simulates aspects of the camera used to take pictures of the Milky Way. The quality of the picture depends on the shutter speed of the camera, the time the shutter of the camera remains open in order to take the picture. Experimenting is trial and error. A first attempt is made with an exposure time of one second or ten seconds and the Milky Way is visible but not very clear. We try again and someone passes by the camera. We're still trying and the headlights of a car spoil the picture. We try with an exposure time of 50 seconds and the photo is overexposed. With another test, with an exposure time of 20 seconds, an excellent result is obtained. In this program, all these scenarios have been programmed. For example, the concept of pattern is included to program the exposure time. With a photo with an exposure time of 0, 5, 10, 15, 20 and 25 seconds, the corresponding image used will be 100, 80, 60, 40, 20 and 0 per cent invisible, respectively. A white block placed on the photo is used to simulate the overexposed photo. If the overexposure time is less than 30 seconds, 30, 35, 40, 45, 50, 55, 60 or 65 seconds, the white block will be 100, 90, 80, 70, 60, or 20 per cent invisible. We see the relationship between the different patterns.

Parents are important so that the student can witness such mathematical experiences.

Mathematical Expressions

It is important to provide opportunities for students to be able to read mathematics effectively. In her book *Math Expressions*, Kathy Marks Krpan argues that reading in language is not the same as reading in mathematics. Mathematical texts are unique. Being able to understand mathematical text depends on students' basic knowledge and previous experience.

Research indicates that reading is influenced by the reader's prior knowledge and personal life experiences they bring to the text. In order to take a picture of the night sky, the student must be able to read the mathematical texts related to the night sky. You can use the STAR WALK application with an iPad to know the objects of the night sky. The application shows constellations, stars, galaxies and satellites. It is possible to know at what time the international space station will move to our position in order to easily take an infrared photo.

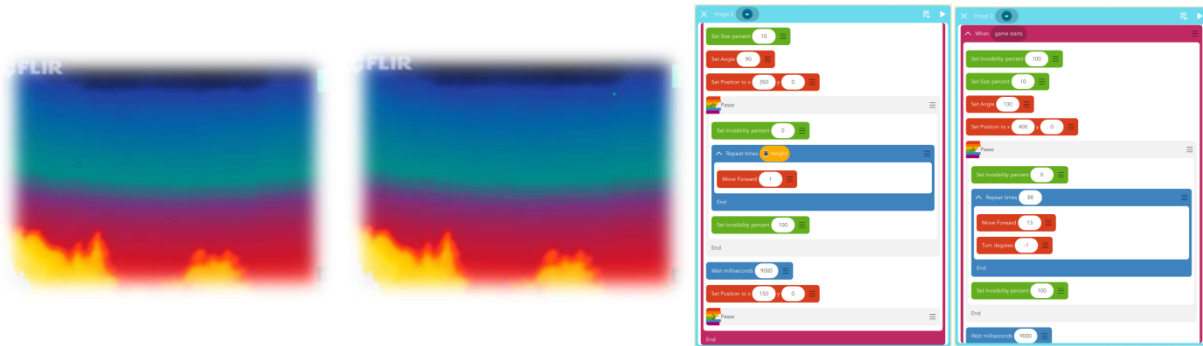


With STAR WALK, the student performs a mathematical reading. It analyzes and interprets a text in a mathematical context. He can paraphrase and explain to others what he has read and contribute to the mathematical discussion. During the first passage of the international space station, we were able to take an infrared photo of the station. We had to wait 90 minutes to see it again in the sky, in its second orbit around the Earth. The second infrared photo was not as good as the first because the trajectory of the station was different and further. In these photographic trials, the student uses an appropriate mathematical vocabulary and offers useful impressions to others. They can also ask questions about what has been read and observed. Once the reading is completed and the photo taken, students are able to describe a model representing mathematical ideas using Hopscotch.

STAR WALK also sends messages such as: "The International Space Station will appear in 5 minutes." The student must analyze and interpret the information in order to properly apply it and take a picture at the appropriate time. The student makes a connection between the mathematical text and his / her personal life. He must take a picture at the right time and in the right place. They use a variety of strategies to decode and understand the mathematics they read.

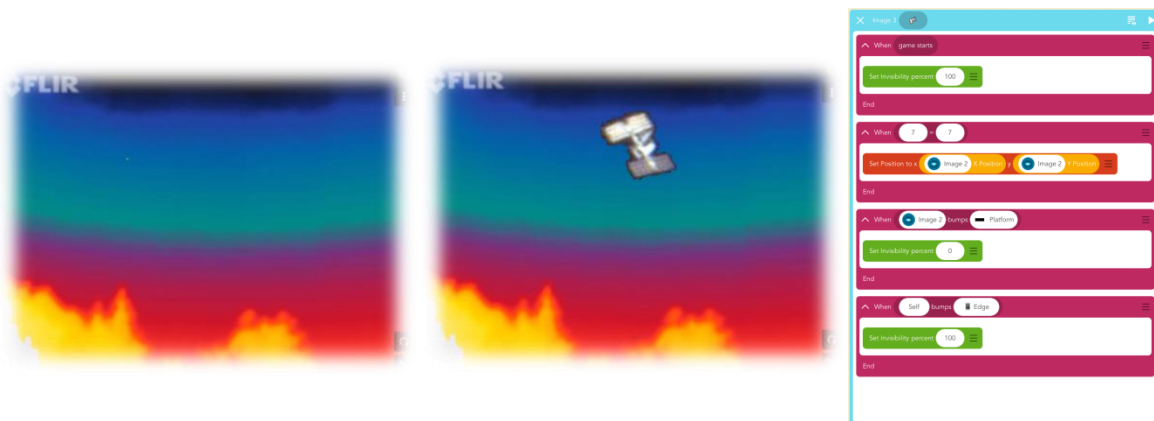
Kathy Marks Krpan also provides the success criteria needed to assess whether our students succeed in writing mathematics. One may think that mathematics consists of

writing mathematical facts, but much more can be done with writing to explore students' mathematical ideas. Writing in mathematics is a wonderful assessment tool. The writing consists in this case of modeling the trajectory of the International Space Station as observed and taken in photo in the sky.



Name of the program : ISS International Space Station <https://c.gethopscotch.com/p/yvcqm60ie>
 Name of the program : ISS International Space Station 2^e algorithm <https://c.gethopscotch.com/p/yve2nkmcj>

With Hopscotch, the mathematical text used to communicate ideas is very clear and makes it possible to use technology in a real situation. The mathematical vocabulary is appropriate to the technological context of the Space Station. We try with a first example where the Space Station travels in a straight line in the sky. Remembering the images of the two flights of the International Space Station, the student revises his program and offers a more curved orbit from the station. The Space Station does not move to the same location each time. The angle of approach is different each time as well as the distance of the observer. There is a mathematical justification for revising the program's writing, based on real-world connections.



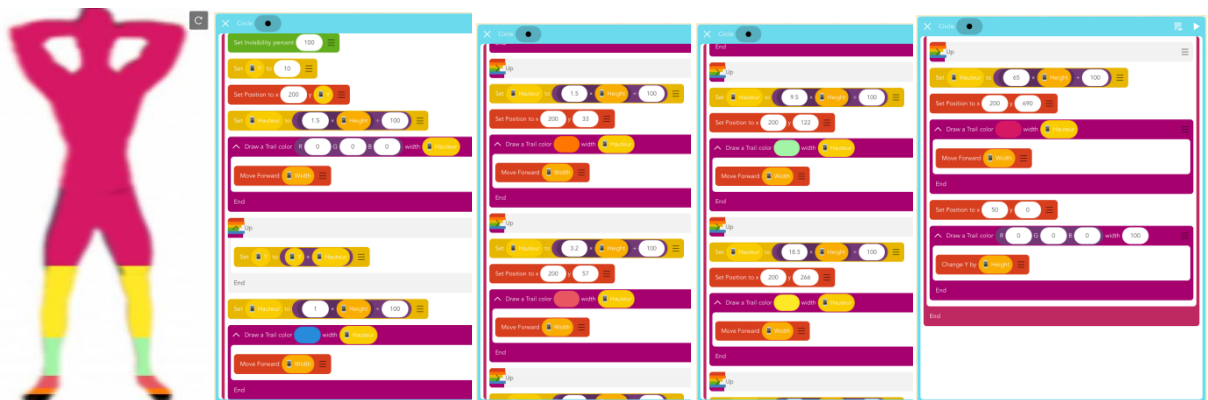
Name of the program : ISS Choisir nos actions IA AI <https://c.gethopscotch.com/p/yvgomg0j1>

It is possible to add connections in Artificial Intelligence. In this program, we see reinforcement learning. With learning by reinforcement, one learns by trial and error in real time. We are able to choose our actions and apply actions on their environment and observe the effects of these actions. This allows you to choose the best actions. Here an object is detected in space. Is this a friendly plane? Is this a drone? Is it the International Space Station? As the station passes, the sensors detect the Space Station and the AI decides to observe it and take a closer look at it, because it is interesting.

Proportional reasoning

What is proportional reasoning? But you will say, the program does all the calculations for the student. They do not learn anything! Although it is true that the computer can calculate all additions and multiplications, the student must understand the proportional reasoning to write many Hopscotch programs. Proportional reasoning is used when multiplicative comparisons are recognized and formed between each of the quantities (Small, 2015). This is the logic behind the fractions. How do you know that $\frac{1}{2}$ is the same as $\frac{25}{50}$?

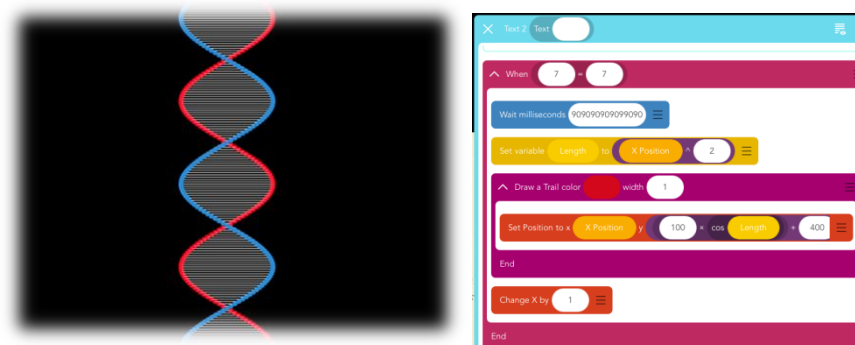
At the beginning of the Big Bang, the universe had no content. The material formed during the expansion of the universe, during the formation and explosion of stars. The solar system was formed and life developed. The dust of stars was found in our bodies with proportions that allow intelligent life. The choice of the example allows a rich and deep reflection about proportions, raising other questions.



Name of the program : Éléments du corps humain <https://c.gethopscotch.com/p/yvw1gnne9>

We see here, visually, the proportion of chemical elements in the human body. In pink, we see that the body contains 65% oxygen. In yellow, the body contains 18.5% carbon. In light green, 9.5% of hydrogen is found. In salmon-colored, 1.5% nitrogen is seen. In orange, one finds 1.5% of calcium. In blue, there is 1% phosphorus and in black, it is the rest of the elements. The proportion was calculated in a vertical fraction of the body height, using a variable. The width of the line drawn is the percentage of the element multiplied by the height of the body that was placed to have the same height as the iPad divided by 100. This proportional relationship is the same for each percentage. Once you draw a percentage line, you draw another line a little higher than the previous one. This makes it possible to see visually the proportions of the elements in the human body.

Each of the elements of the human body had to be present to form the DNA that forms the basis of life.



Name of the program : ADN <https://c.gethopscotch.com/p/yvw2gjxab>

Calculations of the proportional dimension of each DNA ray between the bases A, T, C and G are at the secondary level, using the exponents and the cosine to calculate. Many people are afraid to hear the words mathematics and chemicals. I think they are quite fascinating.

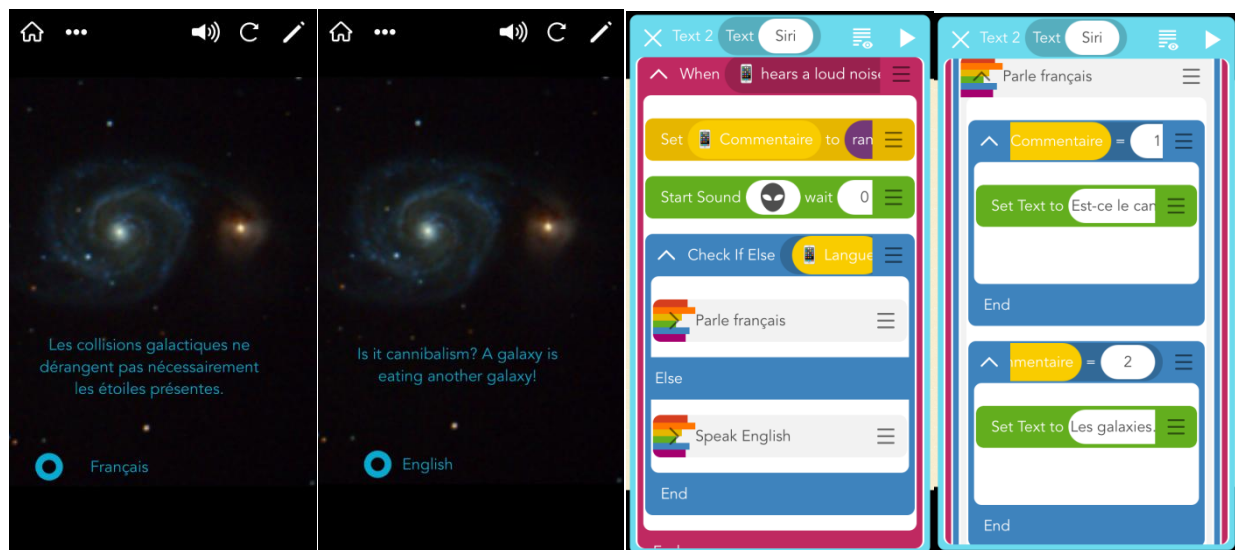
Challenging gifted students in mathematics

Fiévez (2017) states that teachers often have good mastery of technology, but often find it difficult to apply their knowledge to teaching. They are sometimes reluctant to innovate. I would like to encourage these teachers by saying that Hopscotch offers a broad support to the student and the teacher. There is an excellent number of model programs of all levels, videos teaching programming and even an assessment as a learning tool to improve our programs and give ideas for new applications. Gifted students in mathematics can write programs even beyond the teacher's understanding, because the Hopscotch application provides the necessary support. We see here a specific situation where collaboration with Hopscotch forces us to change the way students learn in the classroom. With technology, the teacher transforms his practice. He stops being a transmitter of knowledge and becomes a facilitator of learning.

In the book *Algorithms for Living*, the authors talk to the people who created the best algorithms in the last 50 years. They indicate that the word algorithm invokes ideas of large amounts of data manipulation, large technology companies, or code behind the construction of government infrastructure. Algorithm has a much greater meaning. The algorithms were used well before computers arrived. An algorithm is just a "finite sequence of steps used to solve a problem" (Christian, Griffith, 2016.) For example, if you know the steps to solve a long division, you know the algorithm to solve a long division. If you know how to cook bread using a recipe, you follow an algorithm. The algorithms have been used since the Stone Age to make fire using softwood, two sticks and a string. The word "algorithm" comes from the Persian mathematician Al-Khwarizmi, who wrote a book called al-Jabr, from which the word is derived. The history of science tells us that the Muslim culture of the Middle Ages was one of innovation. They invented several products that we still use today (Al-Jazeera).

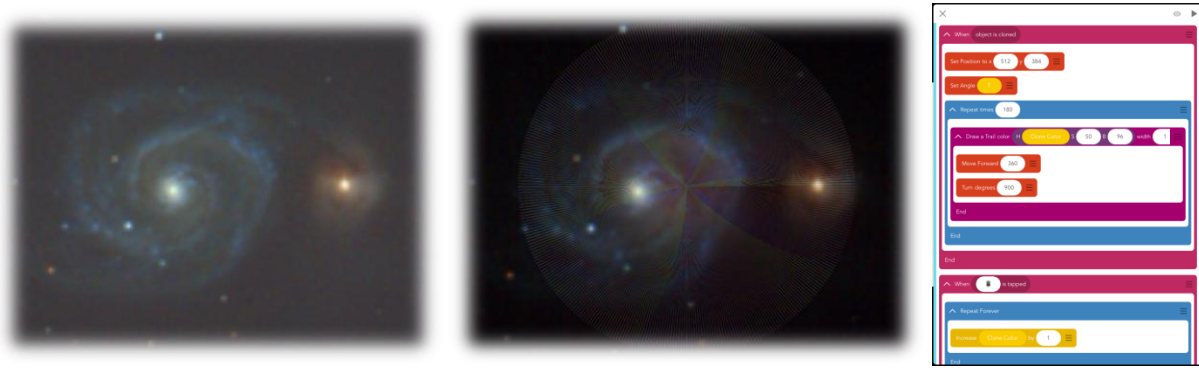
Christian and Griffiths discuss algorithms such as optimal stop, sorting, planning, relaxation, networking and game theory. The best algorithms help solve our most demanding problems. We use these algorithms on a daily basis. For example, we use an algorithm to sort our important documents. Some people could buy files and folders to organize important documents, while others use full documentation online. The algorithms used to program artificial intelligences need to think are highly

mathematical. Various algorithms have varying degrees of effectiveness. The best mathematical minds write the best algorithms.



Name of the program : Collision de galaxies <https://c.gethopscotch.com/p/yvfunnsdi>

This algorithm was written with an iPhone. To be even more innovative, we represent our results in the form of artificial intelligence with Hopscotch. Hopscotch allows to recognize speech. Instead of saying **OK Google**, so that the phone answers us, we will say **OK Hopscotch** and our Hopscotch program recognizes the sound of our voice and will respond, here in the form of explanatory text programmed by the student. We see in the image a galaxy that "eats" another galaxy. The AI makes comments in English or French, responding to the sound of the user's way. One can learn by reading the following comments. (1) Is it cannibalism? A galaxy eats another galaxy! (2) Galaxies frequently collide. (3) The Milky Way has already collided in the past with blobs called dwarf galaxies. (4) About ten percent of all major galaxies collided with another large galaxy. (5) Both galaxies can merge into a galaxy or cross each other like the tide. (6) The collision of galaxies gives new galaxies of spectacular shapes. (7) Galactic collisions do not necessarily disturb the stars. (8) The interaction between galaxies causes the creation of a multitude of new stars. (9) In 5 billion years, the Milky Way will collide with our neighboring galaxy, the Andromeda galaxy, which is currently two million light-years away. (10) When our sun is near death, thousands of young stars will be born thanks to the collision of the Milky Way with Andromeda.



Name of the program : IA fusion de galaxies AI

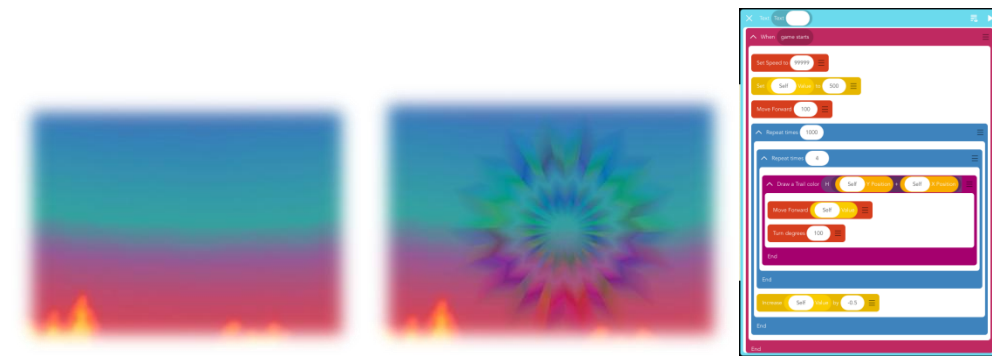
<https://c.gethopscoth.com/p/yvgftnk2g>

With deep learning, artificial intelligence will predict what will happen in the future. In the image on the left, we see the two galaxies as they are today. In the image on the right, artificial intelligence predicts how the galaxy will be in thousands of years. We see the arms of the new combined spiral galaxy of the two ancient galaxies.



Name of the program : IA galaxie AI <https://c.gethopscotch.com/p/yvg4pe0c2>

Artificial intelligence will be found in all fields, including the space domain. The AI will be able to recognize space objects, including galaxies, in order to classify them. To do this, AI must learn to see and interpret images. This is supervised learning. Supervised learning is like showing a child a picture book. We show an image and we say it is a galaxy. We show another image, is it a galaxy or not? After a few images, the AI realizes what a galaxy is. To be really useful, the AI must be able to recognize that what she sees is really a galaxy, and its characteristics.



Name of the program : Supernova visible le jour <https://c.gethopscotch.com/p/yvgky9yrb>

Artificial intelligences have a very specialized intelligence, like calculators that make very elaborate calculations, very quickly, but have no general intelligence. Artificial intelligence is not yet able to do unsupervised learning, as we humans do. With predictive learning, we learn to predict the future, as how the blocks will fall. One has to invent, for example, the rest of the image to predict things that are reasonable. We see here an impression of what would happen when a star of our galaxy explodes and becomes supernova. The intensity of the light would be such that it would be visible even on the day without any instrument. We see here a prediction of the vision of the supernova in infrared.

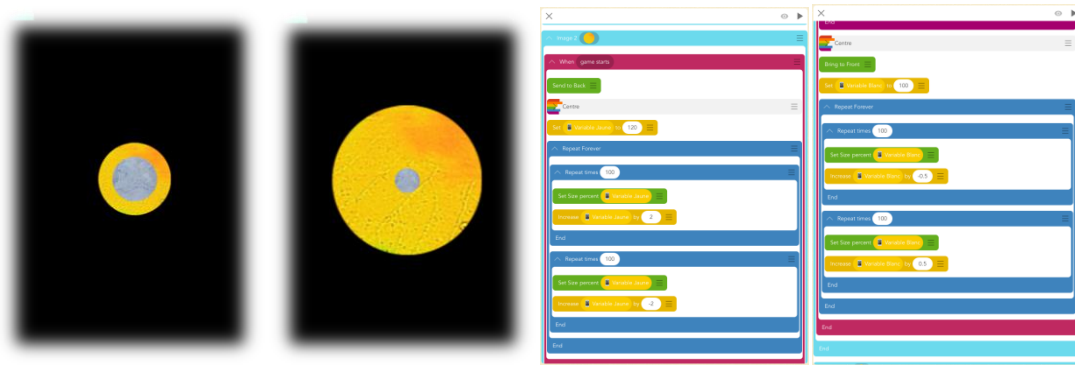
Exploring deep space

In addition to observing the cosmos using terrestrial telescopes and space telescopes, scientists and astrophysicists spend a lot of time on the computer to develop simulations of the cosmos and their observations. The programming languages used by astrophysicists are varied and very elaborate (Czekala, 2017). For the classroom, at primary and secondary level, Hopscotch is a language of choice for the astrophysicist apprentice.

The astrophysicist Natarajan (2016) indicates that the simulations have become substitutes for scientific experiments in astrophysics. The images of the simulation are developed in parallel with the astronomical observations. Simulations are crucial in the development of new knowledge and the verification of new ideas. Astrophysical knowledge is now so complex that simulation has transformed its role as documentation of our current knowledge into a method for creating new knowledge. Astrophysical simulation is no longer a limited tool to test ideas. Astrophysical simulation pushes scientists' questions to new frontiers.

Simulation of Cepheid

In 1912 Henrietta Swann Leavitt of the Harvard Observatory was doing a crucial job in developing our current knowledge of the cosmos. She calculated with her team the position and brightness of the stars. In order to make comparisons, we needed stars of references. Leavitt found these stars of references, the Cepheid variable stars. By analyzing the photos of the cosmos, if the negative and positive images of a photo did not correspond exactly, Leavitt identified this star as a variable. The intensity of their brightness varied at a steady rate. These Cepheids allowed him to measure the distance from the star to the Earth. None of these Cepheids were in the Milky Way. His computational techniques have become a standard cosmic measure (Natarajan, 2016).



Name of the program : Cepheid <https://c.gethopscotch.com/p/youp9aor2>

Star simulations

The stars began to form about 100 million years after the Big Bang. Scientists use their temperature and brightness to classify them. Stars can easily be classified, but it should be remembered that this classification is only temporary. It reflects the life of the star in its life cycle.



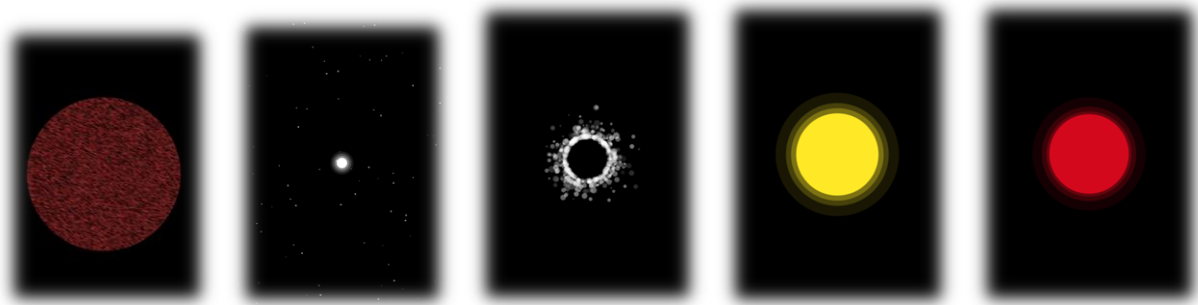
Name of the program : Proto-étoile <https://c.gethopscotch.com/p/ytho24qy5>

Name of the program : premières étoiles <https://c.gethopscotch.com/p/ytkm7accq>

The proto-star is a mass of hydrogen and helium and is an early stage of the formation of a star. For a proto-star to begin to start nuclear reactions and become a star, its mass must be at least 0.08 the mass of our sun.

The brown dwarf is considered a missed star. It is too small to be a star and start nuclear reactions, lacking material. It is also too big to be a planet. They are too cold to be detected with visible light telescopes. Warmer than the rest of the cosmos, since 1994, they can be spotted with infrared telescopes.

The red dwarfs have a surface temperature between 2,500K and 5,000K, which gives them their red color and have a mass smaller than that of the sun, ie 0.08 to 0.8 the mass of the sun. About 80% of the stars in our galaxy are red dwarfs. Yellow dwarfs are medium-sized stars, like our sun. Their surface temperature is about 6,000K. White dwarfs are stars like our sun, but at the end of life. They are dead stars that no longer have nuclear reactions because they have exhausted their fuel. The star Sirius, the brightest star in the night sky, is a white dwarf. After the star dies, it cools slowly to become a black dwarf.



Name of the program : Naine brune <https://c.gethopscotch.com/p/yl0gs3sru>

Name of the program : Naine Blanche <https://c.gethopscotch.com/p/ythu4veoj>

Name of the program : Naine Noire <https://c.gethopscotch.com/p/ytnehtgt5>

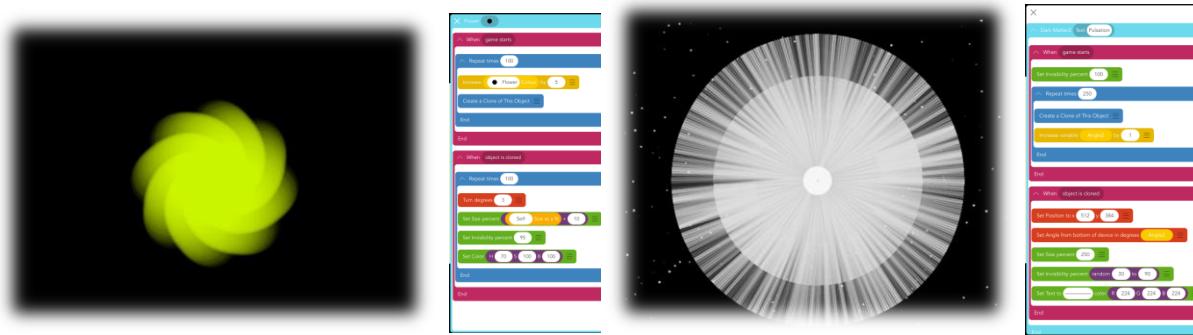
Name of the program : Etoile <https://c.gethopscotch.com/p/ytnd6hf3v>

Name of the program : Géante rouge <https://c.gethopscotch.com/p/ytndct88g>

The giant stars have masses greater than that of the sun. The red giant is a big star at the end of its existence, when it has exhausted its hydrogen fuel. At this point, she began to make nuclear reactions using helium fusion. The red giant closest to the sun is Betelgeuse. The life of the red giants ends in supernova. There are also blue giants that are very warm, massive and shiny. Their lifespan is very short and their life ends in supernova.

Supernova simulations

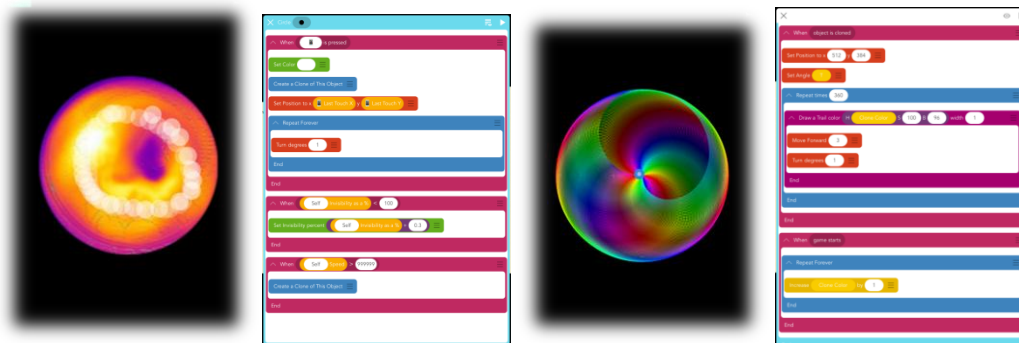
The massive stars, of a mass of at least 8 times that of the sun, end their life exploding in supernova. During the explosion, the star becomes very bright, as bright as a galaxy. Once the explosion is complete, only a supernova residue is visible.



Name of the program : Supernova <https://c.gethopscotch.com/p/ytkmbolys>

Name of the program : Supernova <https://c.gethopscotch.com/p/ytneqir44>

The supernova 1987A was the first supernova observed with the naked eye in the 20th century. It came from the explosion of a blue supergiant with 20 times the mass of the sun. Its brightness, when the explosion was 100 million times that of the sun. This explosion made it possible to study directly the evolution of the stars. We see here what remains of the explosion of the supernova 1987A (Luminet, Reeves, 2016).



Name of the program : Supernova 1987A <https://c.gethopscotch.com/p/ylu8d64gsb>

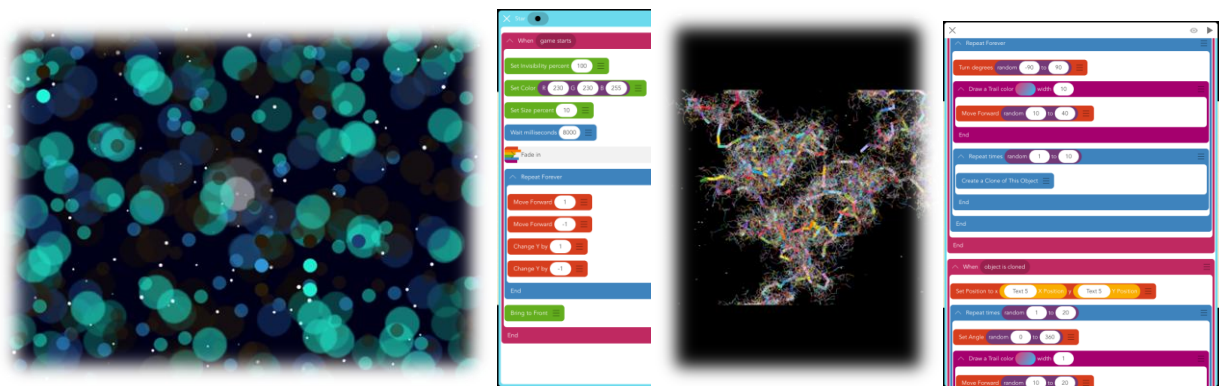
Name of the program : Étoile à neutron <https://c.gethopscotch.com/p/ythn5w5sk>

Remains of supernova continue to shine in the infrared while pulsing in the radio waves. These supernova remnants have become candles of the cosmos to calculate the cosmic distances between the galaxy in which it exploded to the very end of the universe. They have thus replaced the Cepheids to measure the distances in the universe. The selected supernovae all have the same power. Those with lower luminosity are farther away and those brighter are closer to us. Only their luminosity makes it possible to estimate the distances in the cosmos.

Stellar residues are also called supernova explosions, neutron stars. Neutron stars have a mass greater than that of the sun and are the size of a city. They run at a speed of 716 times per second and send rays of energy. Their gravity is 100 billion times stronger than the gravity of the Earth. One can see the magnetic fields during their movement. Only a few places emit light, which explains the regular signal received on Earth. When the energy-emitting region faces the Earth, we receive light, otherwise we receive nothing. There are many pulsars in our galaxy, but they are not all oriented so that we can receive the pulses well. Pulsars were used to indirectly detect gravitational waves.

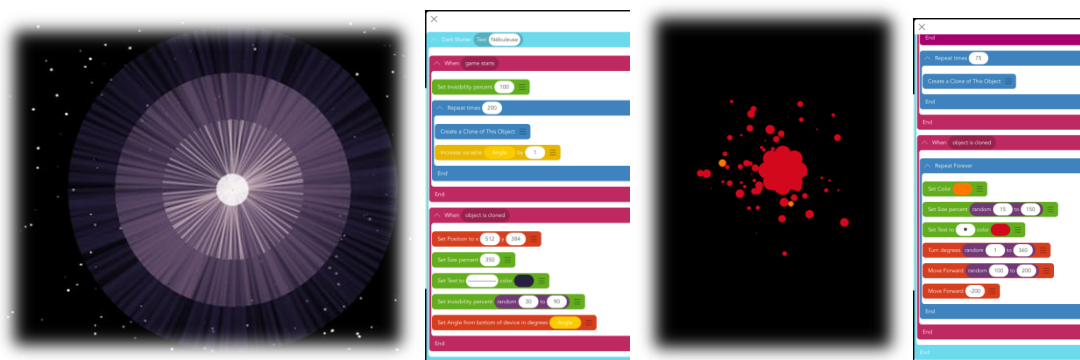
Simulations of nebulae

The name nebula or planetary nebula is used in astronomy, but it is a historical error. The scientists decided to keep the name. They are not planets, but dying stars dissipated in space. The old telescopes saw something fuzzy and circular, so nebulous.



Name of the program : Nébuleuse <https://c.gethopscoth.com/p/ytg52zowi>

Nom de programme : Nébuleuse <https://c.gethopscoth.com/p/ytg8bum29>



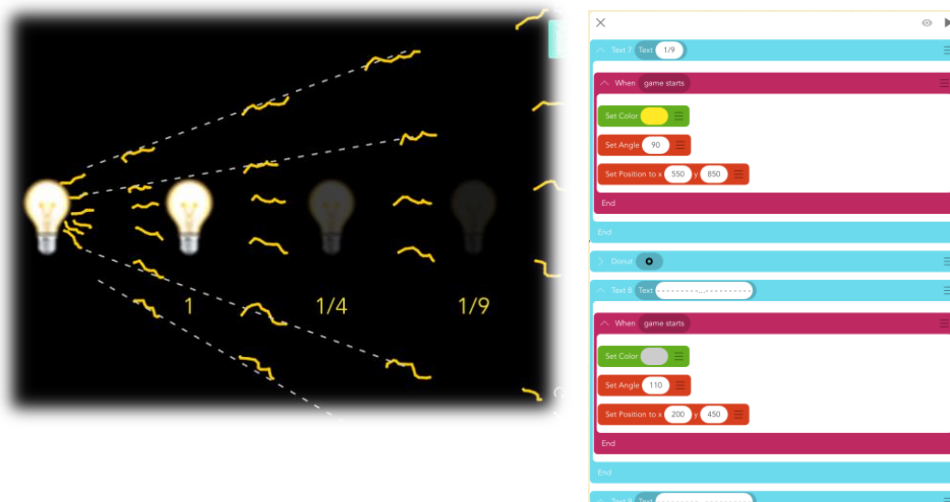
Name of the program : Pulsation dans la nébuleuse <https://c.gethopscoth.com/p/ythrq3ilm>

Name of the program : Nébuleuse planétaire <https://c.gethopscoth.com/p/ytndmkdny>

The lack of resolution of these images did not allow scientists to analyze these objects in detail.

Simulation of Hubble's Law

Edwin Hubble uses the Cepheids to develop his new radical theory of the universe. By doubling the distance, the brightness of a star decreases by a quarter of its value. It is the law of the inverse of the square. There are situations where stars were less brilliant because of the dust in front of them. The Cepheids were necessary because of their reliability. By measuring their greatest luminosity, one could measure its distance with the law of the inverse of the square (Gilliland, 2015).



Name of the program : Hubble <https://c.gethopscotch.com/p/yncvqx0gg>

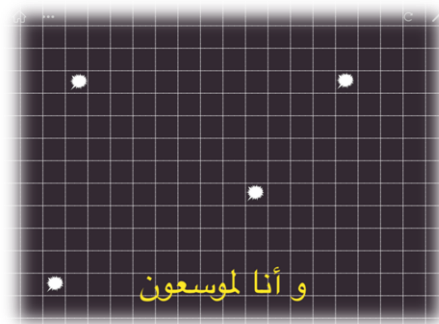
Simulation of the models of the universe

By the 1930s, there were two models of the universe: the model of the stable-state universe and the model of the expanding universe.

In her book 'Mapping the Heavens', astrophysicist Dr Natarajan of Yale University traces the development of radical scientific ideas that have changed our conception of the universe. Scientific theories should be adopted according to the evidences observed, but sometimes this is not the case. There are other factors involved, such as emotions and other personal beliefs. Reactions to these radical new ideas can cause a revision of our deepest beliefs. Towards the 1930s, even though Einstein and Eddington supported the theory of the expansion of the universe, Hubble, who had discovered the law with his research despite all the scientific evidence, remained septic and did not believe in the Expansion of the universe. You see, the stable model theory of the universe represented the atheist vision and the theory of the expanding universe represented the theistic view. In 1952, Pope Pius XII the idea of the Big Bang because it supports the idea of a Creator of the universe. The model of expansion of the universe also supports scientific observations.

Simulations of the expansion of the universe

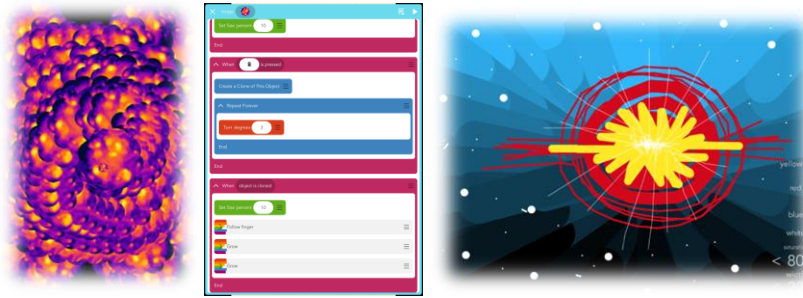
Many Muslims identify Western tradition as "foreign" to their own Islamic tradition (Ramadan, 2009). By discussing questions from all sides, we could allow a Muslim to criticize and integrate "Western knowledge" and his own Islamic knowledge, instead of assimilating "Western knowledge", denying his own knowledge and experience Islamic. This is what Tariq Ramadan calls radical reform. Here is an example where it should not be scary for the Muslim to make a radical reform. The concept of expansion of the Universe is found in the Qur'an (51:47) which was written more than 1400 years ago. How do they compare to the expansion of the universe as calculated by NASA? What is the accuracy of this information? As is the case with most deep and valuable discussions, there will be red and yellow lights on both sides of the question, but this will be the beginning of a very fruitful and interesting discussion.



Name of the program : [لَمُوسِعُونَ أَنَا وَ : https://c.gethopscotch.com/p/y1ya3dsu2](https://c.gethopscotch.com/p/y1ya3dsu2)

Big Bang Simulations

The expansion of the Universe means at its very beginnings of space and time, the universe was only a very small singularity. Observations with the Hubble Space Telescope have determined that this singularity began with a violent expansion, 13.8 billion years ago.

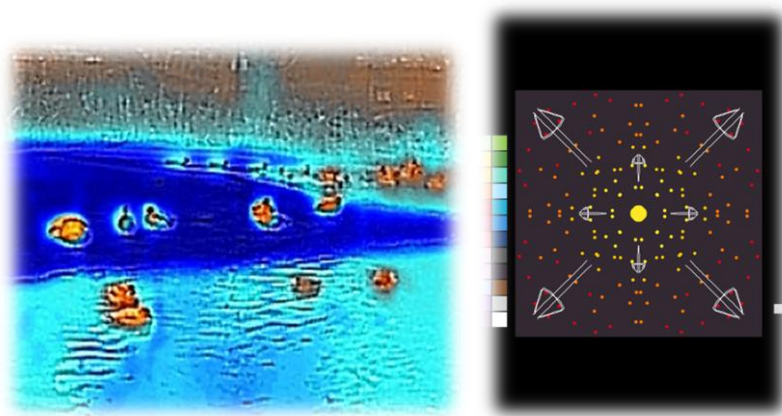


Name of the program : Big Bang <https://c.gethopscotch.com/p/yg4mkq1fl>

Name of the program : Le Big Bang! <https://c.gethopscotch.com/p/yfjnxusux>

Simulation of the Doppler effect

Understanding the Doppler effect is important for understanding the movement of stars and galaxies. It's a bit like when you hear the sirens of emergency vehicles. The sound of the siren as the vehicle approaches and moves away is dramatically different. Also, when you see a duck moving in the water, the waves the duck makes in the water are longer behind him than in front of him. You can see these waves of water here, in infrared. One may think that the universe is like a piece of cloth. When the fabric curls, everything around is going to be bent too. The curved space, curves everything. This is called the gravitational lens. It produces undulations like the duck. This vision gives us a new window of the universe. Scientists are looking for the longest undulations, of the order of 10^{-19} . Sensors must be very sensitive.



Name of the program : Drawing <https://c.gethopscotch.com/p/xo85h9n5e>

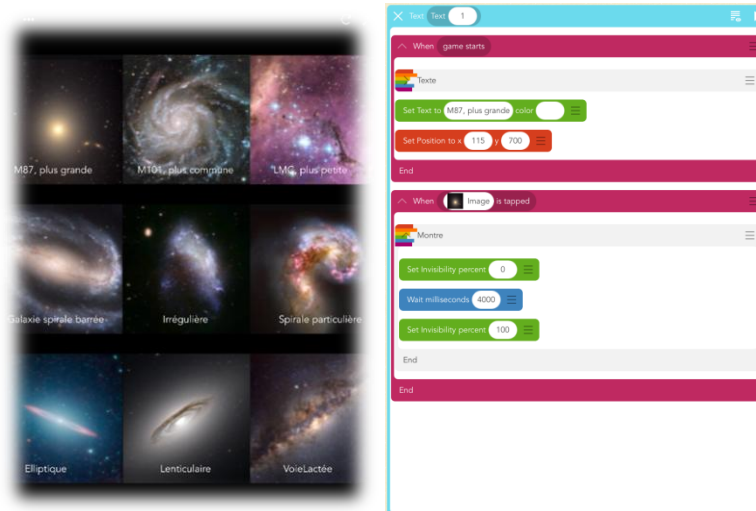
The galaxies that emit light move through the expansion of the universe. The light one receives has a smaller temporal separation than when it was emitted by the galaxy.

There is a shortening of the wavelength of the light. This produces a shift of the wavelength to blue (blueshift). In contrast, when the light of the galaxies moves away from us, light is emitted from a greater and greater distance. A wavelength of the stretching light is observed. There is a wavelength shift to redshift (Gott, 2017).

Space telescopes must be equipped with infrared cameras to make their observations of the deep universe. At the very beginning of the universe, light has changed its wavelength so much that it is only visible in infrared. The near infrared wavelength varies between 0.8 and 8.0 micrometer (or micron). It varies between 8.0 and 30 microns in the middle infrared and between 30 and 300 microns in far infrared.

Simulation of the Sloan Digital Survey

Here are some images of the Spatial Hubble telescope, our most powerful telescope. One can see, for example, in the Sloan Digital Sky Survey, a catalog of galaxies that can be seen from our course at the back of our house. One sees for example M87, the largest galaxy, M101, the most common and LMC, 1000 times smaller.



Name of the program : Sloan Digital Sky Survey

<https://c.gethopscotch.com/p/yhpddgnmf>

Simulations of galaxies

Our Milky Way is only a galaxy among an infinity of other galaxies in the universe. Hubble, by observing the cosmos, classified the galaxies according to their form. He measured their distances, their spectra and their speeds. He also noticed that the further away the galaxy was, the faster it moved away. Hubble was one of the most important astronomers of the twentieth century.

Spiral galaxies are the best known. 60% of the galaxies in our local universe are spiral galaxies. They are recognized by the winding of their arms in a spiral. Galaxies give rise to many stars and are often accompanied by black holes.



Name of the program : Galaxie spirale <https://c.gethopscotch.com/p/ythtbey9r>

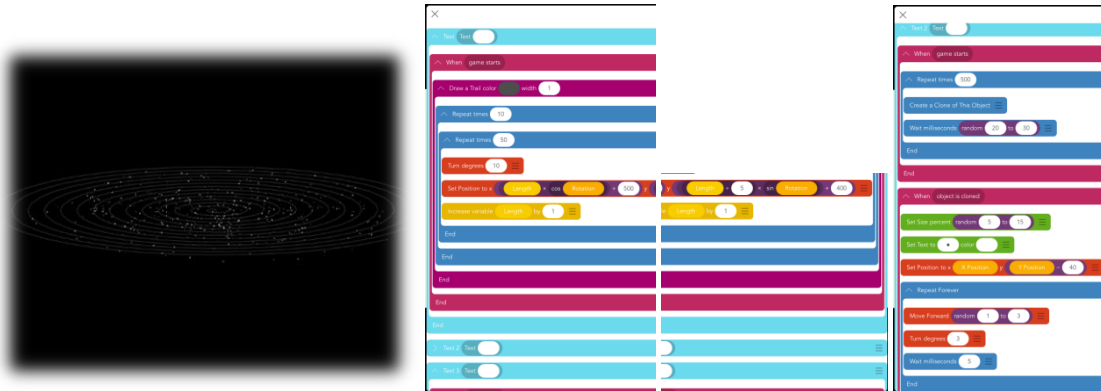
Name of the program : Galaxie spirale <https://c.gethopscotch.com/p/ythtfgkp5>

The barred spiral galaxy has spiral arms that seem to come from a central star bar. They are also numerous. They originated from the crossing of two different galaxies where the stars do not collide. Spiral galaxies contain young stars. Since 2005, the Milky Way has been classified as a barred spiral galaxy.



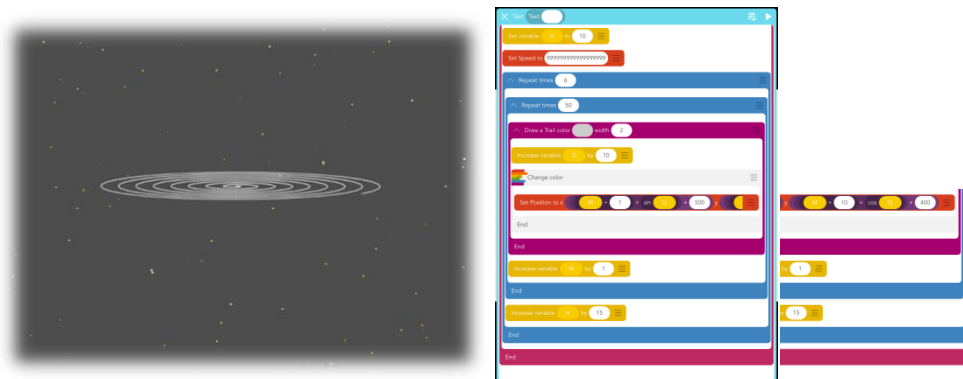
Name of the program : Galaxie spirale barrée <https://c.gethopscotch.com/p/ytht63h6l>

Elliptical galaxies contain old stars. At least two fused spiral galaxies form the elliptical galaxies. The most famous elliptical galaxy is the M87 galaxy discovered in 1781 by Charles Messier.



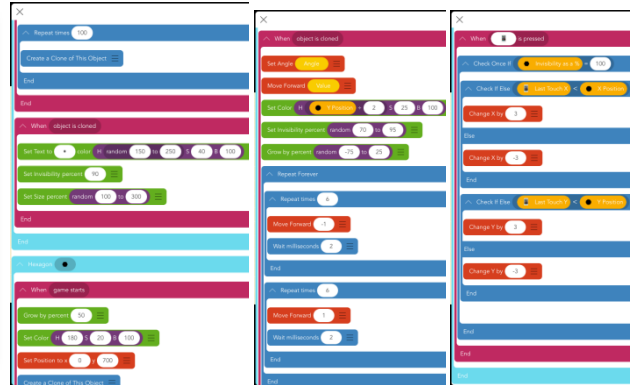
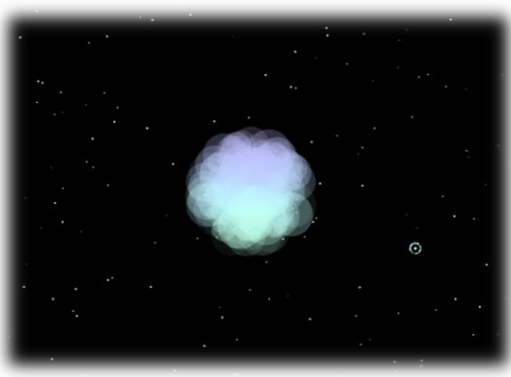
Name of the program : Galaxie elliptique <https://c.gethopscotch.com/p/ythtitod8>

Unlike spiral and elliptical galaxies, lenticular galaxies have a structure that resembles a spiralless disk. They contain very few star formation and a lot of interstellar dust. They contain aged stars and globular clusters.



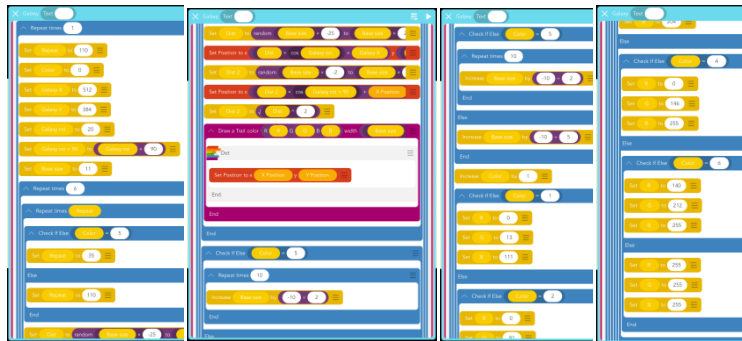
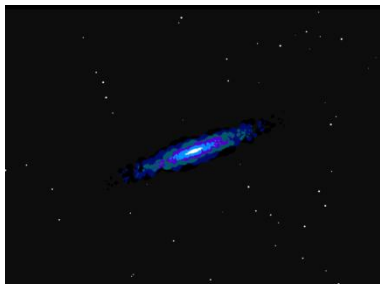
Name of the program : Galaxie lenticulaire <https://c.gethopscotch.com/p/ytht8lpjk>

The irregular galaxies are recognized by their lack of regular structure that can be detected. They are small sizes. They often contain young stars, gases and dust. They were probably much more numerous at the beginning of the universe. They now form only 10% of the observable universe.



Name of the program : Galaxie irrégulière type I

<https://c.gethopscotch.com/p/ythsn0su>



Name of the program : Galaxie irrégulière type II <https://c.gethopscotch.com/p/ytg4t63cc>

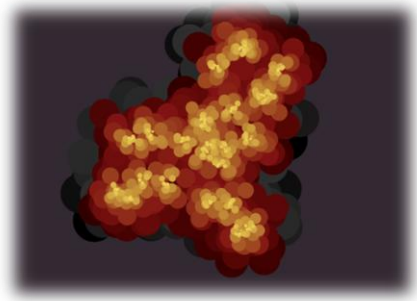


Name of the program : Galaxie en cours de formation

<https://c.gethopscotch.com/p/ytg4mersy>

Special galaxies have unique characteristics that other types of galaxies do not possess. Their luminosity is very low in visible light, but they have a very high brightness in

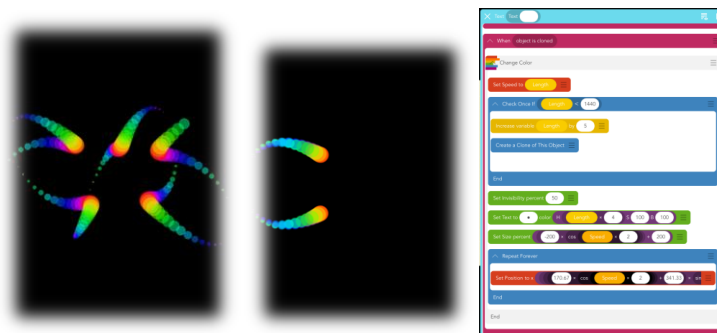
infrared. There is no formation of stars in these galaxies, which makes them difficult to detect. The best known are M87, M82 and M104.



Name of the program : Galaxie spéciale <https://c.gethopscotch.com/p/yuv5s6sa3>

Simulation of collision of galaxies

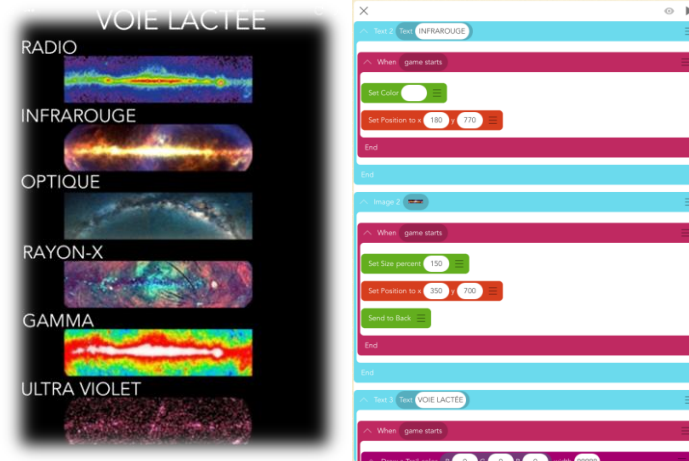
The galaxies are always moving. We have seen that elliptic galaxies are formed by the collision of spiral galaxies. For example, the Andromeda galaxy has a shift towards blue. Slipher calculated that this offset corresponds to a speed of 300 km / sec, which corresponds to 0.1% of the speed of light. Our Milky Way is also heading towards Andromeda. There is a gravitational pull between the two galaxies. Andromeda is 'falling' into the Milky Way (Gott, 2017). It will collide with the Milky Way in 4 billion years.



Name of the program : Collision de galaxies <https://c.gethopscotch.com/p/ytkm42nru>

Simulation of the Milky Way

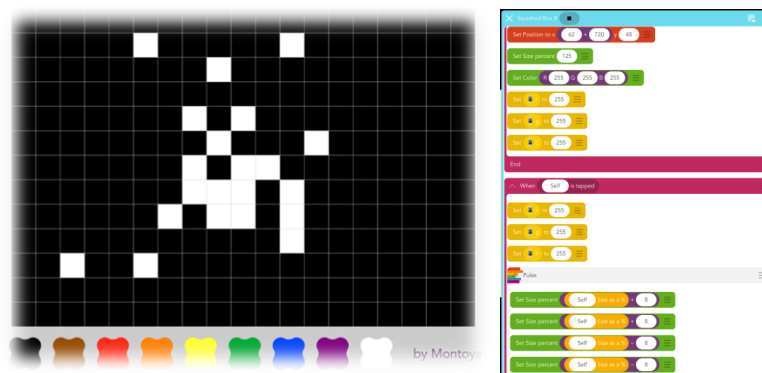
Here we see the Milky Way in the way it appears taken by using different wavelengths of light. It shows the radio waves, infrared, visible, X-ray, gamma and ultraviolet. Each of the NASA photos was taken using a different telescope.



Name of the program : Voie lactée selon la fréquence <https://c.gethopscotch.com/p/ytn44tuxk>

Simulation of the galaxy GN-11

We use Hubble at the limit of his vision. GN-11 is the place where you can see the farthest galaxy with the Hubble telescope. It takes a full day to see it. It's just a fuzzy form. We have trouble seeing it. Dr. Adam Muzzin said that for the press release, astrophysicists do as President Trump, they dress the photo well.



Name of the program : GN-Z11 Galaxy <https://c.gethopscotch.com/p/yhcu8kxiw>

James Webb Space Telescope Simulation

The James Webb Space Telescope will be launched in October 2018. The cost of the James Webb Space Telescope is \$ 9 billion. The mirror is about the size of a tennis court. The white part is the thermal shield of the telescope that protects it from the sun. It is too big to be placed in the biggest rocket available. It will be necessary to send the parts in several launches of rockets and to assemble it in the space. It will be placed in orbit at 1 501 517 km from Earth and will follow Earth in its orbit around the sun. The place where the telescope will be placed is called L2, the second Lagrange point. It is a place where the gravity of the space of the sun-earth system is semi-stable. From here, the space objects stay in place and follow the Earth as it orbits the sun.

The Hubble telescope is a telescope that works primarily with visible light and some infrared light. The James Webb telescope will operate only with infrared, from near infrared to middle infrared. Infrared makes it possible to cross the dust in space, and to see all the stars that are beyond. The James Webb telescope will be able to see stars and galaxies at their formation 100 million years after the Big Bang. The James Webb telescope is so sensitive that it could detect the heat of a bee on the moon (Hunter, 2017).

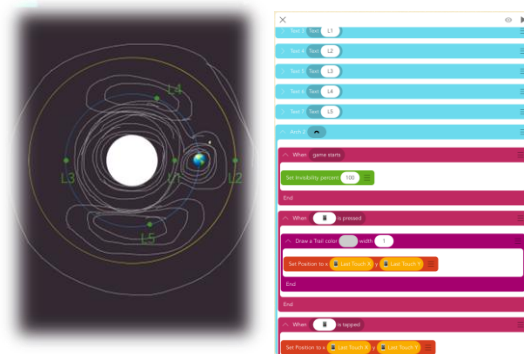


Name of the program : James Webb Telescope <https://c.gethopscotch.com/p/yhcopiyp>

Simulations of Lagrange points

Isaac Newton is well known for his laws on gravitation and movement in general. Its laws explain very well gravity and movement in general when two celestial bodies are

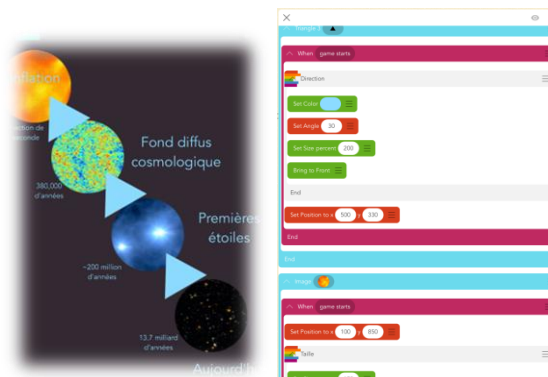
analyzed. When a third body was introduced, the calculations were more difficult. In 1772, Joseph-Louis Lagrange studied this phenomenon and predicted that in any three-body system where one of the masses (as an asteroid) is smaller than the other two (like the Sun and Jupiter), we will observe 5 positions Specific ones where the body of small mass remains immobile in relation to the others. We see, for example, asteroids which can not leave points L4 and L5.



Name of the program : Points de Lagrange <https://c.gethopscotch.com/p/ytnm07v2v>
Le télescope James-Webb sera placé au point L2.

Simulation of the universe

The light of the cosmos that reaches our eyes at a light-year distance has taken a whole year to reach us. The light of the beginning of the universe took 13.8 billion years to reach our eyes. The area of space called inflation is the area of space where we seek to understand the beginnings of our universe, the Big Bang, 13.8 billion years ago. Think of it, it is possible to see today the light of the cosmos, from the very beginning of the universe, at a time when the Earth was not yet formed, at a time when life did not yet exist!

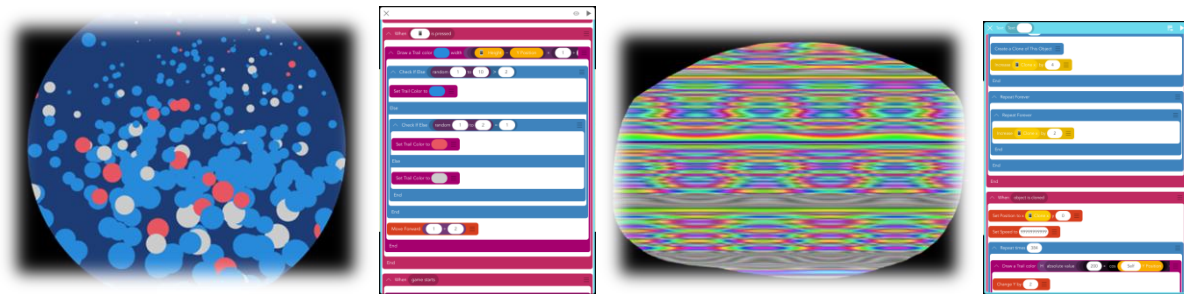


Name of the program : cosmologie théorique <https://c.gethopscotch.com/p/ysn74nw21>

Dr. Adam Reiss, who received a Nobel Prize, discovered that the universe is not only expanding, the expansion is accelerating instead of slowing down. This acceleration would work with dark matter. Dark matter is what keeps the galaxies together. In the deep universe, dark matter dominates the universe. The dark energy causes the acceleration of the galaxies that move away from one another at an accelerated rate. One wonders how the structure of the universe occurred? Today we have close to 60,000 galaxies, but there was a time when there were no galaxies at all. With telescopes like the Planck telescope, we can see the primordial light, the cosmic microwave background.

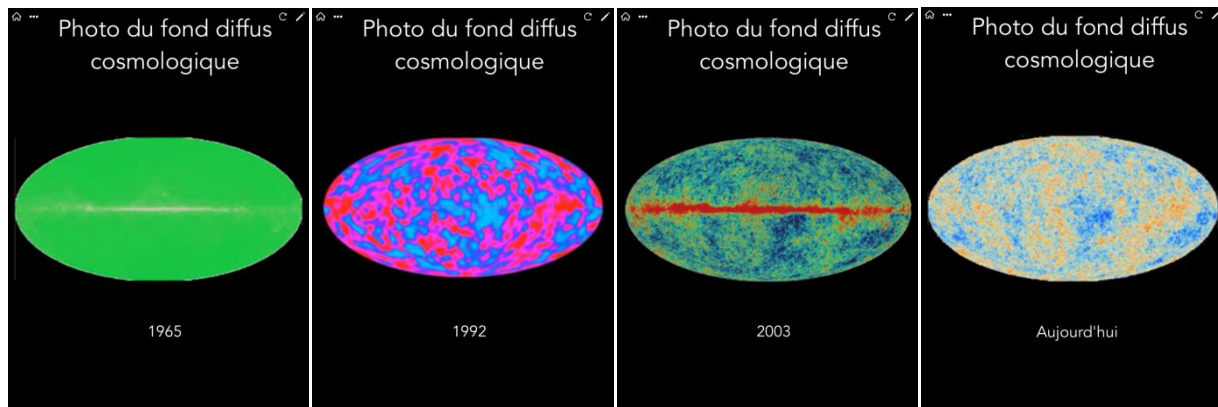
Simulations of the cosmic microwave background

In 1610, Galileo, with his telescope, had discovered that a faint glimmer of a luminous band came from the accumulation of light from distant stars. Today, our most powerful telescopes allow us to observe electromagnetic waves from time, shortly after the Big Bang, at a time when no stars or galaxies existed. At 380,000 years after the Big Bang we notice the cosmic diffuse background or the fossil radiation. This is very far in the past, if we understand that our universe is 13.8 billion years old. The cosmic microwave background was detected for the first time in 1965. In 1992, the COBE satellite was able to record the details of the cosmic microwave background. The WMAP and Planck telescopes have improved the first COBE measurements.



Name of the program : Fond diffus cosmologique <https://c.gethopscotch.com/p/ytn7etscd>

Name of the program : Fond diffus cosmologique <https://c.gethopscotch.com/p/yo0r6mcgc>

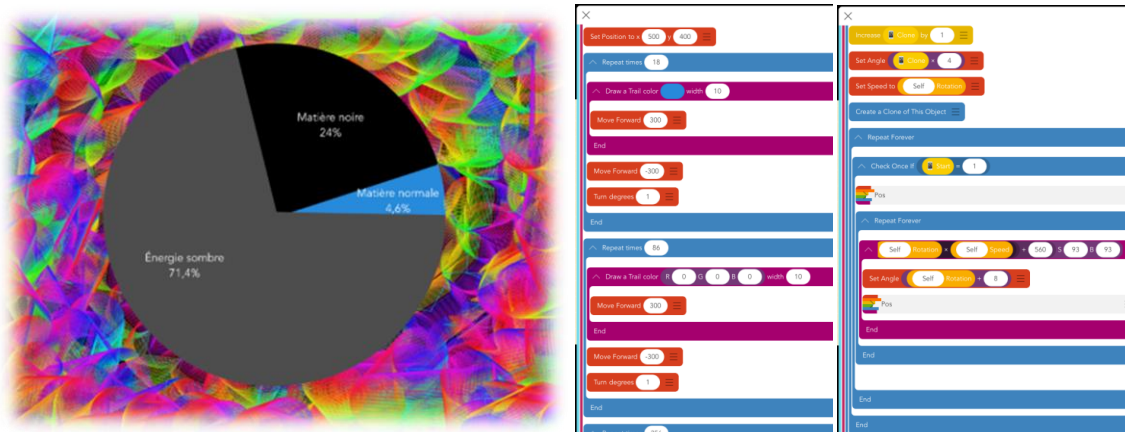


Name of the program : Fond diffus cosmologique <https://c.gethopscotch.com/p/ytn7plcbn>

These instruments measured the cosmic microwave background temperature at 2.7 K and all temperature fluctuations to the nearest millionth of a degree. By studying temperature fluctuations, cosmologists can deduce the density of energy from the universe, the distribution between matter and dark energy, the age of the universe, the curvature of space and its size (Luminet, 2014).

Dark energy graph

When one looks into the cosmos, we see only a tiny part, 4.4%. The rest of the universe is composed of dark matter (24%) and dark energy (71.4%). They are hardly understood. In the cosmic microwave background, gravity strikes light. These strikes are propelled by dark matter.



Name of the program : Energie sombre <https://c.gethopscotch.com/p/yod9xffzf>

Simulation of dark matter

You cannot see the dark matter. Its existence can be deduced with theoretical calculations and indirect observations. There would be 10 times more black matter than light matter. Dark matter would produce gravitational effects similar to those produced by the visible mass. Dark matter would come from interstellar dust and also from brown dwarfs. It would contain particles from the very first moments of the Big Bang capable of generating great gravitational effects. Some physicists try to recreate their existence in particle accelerators (Luminet, 2014). In the simulations of dark matter, we see the distribution of dark matter in the local universe.

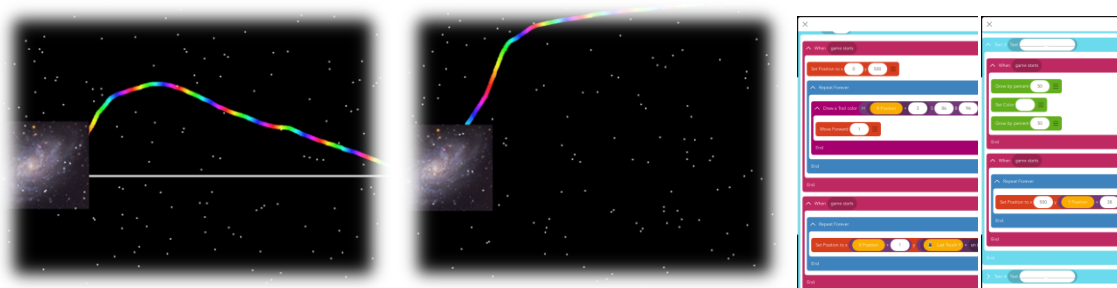


Name of the program : Matière noire <https://c.gethopscotch.com/p/yvtttdwx0>

Name of the program : Matière noire <https://c.gethopscotch.com/p/ytho7ebui>

Name of the program : Simulation de la matière noire <https://c.gethopscotch.com/p/yu7evyxb>

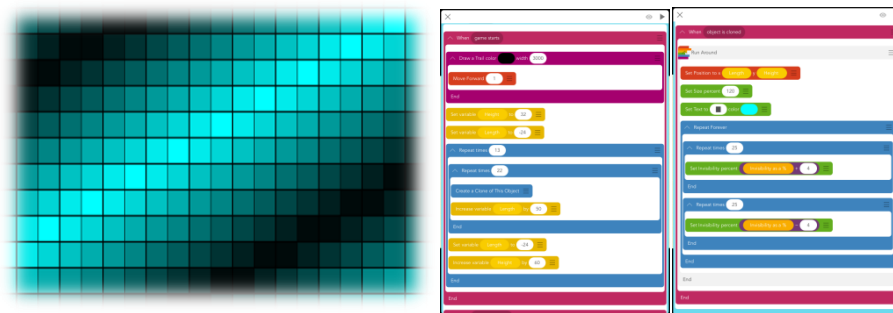
Without dark matter to explain certain phenomena, stable galaxies defy the laws of physics. The fact that galaxies remain stable is a reason that scientists think our present explanations are insufficient. For example, the stars near the galaxies travel too fast to be retained in their orbit only with the gravity of the visible material of the center of the galaxy. We see in the graphs of the relative velocity of the stars on the left, the expectations according to the calculations of our current theory and to the right, which scientists observe New Scientist (2017).



Name of the program : Evidence de la matière noire <https://c.gethopscotch.com/p/yl7ctopggp>

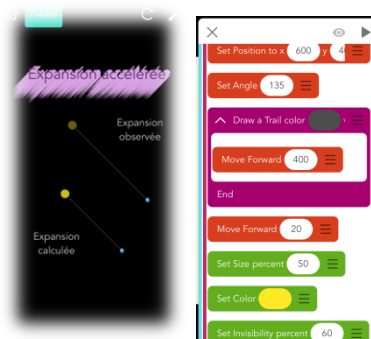
Simulation of black energy

Little is known about black energy. However it is necessary to explain the rapid expansion of the Universe, just after the Big Bang. The gravity we know is a force that draws and collects objects together. On the other hand, dark energy would be a force pushing objects outward. This energy pushes the galaxies away from each other. Eventually, the galaxies will be alone in their little corner of the universe, far too far apart from one another.



Name of the program : Energie noire <https://c.gethopscotch.com/p/yltg5g3jov>

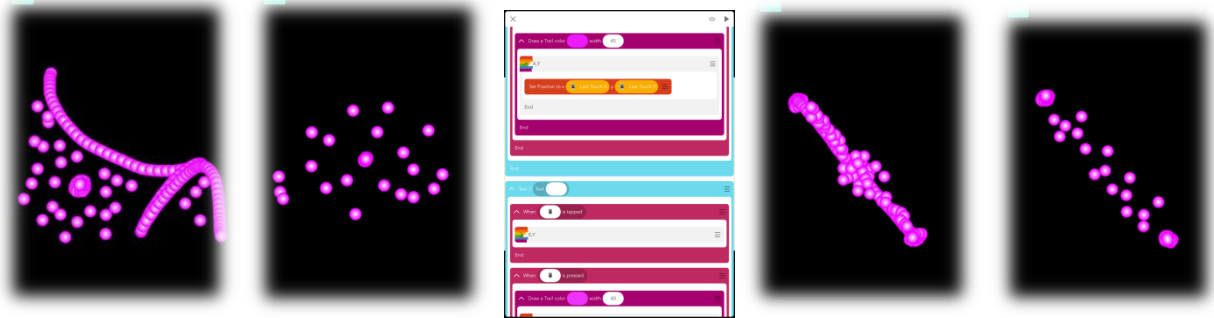
Research on black energy is continuing. With the appearance of a new supernova that adds to the sounding, the position of the galaxies can be carefully calculated over time. The supernovae that are farther away, are less luminous than the supernovae that are closer. These supernovae give us the rhythm of the expansion of the universe.



Name of the program : Expansion accélérée <https://c.gethopscotch.com/p/yuxopls7v>

With only the laws of gravity, our universe should be bent. However, it seems almost flat. In addition, distant galaxies appear to be less distorted than expected. Another

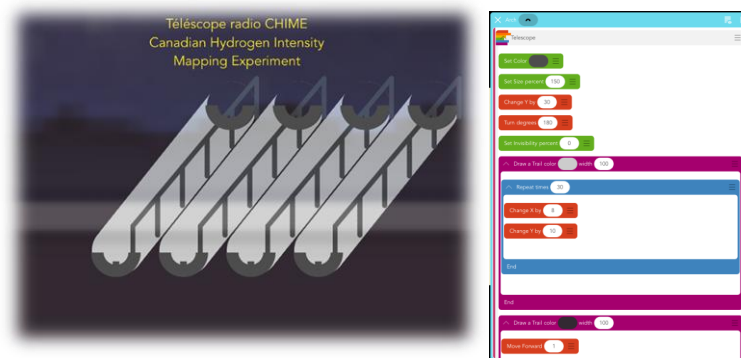
force seems to be at stake. By measuring the size of the super groups of galaxies, it will be possible to have a new vision of the history of the universe (New Scientist, 2017).



Name of the program : Dessine l'expansion de l'univers <https://c.gethopscotch.com/p/yuxr6almz>

CHIME radio telescope game

A new fixed telescope is under construction in British Columbia. It will document the acceleration of the expansion of the universe. This telescope is stable and does not move at all. It allows to see an image of the sky in its entirety. He sees different stars only because of the rotation of the Earth. This is a new telescope paradigm. You do not have to wait for the night to work. With this telescope, scientists will try to see the first day of the life of the universe. Construction will be completed in the fall of 2017.



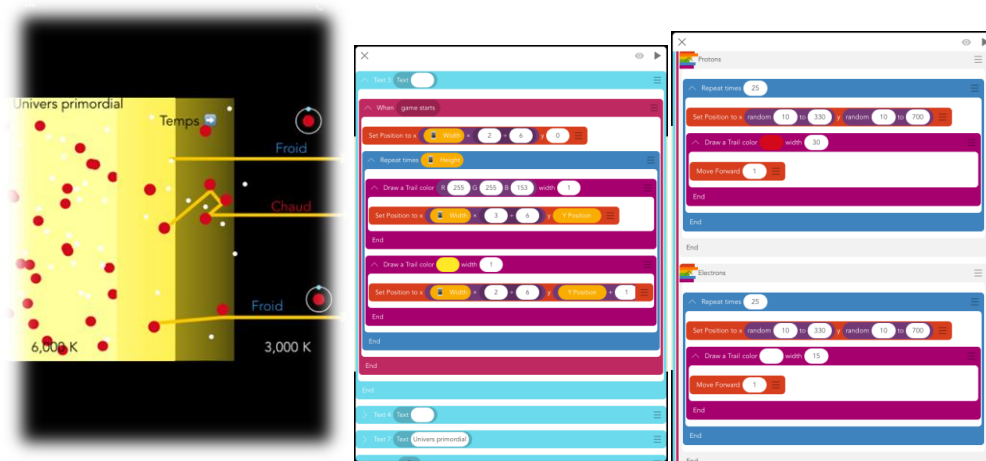
Name of the program : CHIME <https://c.gethopscotch.com/p/xunmu28oi>

Simulation of the primordial universe

There are other telescopes that study the same area of space. Dr. Tyler Natoli, University of Toronto, participated in the construction of the South Pole Telescope, collecting and analyzing its data. The South Pole Telescope allows the study of the cosmic diffuse

background. Observation in the Antarctic has advantages since it is night 6 months a year and one is in very high altitude. You can see the same stars 24/7/52. With the cold, the air is really very dry, because the water does not evaporate. The atmosphere is stable because there is no sunrise and sunset that stir the particles into the atmosphere. When the radiation touches the bolometer detector, it records the temperature differences on the detector. The images obtained are passed through computer filters to obtain the image on the right. It is a picture of the universe 380,000 years after the Big Bang, in the first 3% of the formation of the Universe.

In the primordial universe, at 6,000 Kelvin, one can see particles, protons and neutrons. After some time, the temperature cools down to 3000 K, allowing the particles to assemble and form atoms. With the cooling, one also sees the light which generally goes in a straight line, except when it meets particles that reflect the light. Scientists are continuing their research to understand the first trillion of the trillionth of a trillionth of a second after the birth of the universe.

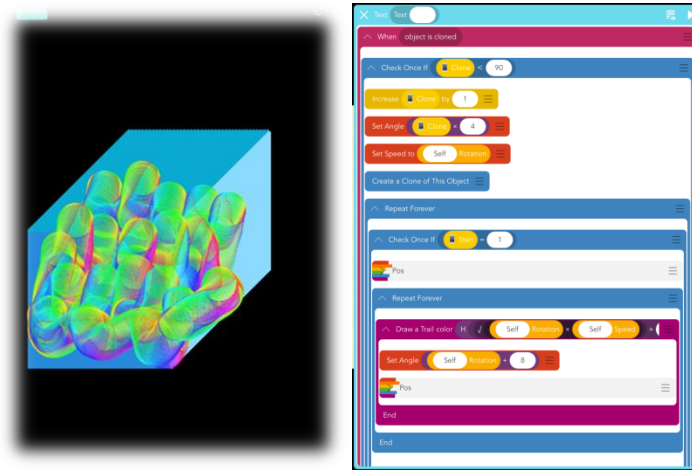


Name of the program : Univers primordial <https://c.gethopscotch.com/p/yjal6j8vs>

Simulation of the inflationary world

It is Dr. Andrei Linde of Stanford University who is behind the theory of inflation, which is the theoretical model used by scientists to study the beginning of the universe. His theory assumes a brief period of acceleration followed by an expansion in all directions. Our observable universe would have started from a subatomic size and become the size of a few centimeters in a fraction of a second. The period of inflation is considered as the time between 10×10^{-36} and 10×10^{-33} seconds after the beginning of the universe.

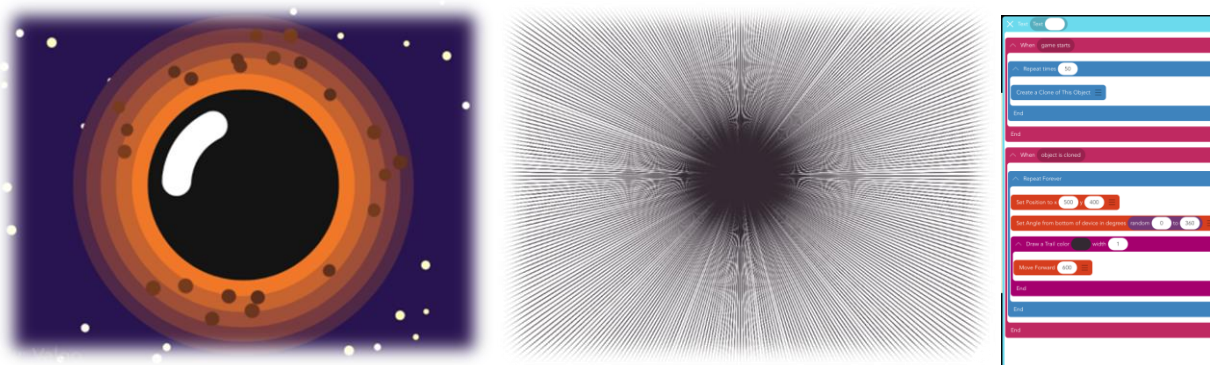
It is always possible to see the glow of inflation, which is called the cosmic diffuse background.



Name of the program : Fluctuations chaotiques du vide quantique
<https://c.gethopscotch.com/p/yjg1jxap8>

Black hole simulations

It was a University of Toronto scientist, Charles Thomas Bolton, who discovered the first black hole with the David Dunlap Observatory in 1971. Black holes exist in the center of almost all galaxies. Our Milky Way contains a black hole, Sagittarius A, four million times the size of the sun. Around a black hole, gravity is so intense that space-time becomes infinitely curved and creates so intense gravity that nothing escapes, not even light. One cannot "see" the black holes, one can detect them by observing the material moving around. You see here a simulation vibration around the black holes.

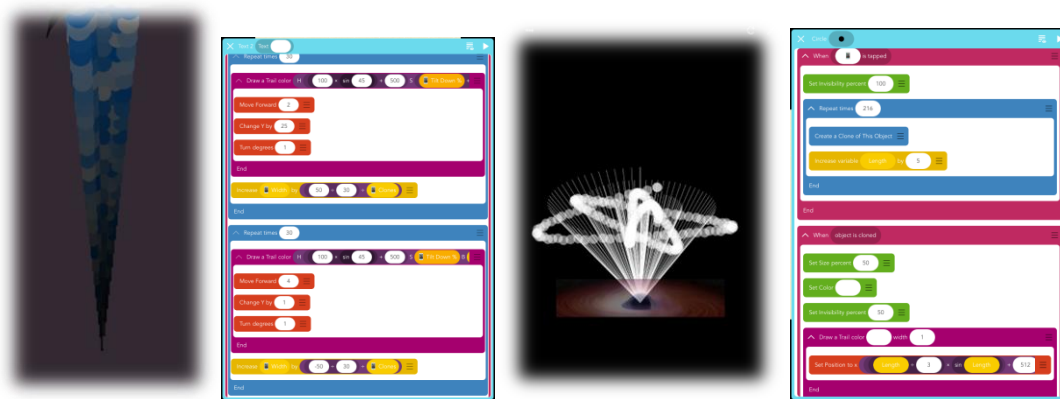


Name of the program : Trou noir <https://c.gethopscotch.com/p/ym1p1ikyq>

Name of the program : Trou noir <https://c.gethopscotch.com/p/yths7st0p>

Scientists note that certain physical laws must be reviewed. Indeed, in the center of the black hole, the laws of the curvature of space-time becomes infinite and Einstein's relativity equations do not work. The escape velocity of a black hole is greater than the speed of light. We recall that the speed of light is supposed to be the fastest. Since the black hole is invisible, we must deduce what happens by observing what is happening around the black hole. We observe the mass of objects, their rotation and change.

At the center of the black hole, at the singularity, the density becomes infinite and has an infinite curve in space-time.



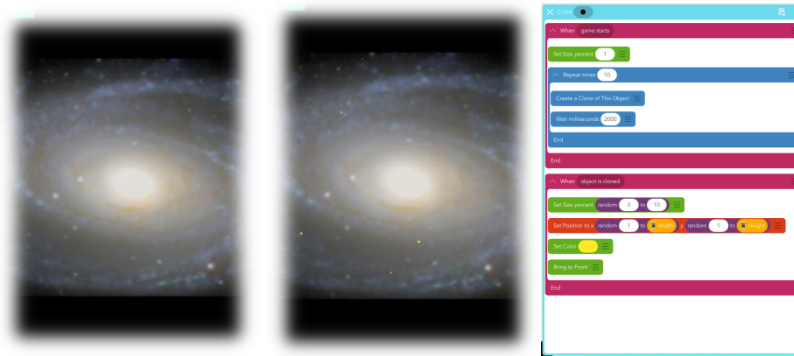
Name of the program : Singularité <https://c.gethopscotch.com/p/yo02f6rz3>

Name of the program : Quasar <https://c.gethopscotch.com/p/yuke57fw3>

A black hole can emit the energy of billions of stars. The cosmic rays found there probably originated from the magnetic field around the black hole that would accelerate the surrounding particles.

Simulation of Star Explosions

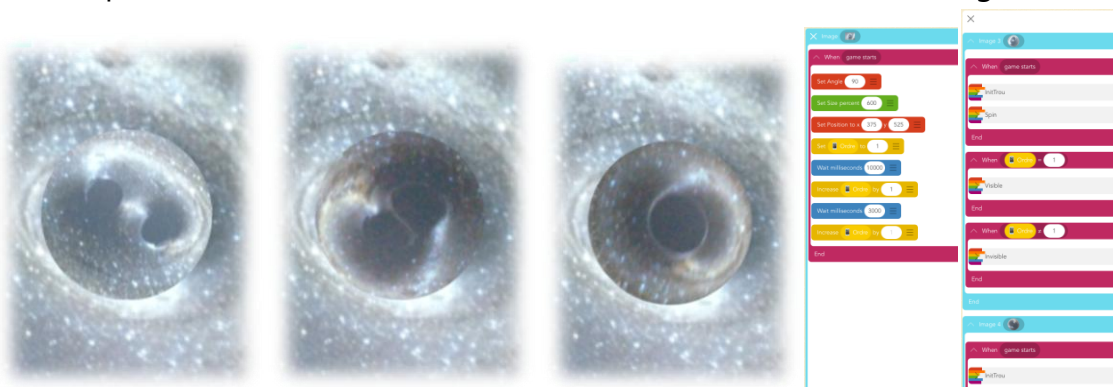
Scientists estimate that every second a star explodes. With the current instruments, it is not possible to see all these explosions, all these supernovae. Scientists focus on rare events. The new CHIME telescope will be able to detect all new supernovae since it will be concentrated on the universe as a whole every day. When a star explodes, it will be possible to detect the region of the universe where this happens. The Big Bang has only created some elements like hydrogen. Supernovae produce other heavier elements. Observation of supernovae is important for understanding the formation of galaxies and how they evolve over time. The public wonders if some of these explosions could be an alien signal. Scientists are not convinced. There is only one way of knowing it: to explore more and more.



Name of the program : explosion d'étoiles <https://c.gethopscoth.com/p/ysnbreur8>

Simulation of collision of black holes

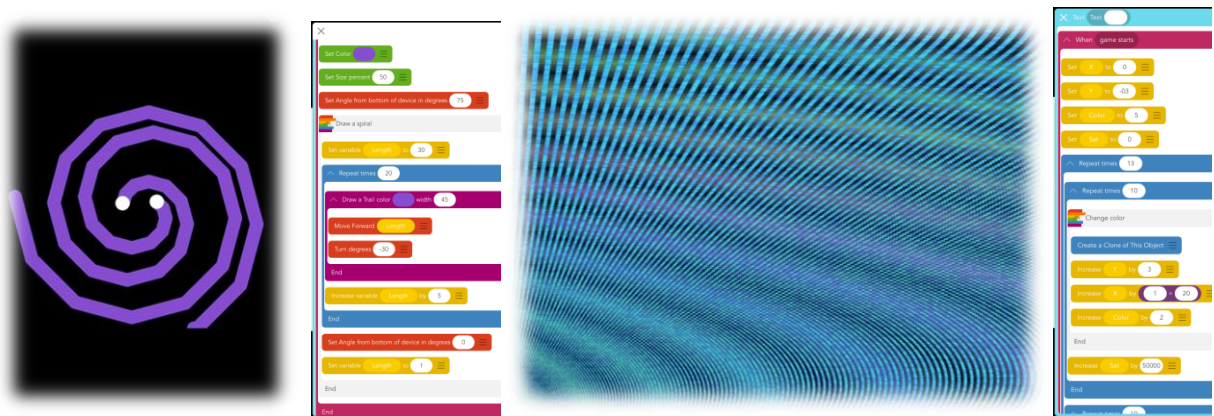
Dr. Harald Pfeiffer defines black holes as well: a lot of matter in a small place. Their size is 100 times smaller than Earth and has 15 times the mass of the sun. The black holes are so compact that even light cannot escape. Newton's gravity laws do not apply with black holes. One must use Einstein's physics. Einstein tells us that space-time is bent. This space-time curvature tells spatial objects how to move. During the black hole collision, 1.3 billion years later, gravitational waves reached the earth and distorted the earth the size of an atomic nucleus. The LIGO instrument detects these deformations. There are collisions of black hole every 15 minutes, friends they are way too far for LIGO to be able to detect them. A black hole is an extreme curvature consisting entirely of curved space-time. A black hole can circulate around another and merge.



Name of the program : Collision de trous noirs <https://c.gethopscoth.com/p/yodvsuved>

Simulation of gravitational waves

Einstein predicted the existence of gravitational waves in 1915. It was not until 1960 that scientists began to search for them. When one black hole circulates around another and merges, one observes a disturbance of space-time that travels at the speed of light. This disturbance distorts the Earth by an order of 10^{-15} meters (0.000.000.000.000,001m) through the passage of gravitational waves. The gravitational waves were measured by MIT's LIGO instrument (11.02.2016, Al-Jazeera). Interestingly, these gravitational waves are within the range of sounds that the human ear can hear.



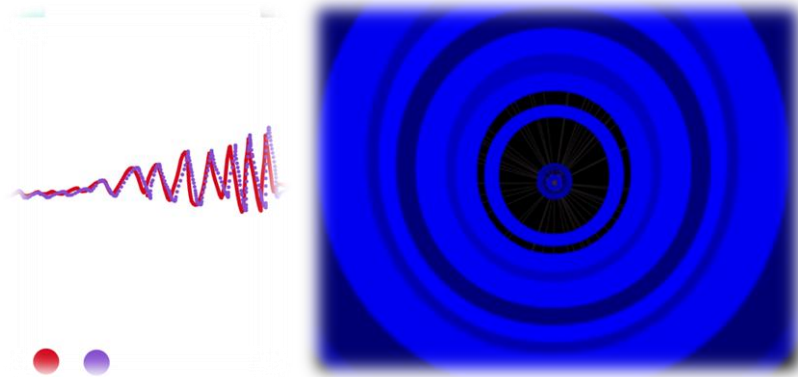
Name of the program : Ondes gravitationnelles <https://c.gethopscoth.com/p/xt065tirn>

Name of the program : Champ gravitationnel <https://c.gethopscoth.com/p/yu04jlnbp>

In the next two years, LIGO instruments should be sensitive enough to detect gravitational waves of fusion of neutron stars that are within the nearest 300,000 galaxies. It is estimated that one signal would be received per month (New Scientist, 2017).

Graphic simulation

The LIGO instrument consists of two independent measurements. One in Hanford, Washington, and the other in Livingston, Louisiana, United States. They use 4km lasers to measure the slight distortion caused by gravitational waves. Using two independent instruments, which obtain almost similar results, the validity of the observation can be confirmed.



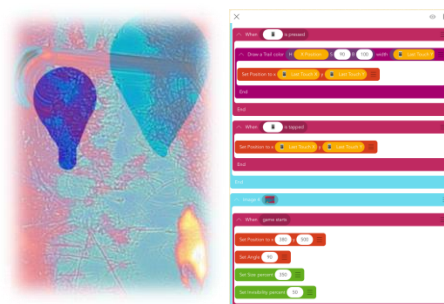
Name of the program : Graphe de comparaison <https://c.gethopscotch.com/p/ynsbfwgg9>

Name of the program : Ondes Gravitationnelles <https://c.gethopscotch.com/p/yoxi8hgrd>

Scientists hope that the detection of gravitational waves will open new openings in the study of the universe (11.02.2016, Al-Jazeera).

Simulation of the polarization of light

Graduate students do not work with the most powerful instruments. They therefore manufacture other powerful instruments with a fraction of the cost of the most recent instruments. For example, they make balloons the size of half a football field and take them to Antarctica. These balloons equipped with infrared camera make it possible to watch the polarization of the light.



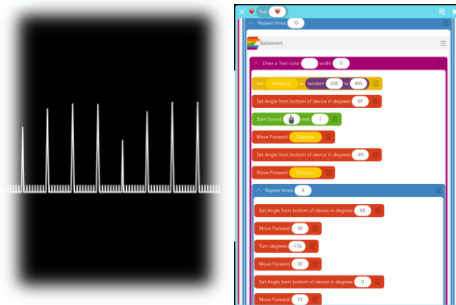
Name of the program : Polarisation avec ballons

<https://c.gethopscotch.com/p/ysnej6usy>

Simulation of pulsar

A doctoral student, Jocelyn Bell, discovered the pulsars, by chance, in 1967 using a radio telescope. She noticed strange signals, regular pulsations. She thought at first that it was

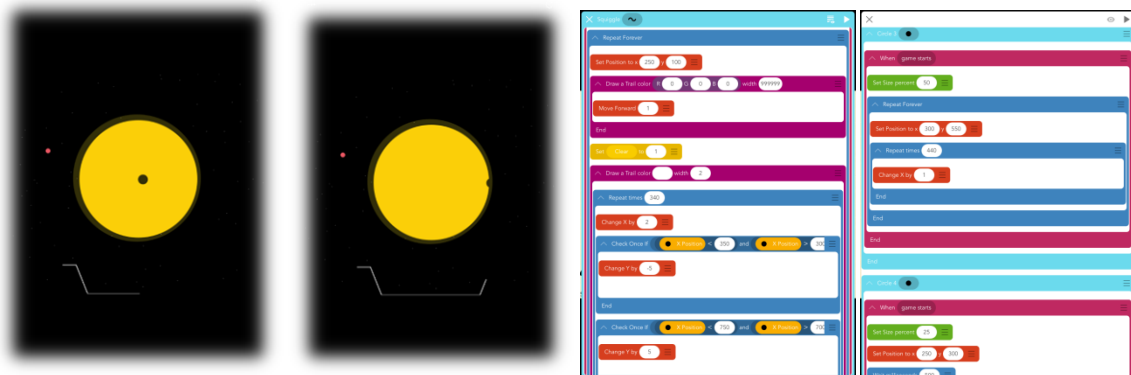
a civilization of extraterrestrials sending signals. But when she found other similar signals, she realized that it was a natural cosmological phenomenon. It was the oscillation of neutron stars. His supervisor, Anthony Hewish, will be awarded the Nobel Prize, alone, for the discovery of Jocelyn Bell.



Name of the program : simulation de pulsar <https://c.gethopscotch.com/p/ysnhxd0md>

Simulation of the transit method

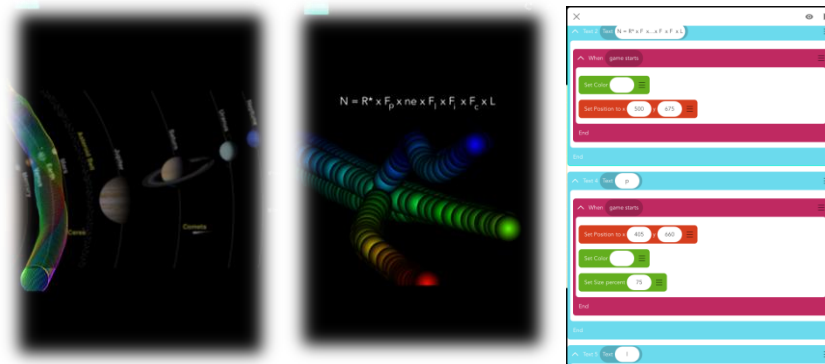
The Kepler satellite regularly finds exoplanets in the Milky Way. When Kepler finds an exoplanet, other telescopes on Earth confirm the discoveries to make sure they are not false positives. Results should be verified and confirmed. Just last June (Al-Jazeera, 2017) NASA announced ten other planets similar to the Earth, located in the habitable zone of their sun. These planets are found using the transit method. When a planet passes between an observer and its star, the observer perceives less light from the star. When the planet is no longer in front of the star, the level of light returns to normal. This method works only if the orientation of the orbit of the planets is on an observable plane of the earth. If the orbits of the planets are on a different plane, they cannot be observed using this method.



Name of the program : Détection exoplanète transition - <https://c.gethopscotch.com/p/yszv28gz3>

Simulation of the living area

For a planet to be considered habitable, it must have temperatures similar to the Earth, so that life can develop. There must be temperatures between -15 and 121 degrees Celsius. There must be temperatures where water can become liquid. Beyond these temperatures, we are outside the habitable zone. In our solar system, this zone extends from the planet Venus to the planet Mars. To determine if there is life on an exo planet, temperature is one of the important criteria.



Name of the program : Zone habitable <https://c.gethopscotch.com/p/yodj2flny>

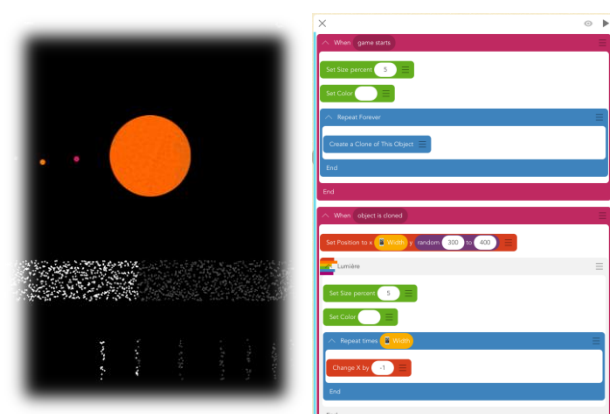
Name of the program : Vie extraterrestre <https://c.gethopscotch.com/p/yu0rcaxxa>

Other criteria are important too. On the galactic side, the planet must be in an equilibrium zone. It must be located in a place where minerals have been formed by the death of stars, but far enough to avoid supernova explosions, extreme radiations or black holes. The planet must be neither too big nor too small, with a stable axis of rotation. It must have in its vicinity a star which deviates comets and asteroids. The habitable planet must also have a magnetic field that protects the surface from solar radiation and cosmic rays. It must have an atmosphere that protects the planet from the sun's rays and a geology that makes it possible to renew the atmosphere (Luminet, Reeves, 2016).

Drake's formula allows us to know if there is extraterrestrial life in the Milky Way. It is dependent on the rate of formation of stars in our galaxy, the fraction of stars with planets, the average number of habitable planets, the fraction of planets that already has life, the fraction of planets with intelligent beings, the fraction of planets with beings capable of communicating, and the life span of technological civilizations. Many of these quantities are not yet known. If we deduce the appearance of life capable of producing the technology at 0.001, it will take statistically, according to Drake's equation, 100,000 years before we can get in contact with them (Science & Vie, 06.2017).

Simulation of TRAPPIST-1

Last February, Dr. Michael Gillon of the University of Liège gave a press conference at NASA about his discovery of 7 rocky planets circulating TRAPPIST-1 at only 39 light years in the Milky Way. It is a record for the largest number of planets that are in the living area, orbiting a single star. It is 7 planets with similar Earth-like orbiting temperatures around the star TRAPPIST-1. Dr. Gillon's measurements were sufficiently precise to suggest a water-rich composition. Only the James Webb telescope will be able to measure definitively the presence of water or methane on these distant planets. If oxygen is detected, we could see the possibility of plant life. Finding a second Earth is not a matter of IF, but a matter of WHEN.

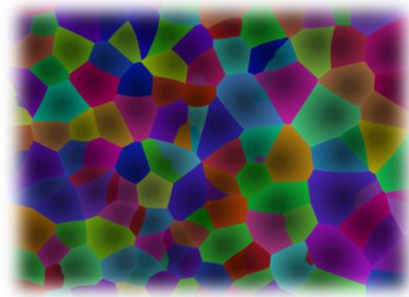
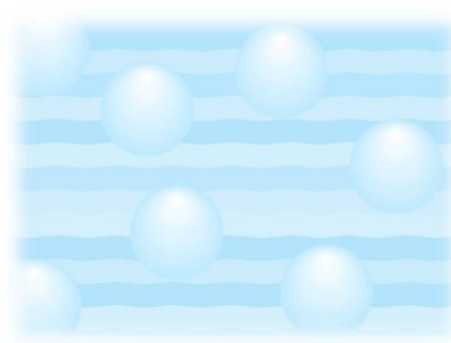
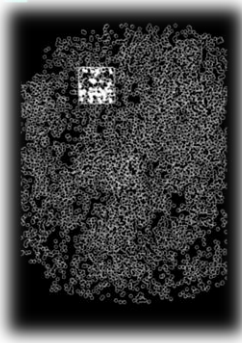


Name of the program : TRAPPIST-1 <https://c.gethopscotch.com/p/ykbekclta>

Particle simulations

The material is composed of several types of particles. There are all the elements of the periodic table which are particles. The elements combine into molecules that are particles. Each atom is formed of sub-particles such as protons, neutrons and electrons. There are elementary particles like the Higgs boson whose existence and properties are sought in particle accelerators.

Atoms and molecules can take 3 forms depending on temperature and pressure. Here we see simulations of particles in their gaseous, liquid and solid form.



Name of the program : Particules <https://c.gethopscotch.com/p/yucie9nim>

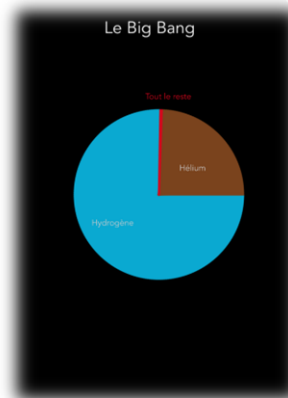
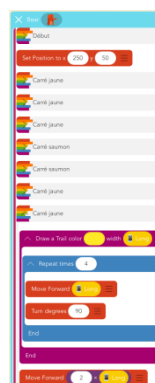
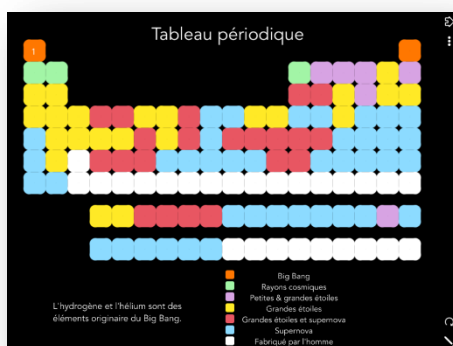
Name of the program : Particules dans un liquide

<https://c.gethopscotch.com/p/yucjvagt>

Name of the program : Particules dans un solide

<https://c.gethopscotch.com/p/yucixtbz0>

91 of all the elements of the periodic table are naturally found on Earth. They have been trained in various places in the cosmos, from the Big Bang, before being on Earth. For example, hydrogen and helium, with the orange color in the table, were formed at the time of the Big Bang. Lithium, beryllium, and boron, in green, are formed by the aid of cosmic rays. Carbon, nitrogen, oxygen, neon, and sulfur, in pink, are produced by small and large stars. The yellow elements, including fluorine, sodium, chlorine and calcium, come from large stars. The elements in red, including aluminum, iron and mercury, come from great stars and supernova. The elements in blue, such as nickel, lead, gold and uranium, come from supernova. Finally, the elements in white are so rare in nature that they must be manufactured in the laboratory. At the time of the Big Bang, none of these elements existed (BestChinaNews, 2017).



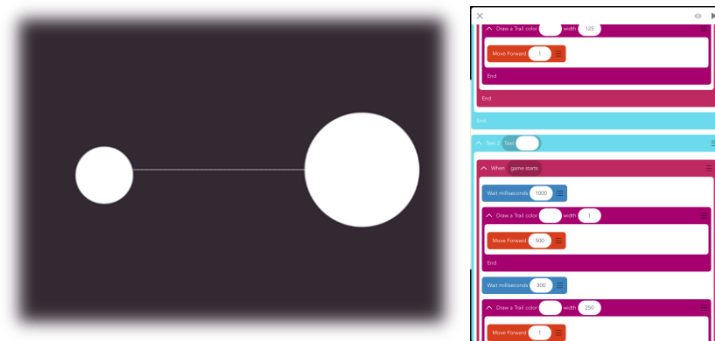
Name of the program : Tableau périodique <https://c.gethopscotch.com/p/yuif64c42>

Name of the program : Éléments du Big Bang <https://c.gethopscotch.com/p/ytnbuf4cg>

We also see the distribution of all the elements at the time of the Big Bang.

Overwhelmingly, we had hydrogen, a smaller amount of helium, and a minimal amount of other elements.

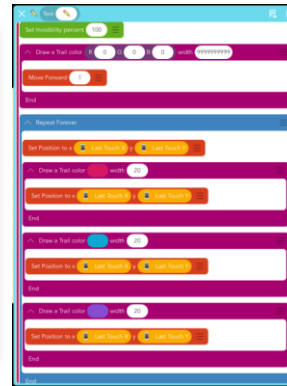
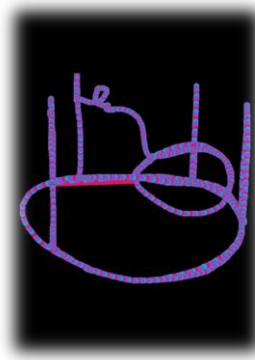
Scientists believe that dark matter is made up of something completely different from the particles we already know. Physicists are developing new possibilities, such as supersymmetry. Scientists believe that the new particles of supersymmetry are much heavier than each partner particle in the visible universe. The presence of these new particles must always be confirmed (New Scientist, 2017).



Name of the program : Supersymétrie <https://c.gethopscotch.com/p/yuxlrl8h3>

Particle Accelerator Simulation

Scientists from CERN in Switzerland are doing experiments that could find the Higgs boson that could give more information about the beginning of the Universe. These experiments which would make it possible to find the nature of dark matter and dark energy require great international efforts. Here we see a close-up of the particle accelerator at CERN (09.01.2012 Al-Jazeera).

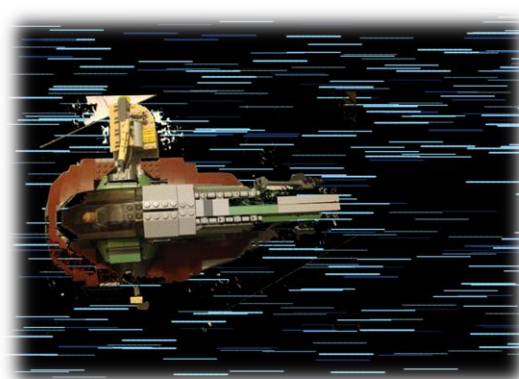


Name of the program : Accélérateur de particules

<https://c.gethopscotch.com/p/yodmo693x>

Simulation of the speed of light

Another experiment at CERN, the Opera experiment demonstrates that some particles travel faster than the speed of light. A fundamental point of Einstein's theory is that the speed of light is constant. According to Einstein, nothing can go faster than light. If these experiments can be repeated and confirmed, the theory of Einstein (22.09.2011 Al-Jazeera) must be revised. Will this eventually lead to high-speed travel?

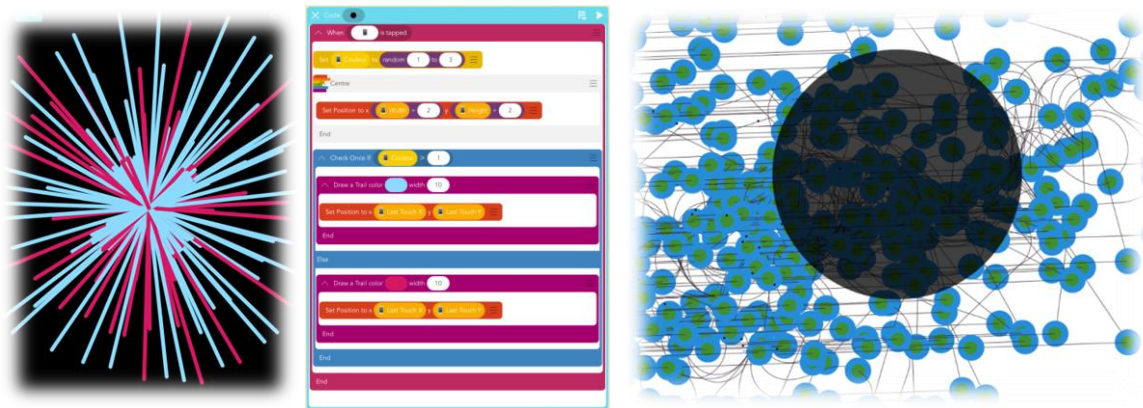


Name of the program : Worp speed 2 <https://c.gethopscotch.com/p/y7w2m95mz>

Simulation of the Higgs boson

The atoms are formed of particles. There are protons, neutrons, electrons, quarks and now Higgs bosons. The Higgs Boson is the last particle discovered with the aid of the CERN particle accelerator. The Higgs boson generates the mass of all other particles. It is

perhaps one of the most important building blocks of nature. This particle is very heavy. To measure it, it must be accelerated and collided in order to measure its rate of disintegration. The Higgs boson may have played an important role in the initial formation of the universe. The Higgs boson interacts with cosmic matter which initially has zero mass. Cosmic matter transmits their mass to protons and atomic nuclei. The gravity produced by the fusions of matter allows the development of stars (Luminet, Reeves, 2016).



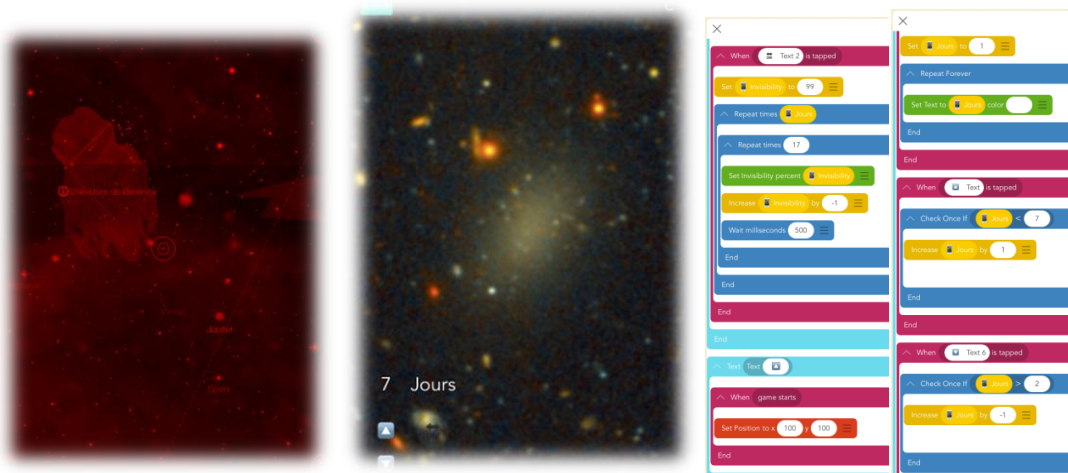
Name of the program : Boson de Higgs <https://c.gethopscotch.com/p/yodl8i1zm>

Name of the program : Boson de Higgs <https://c.gethopscotch.com/p/yv2wqukwu>

The theory of supersymmetry has been developed in order to understand dark matter. Another theory is to "imagine that the mass of the Higgs results from a mechanism associated with the evolution of the Universe since its creation" (Science & Life, 06.2017). These theories are still being worked on.

Simulation of taking the photo of the black galaxy

In the constellation of Berenice's Hair that we see here with STAR WALK, we find the galaxy Dragonfly 44. It is a black galaxy. It is populated only by a few billion stars, a hundred times less than the Milky Way. This black galaxy consists of 0.01% of material. The rest, the 99.99%, would be dark matter. It takes almost 7 days to capture the image of Dragonfly 44. It is like no other known galaxy (03.2017, Science & Life).

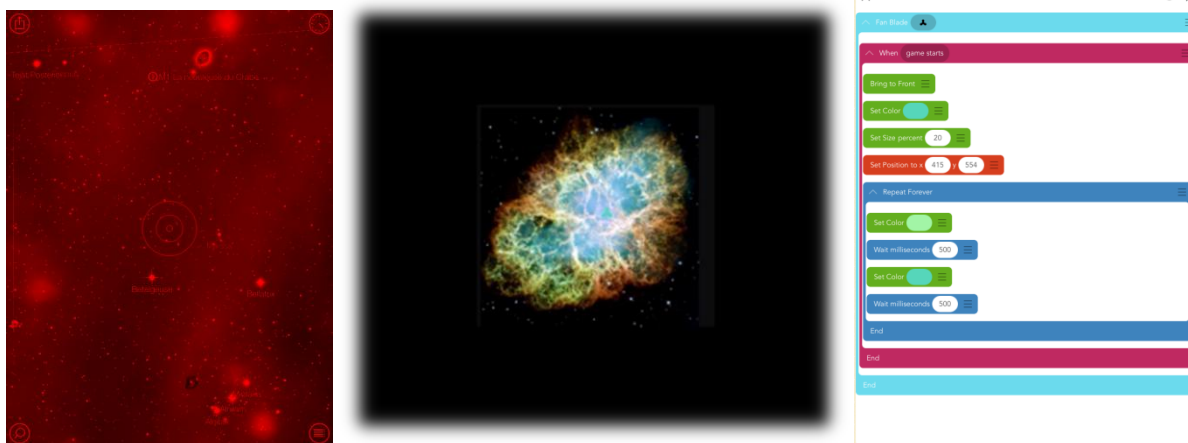


Name of the program : temps d'exposition galaxie noire

<https://c.gethopscotch.com/p/yodd49ker>

Simulation of the crab nebula

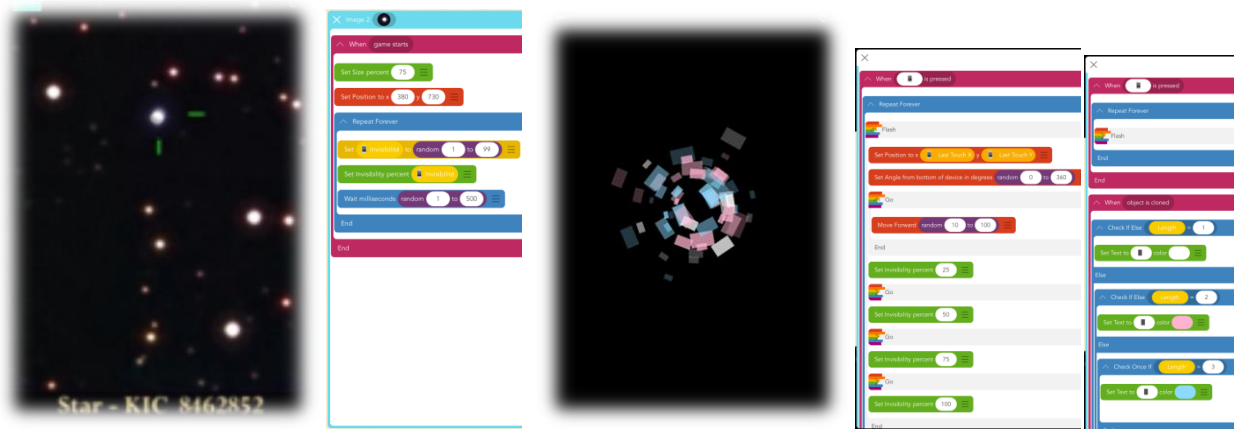
The crab nebula, which is seen on the stellar map near the star Betelgeuse, is one of the most beautiful regions of the Earth's sky. There was a new mystery. In his heart is a pulsar, a rotating star. It rotates at the rate of 30 rotations per second. One asks the question as to the nature of this heart. In a neutron star, the electrons of the atoms merge with the protons to form neutrons. Scientists are wondering if in this case, new particles are formed (03.2017, Science & Life). The Hopscotch simulation shows the heartbeat of the crab nebula.



Name of the program : Nébuleuse du crabe <https://c.gethopscotch.com/p/yodzoau0n>

Simulation of the random star

In Orion's arm is a star that does anything. Teams of different scientists have tried to explain the phenomenon, but none of them has succeeded until now. The random jumps of KIC 8462852 always remain without explanation of the data received (03.2017, Sciences & Vie).

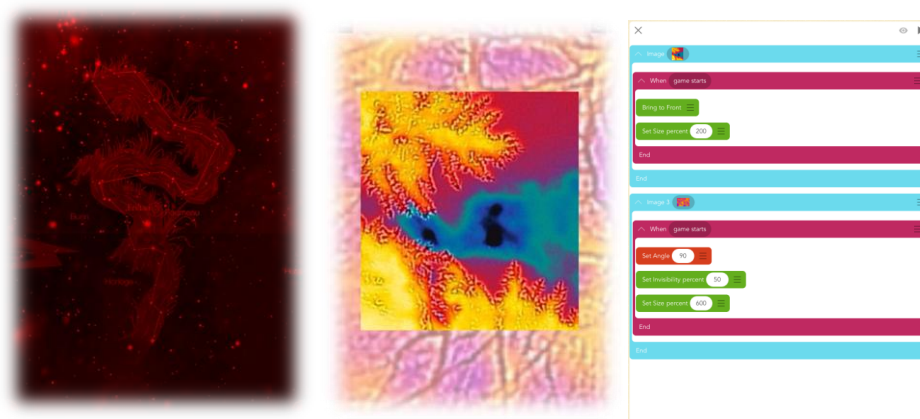


Name of the program : Astre random <https://c.gethopscotch.com/p/yodyina8h>

Name of the program : astre aléatoire <https://c.gethopscotch.com/p/ythu0ggij>

Cold Spot Simulation

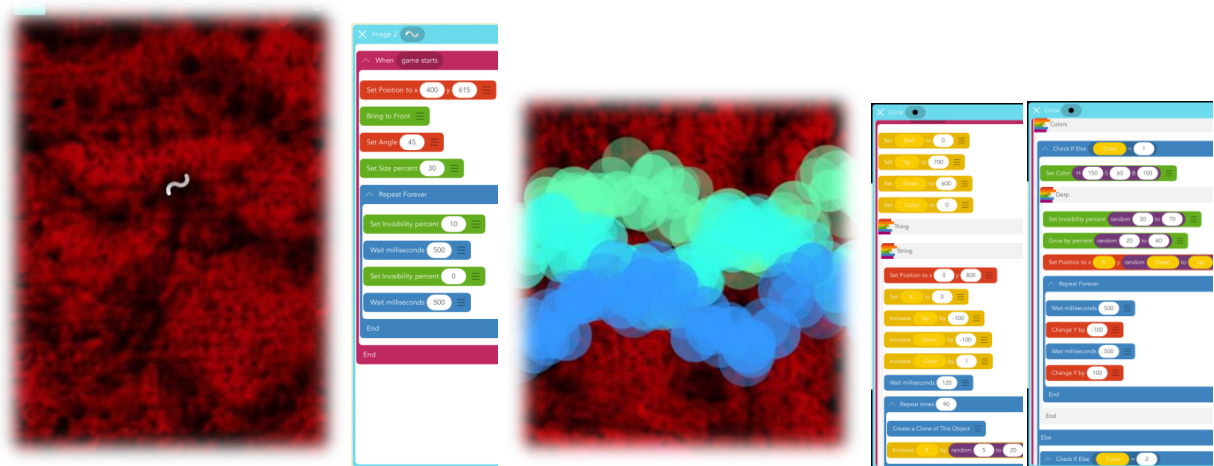
In the deep cosmos, the particles are uniformly heated to 3000 Kelvin. In the constellation of Eridan, however, one notices an area where the particles are slightly colder. There is a difference of -70 Kelvin microphones. One wonders what happened so that this cold region is present in a burning universe (03.2017, Sciences & Vie).



Name of the program : Cold Spot <https://c.gethopscotch.com/p/yodtl148j>

Simulation of the flashing galaxy

In the constellation of the coachman, there is a galaxy that flashes. The intensity of its signal is one million times more intense than expected. This phenomenon is still unexplained (03.2017, Sciences & Vie).

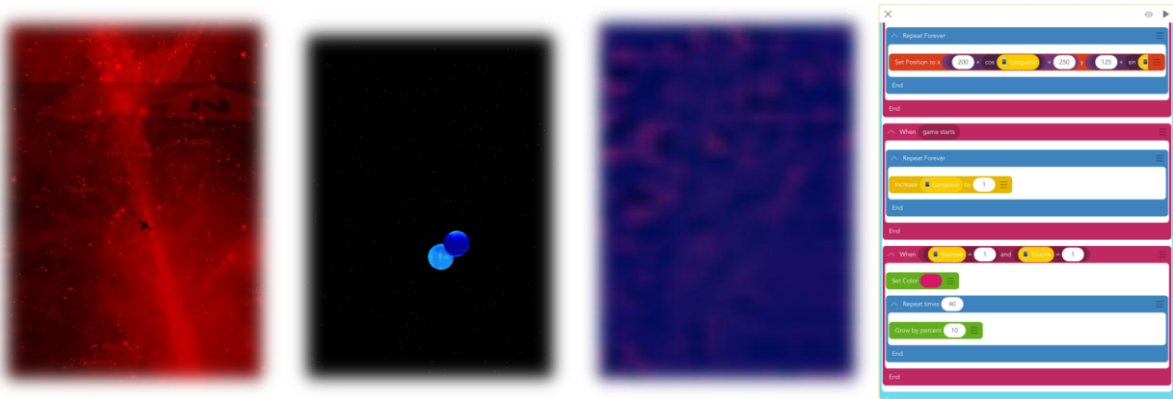


Name of the program : Galaxie clignotante <https://c.gethopscotch.com/p/yodu90sno>

Name of the program : Galaxie clignotante <https://c.gethopscotch.com/p/ythnofry>

Simulation of the explosion of double stars

In the constellation of the swan, one now notices a double star, two stars that revolve around the other. Their pulsation becomes faster and faster. Scientists observed the system for 2 years and predicted this explosion caused by the collision of two stars. This would give rise to a red nova, 10,000 brighter than the initial double stars. In addition, scientists have calculated that this explosion would take place in 2022 (14.01.2017 Science and Life). It is a first to witness the birth of a red nova in 5 years from here.



Name of the program : Etoiles doubles explosent

<https://c.gethopscotch.com/p/yod3a8o0z>



Name of the program : Explosion d'étoile double <https://c.gethopscotch.com/p/ythm7ebui>

Assessing a Hopscotch Project

Assessment is meant to inform learning. Teachers traditionally use assessment OF learning to document what students are doing to report to parents in report cards. As the Lorna Earl (2006) video suggests, assessment is much more than that. There is also assessment FOR learning which is meant to understand what students are thinking before instruction. There is assessment AS learning where we provide regular feedback, and based on what we see, provide opportunities to further practice. During assessment AS learning, students are also encouraged to reflect on their own work and self-regulate their work. Students are encouraged to become self-assessors. She indicates that most of our time should be spent in assessment AS learning. We can use all the tools available for all three types of assessment but it is what we do with the assessment which makes the difference.

Assessment AS Learning

With regards to Hopscotch, assessment AS learning is an important part of the app. Hopscotch is not only about learning how to code, it provides a safe environment for all types of learners, whether they are a beginner or advanced coders. Let's look at one example.

This is a Google Earth program written using Hopscotch. To write a program like this, I searched the Hopscotch app and found a program already started that I had to complete or modify. In order to remix a program, we need to be able to read existing code, understand how it works in order to be able to make modifications. Using the buttons, we can make the Earth move right, left. The other buttons make the Earth bigger or smaller. Some buttons are for viewing the Earth from space and some from the surface of the Earth. I modified the code to be able to see the entire planet Earth, not just America. I also removed some part I did not want like Google Moon, and I had one view from the Earth surface. After modifying the program, I published it on the Hopscotch community. Hopscotch analyzed the code and suggested modifications I could bring to the program. For example, I noticed that in one of the programs suggested following the publication that one had a large selection of images. This gave me the idea to add more Earth view buttons that could be selected and viewed. I unpublished the code and added several other earth views and republished my program

on the Hopscotch community. The next day, upon hearing conversations with family about unrelated topics, I thought to add different icons, to at least show a house with a tree. I unpublished the program, made the changes and republished it. The app is providing support for assessment for learning. Teachers need to make sure that students are aware of its existence, how to use it to improve their work, even when the teacher is absent.



Name of the program: Google Earth: <https://c.gethopscotch.com/p/yauw5k57b>

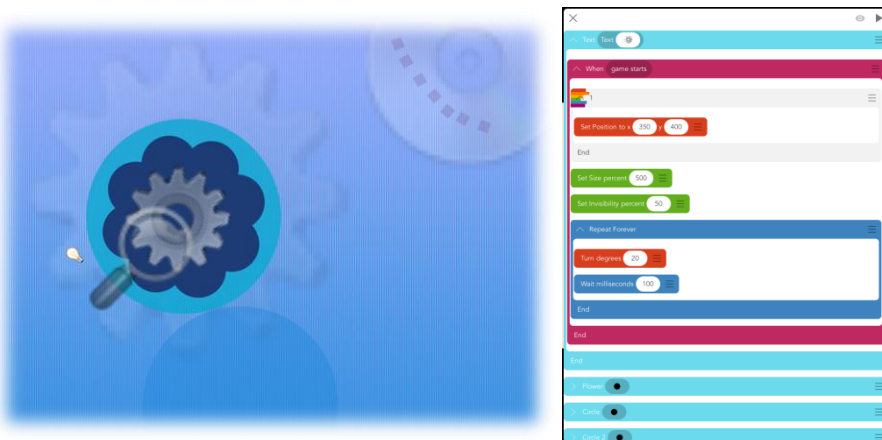
Assessment using Hopscotch is especially effective in the STEAM area: Science, Technology, Engineering, Art and Mathematics. It reflects what professional scientists, technologists, engineers, mathematicians use on a daily basis while including a strong element of art. Hopscotch provides the safe support for the struggling learners need. The app is easy to use and allow developing reading responses in a way that students find fun and engaging. The support for gifted learners is extensive. They can be challenged beyond what is expected of them by the curriculum. They can learn at school and at home, even if the student's knowledge exceeds the knowledge of the teacher. After reading a scientific text for instance, students can show their understanding with a Hopscotch written response. The written response takes a mathematical, scientific, artistic and engineering perspective. The app provides assessment AS learning to each learner, each time they publish a program.

Co-Constructing Success Criteria

When teachers co-construct success criteria with students, they benefit from the most powerful aspect of assessment. Teachers and students develop a common understanding of what is being learned. By discussing what needs to be learned, the learning goals, teachers and students clarify their understanding. By examining samples work with the criteria, students have a better understanding of what is expected, and will work towards that clear goal with more motivation. A Hopscotch program will need to be assessed according to the expectations you are working with.

Let's say, we are working with science reading. As with struggling readers and French Immersion readers, students need to discuss what they are reading in order to understand the meaning of what they are reading. Allington and Gabriel (2012) offers six elements for a successful reading program. One of them, especially relevant for struggling readers, is that every child should write about something personally meaningful. Students should write about something they care about. In this example, we will write a Hopscotch summary of a text about biometrics. Let's develop the success criteria for a summary.

- 1- I have included important parts of the text
- 2- I have included the main idea
- 3- I made a connection to another text or personal experience



Name of the program: Technology & Engineering Literacy Briefing

<https://c.gethopscotch.com/p/y1nvkguxp>

The student wrote using a tool that is personally meaningful and fun for him. As a result, he spends more time and effort with his work. For many students, using such a tool means going up one entire level in their final assessment. The main idea of the text is stated at the top. A summary including the important part of the text read is provided, in the students' own words. The student made a profound connection to engineering and how computers really work by coding an example of how biometry works. In this example, the student draw using his finger on the face provided. A different face is placed on the right. The code is programmed to mirror on the right what the left side is drawing on the left. We can see the lines do not match exactly, so we have a different person. The student could also have made a connection to a movie he had seen such as the Jack Ryan movie where Jack Ryan's face is compared with an identity card of another person and found not to match.

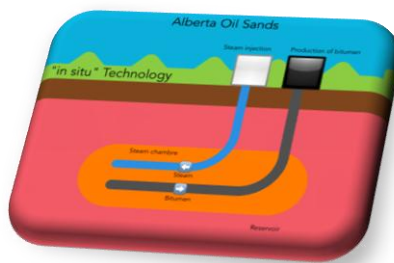
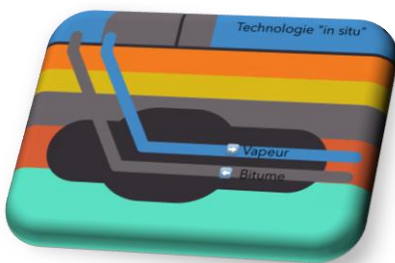
Portfolios

Portfolios can be used to create assessments of reading and writing over time (Government of Ontario, 2008). Portfolios contain work selected by the student that shows their best work and shows what the student has learned. Portfolio show aspects of students' learning that cannot be captured during tests. It shows evidence of learning of specific curriculum expectations. They demonstrate mastery of a particular curricular area. There are also several audiences for the portfolio. It could be the classroom teacher only, the class, a region or the entire world (Danielson & Abrutyn, 1997).

The two following Hopscotch programs could be seen as an equivalent reading response to an article about the oil sands. Both reading responses show the same scientific concepts being explained. The two programs were coded quite differently and show quite different levels of thinking. The program on the left consists only of drawing lines of different sizes, lengths, angles, colours and different starting points. The end result is an image showing the functioning of 'in situ' technology. The image was photographed and shared only with the teacher.

The program on the right is actually an interactive video game. It shows the same 'in situ' technology for petroleum extraction in a video game. Similarly to the first programs, lines were drawn to create the image. Interaction has been added. The

steam and bitumen lines are only drawn upon pressing on the buttons. For example, pressing on the white button will draw the water line and pressing on the arrow will change the direction in which the line is drawn. It shows some of the difficulty engineers face when constructing technology for petroleum extraction. If the angle is not right, the pipes will not go to the bitumen. If the steam line is not above the bitumen line, it will not allow the bitumen to be transformed into liquid by the steam. Using gravity, liquid bitumen fall down to the lower pipe in order to be collected. More thinking is involved into coding the second program. The repeating code is placed into self-created blocks showing different levels of abstraction. An object can do several functions based on events occurring in real time. The completed project is shared with the entire world, on the Hopscotch app and on social media.



Name of the program: Jeu de forage des sables bitumineux :

<https://c.gethopscotch.com/p/y07mr3tkj>

Hopscotch can be used with other apps such as **ExplainEverything** to explain the student's thinking. Such explanations can be published on a YOUTUBE channel. We can see here, an explanation of an intermediate version of the program :

<https://www.youtube.com/watch?v=r-tqWSfRHzo>.

All versions of the code was written by the same person. Those examples from the portfolio shows the progression in thinking about the code, progression in creativity, progression in confidence and interest, and progression with the audience.

At the time of this writing, a single Hopscotch programmer, **SlickJudge**, created more than 537 different sample Hopscotch projects that could be used from grade 3 to grade

10, across the entire curriculum. The programs are available 24 hours a day, 7 days a week, 365 days a year, across the entire globe where the Internet is available. Anyone can use them, free of charge, for learning purposes.

In order to help two-thirds of the world's population without access to the Internet, Google is developing its Loon project to offer the Internet to hard-to-reach areas. Indeed, using balloons at 100km altitude piloted by artificial Intelligences the whole world could have access to the Internet. The first trials were held in Puerto Rico and Peru (Science & Vie, 05.2017).



Name of the program: Ballon piloté par I.A. IA <https://c.gethopscotch.com/p/yv341whj7>

Links to Hopscotch programs can be accessed using any device with access to the Internet. The Peel District School Board brought the policy BYOD. If the school does not have computers, students can bring their own device for use in the classroom. Students are invited to be curious and creative with their own device. Hopscotch code can be written using an iPhone. In my experience, many of my most challenging students owned a phone and brought their phone to school. Instead of being distracted by their phone, we can use their phone to ignite their curiosity, to inspire them and be more engaged in the classroom.

Highlighting Misconceptions

A written response or visual response to a text is quite useful in science at the beginning of a unit to find out about misconceptions students have about a topic and what they would be interested in exploring further. The assessment could be done talking one-on-one, or in writing assessed for the next day.

Let's take the example of space. Many students may have seen movies like Star Wars or Star Trek or even seen actual NASA news (NASA, 2016). Using a tool like THINK-PUZZLE_EXPLORE from the book Making Thinking Visible, we can highlight several examples of misconceptions students have. These movies inspire students to study space but contain scientific misconceptions. For example, in the Star Wars movie, the light sabres are supposed to be laser. Laser is invisible and should not be seen with the naked eye. With the Juno probe, students might think that it is the only probe that was sent to Jupiter or the only tool available to study Jupiter. In fact, several space tools exist to study Jupiter, and Juno is only the latest space probe. Space probes have been sent to several planets.

Students could have several misconceptions. Finding out about misconceptions early in the unit and by identifying what are students' interests would benefit their learning.

Hopscotch provides a tool where the most shy and quiet of the students can show their understanding to be discussed with the teacher. We might also find out what resources students use the most to inform their learning and have a discussion of what resources are more credible on the Internet.



Name of the program: Reading response: <https://c.gethopscotch.com/p/y4evudtqs>

Creativity Rubric

Creativity is at the heart of the arts curriculum. The Ontario Arts curriculum indicates that creativity involves the invention and the assimilation of new thinking and its integration with existing knowledge. Art can be integrated with other subjects like science or improving our learning skills. After watching an episode of Star Trek,

students realize that certain chemicals and combinations cause explosions. Providing a simulation of what happens with some chemicals using Hopscotch might be much safer than doing the chemical reaction at home or in class. It is a question of security. This Hopscotch program could also show how someone feels as a result of consistent discrimination against them. With the image of Deanna Troi in mind, Star Trek's Enterprise's counselor, the student might be showing how to creatively discuss feelings in order to improve our well-being and learning skills as a result of reducing tension. Brookheart (2013) provided an interesting rubric to assess creativity. It involves the following descriptors: 1- Variety of ideas and context, 2- Variety of sources, 3- Combining ideas, 4- Communicating something new. The qualifiers in the image below corresponding to a level 4. The Brookhear (2013) rubric could be modified to include also content knowledge in other areas, in order to assess other subject areas. Also, each descriptor of the rubric could be weighted to take into consideration key look-fors.



Name of the program : El – Mélange explosif : <https://c.gethopscotch.com/p/y20zj6473>

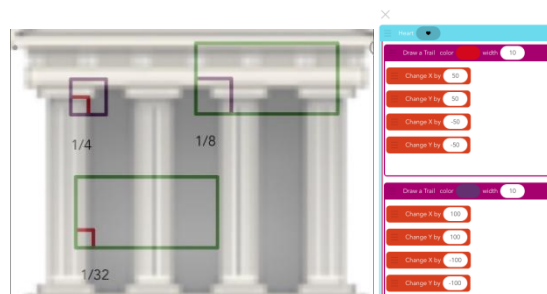
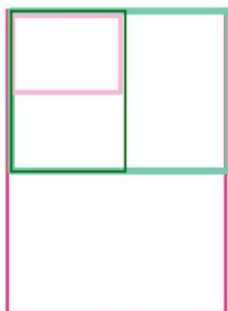
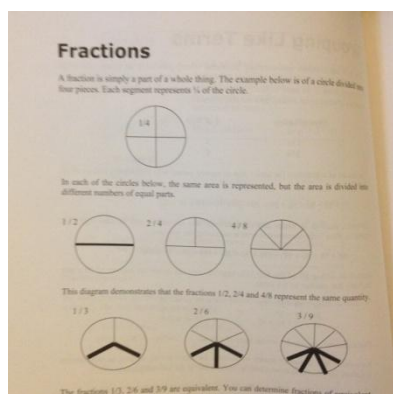
Teacher Moderation

Teacher moderation is a process where teachers come together to assess students' work based on a predetermined success criteria (Literacy & Numeracy Secretariat, 2007). Teachers who participate in teacher moderation assess students' work more fairly and consistently and share effective practices that meet the needs of all students. In his webcast, Douglas Reeves indicates that at the beginning of such a process, we could very well find the same student's work could be assessed at levels 1, 2, 3 and 4 by different teachers. Teachers had heated arguments about their point of view and reminded teachers that the enemy is not each other, the enemy is ambiguity (Reeves, 2007). If teachers do not have a common understanding of success looks like, they will not be able to assess students' work properly. If mathematics is not assessed properly,

nor is its usage with technology. It is an ethical issue. Since coding has deep connections to the mathematics curriculum, we will use a rubric from the Ontario Mathematics Curriculum. The rubric consists of levels of thinking. Many times, students are able to do the math calculations, but have no idea what problems they are solving. This rubric helps in the assessment of the higher levels of thinking in mathematics.

Thinking The use of critical and creative thinking skills and/or processes*				
	The student:			
Use of planning skills - understanding the problem (e.g., formulating and interpreting the problem, making conjectures) - making a plan for solving the problem	- uses planning skills with limited effectiveness	- uses planning skills with some effectiveness	- uses planning skills with considerable effectiveness	- uses planning skills with a high degree of effectiveness
Use of processing skills* - carrying out a plan (e.g., collecting data, questioning, testing, revising, modelling, solving, inferring, forming conclusions) - looking back at the solution (e.g., evaluating reasonableness, making convincing arguments, reasoning, justifying, proving, reflecting)	- uses processing skills with limited effectiveness	- uses processing skills with some effectiveness	- uses processing skills with considerable effectiveness	- uses processing skills with a high degree of effectiveness
Use of critical/creative thinking processes* (e.g., problem solving, inquiry)	- uses critical/creative thinking processes with limited effectiveness	- uses critical/creative thinking processes with some effectiveness	- uses critical/creative thinking processes with considerable effectiveness	- uses critical/creative thinking processes with a high degree of effectiveness

While assessing the work, teachers would initially place their work samples in three categories: low, medium, high for discussion. We have on the left, a page from the ProlicePrep program. In the middle, we have a Hopscotch game, not coded by the student that was used to describe fractions. On the right, we have a Hopscotch program, coded by the student. In reality, such an assessment is not complete without talking to the student or have samples writing from the student, explaining their thinking, or knowing the grade level of the student.



Name of the program: Tap Twice To Draw Rectangle

<https://c.gethopscotch.com/p/y4horj9gx>

Name of the program: Fractions : <https://c.gethopscotch.com/p/xu0jke28e>

In these examples, it is the design of the activity by the teacher that would allow a student to show higher levels of thinking. The worksheet allows the student to understand the problem, make a plan to solve and model the solutions but does not allow students to show critical and creative thinking. The second example does not involve any coding on the part of the student. The student plays a game to show understanding. The student can understand the problem, make a plan to solve the problem, make a model of the solution and form conclusion. Students use critical and creative thinking to approximate the points on the screen that would best models the fractions. The student can demonstrate all expectations at level 3. The third example allows the student to go beyond all thinking expectations by allowing the making of an elaborate, critical and creative plan to show fractions using code. It all depends on the activity, but coding allows a student to develop his critical and creative thinking skills while allowing them to go beyond the ministry grade level expectations.

Learning Skills

The development of learning skills and work habits go hand in hand with students' academic development (Growing Success, 2010). It is an integral part of Ontario students' character development. Hopscotch does not only allow the development of academic skills, the app is designed to also allow the development of students' learning skills of responsibility, organization, independent work, collaboration, initiative and self-regulation.

LEARNING SKILLS AND WORK HABITS IN GRADES 1 TO 12	Learning Skills and Work Habits	Sample Behaviours
	Responsibility	The student: <ul style="list-style-type: none"> fulfills responsibilities and commitments within the learning environment; completes and submits class work, homework, and assignments according to agreed-upon timelines; takes responsibility for and manages own behaviour.
	Organization	The student: <ul style="list-style-type: none"> devises and follows a plan and process for completing work and tasks; establishes priorities and manages time to complete tasks and achieve goals; identifies, gathers, evaluates, and uses information, technology, and resources to complete tasks.
	Independent Work	The student: <ul style="list-style-type: none"> independently monitors, assesses, and revises plans to complete tasks and meet goals; uses class time appropriately to complete tasks; follows instructions with minimal supervision.
	Collaboration	The student: <ul style="list-style-type: none"> accepts various roles and an equitable share of work in a group; responds positively to the ideas, opinions, values, and traditions of others; builds healthy peer-to-peer relationships through personal and media-assisted interactions; works with others to resolve conflicts and build consensus to achieve group goals; shares information, resources, and expertise and promotes critical thinking to solve problems and make decisions.
	Initiative	The student: <ul style="list-style-type: none"> looks for and acts on new ideas and opportunities for learning; demonstrates the capacity for innovation and a willingness to take risks; demonstrates curiosity and interest in learning; approaches new tasks with a positive attitude; recognizes and advocates appropriately for the rights of self and others.
	Self-regulation	The student: <ul style="list-style-type: none"> sets own individual goals and monitors progress towards achieving them; seeks clarification or assistance when needed; assesses and reflects critically on own strengths, needs, and interests; identifies learning opportunities, choices, and strategies to meet personal needs and achieve goals; persistence and makes an effort when responding to challenges.



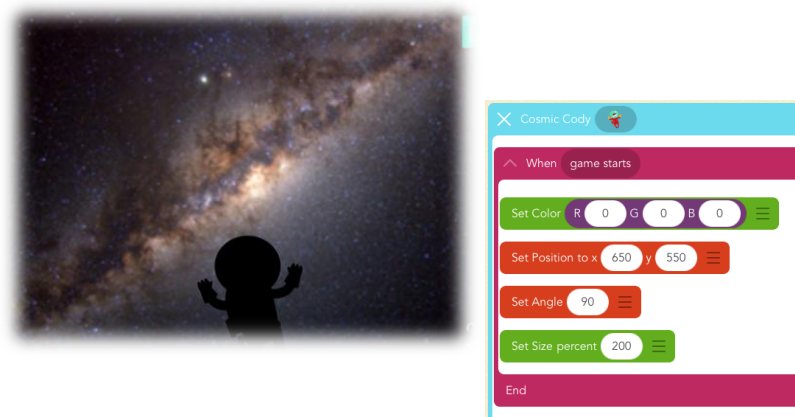
Name of the program: WikiLeak: <https://c.gethopscotch.com/p/xyewpx09y>

A student using Hopscotch can demonstrate **responsibility** by completing their work on time. Completed work is shared on the Hopscotch app and made accessible to everyone. The student makes a positive and ethical contribution to the world. Intellectual property is respected since if a student build upon another person's project, references are cited and the author of the first project is listed. A student shows **organization** by completing all parts of his assignment and by maintaining his own portfolio of best works. Coding also forces the development of more organized thought. Hopscotch Programs that are not well organized, just do not work. A completed program is an organized program. With Hopscotch, students are strongly encouraged to develop **independent work** practices. They use their time wisely by completing their work and by learning about a highly needed profession from an early age. They can use all the resources available to them, including classroom materials, social media, featured programs and searched programs provided by the Hopscotch community. They are able to work in the classroom and continue at home with their own device. Students are able to work with minimal supervision. Students show **collaboration** by integrating the feedback provided by the app and their peers to improve their own learning. Using the Hopscotch app, students become active members of an online community. By sharing their work online, they assist others by sharing their ideas and expertise. The type of projects they decide to code can show solutions to real conflicts in the world. Coding is new to most teachers and schools. Students using Hopscotch show **initiative** by using new ideas and opportunities for learning. Coding with Hopscotch is so interesting, students develop a positive attitude

towards learning. Many students would work on several projects without being asked. Students develop curiosity by exploring the app and learning what they can do with code and integrating their learning into their work. Students show **self-regulation** by persevering when a project that seems difficult. They ask for help in the classroom or with the app by posting questions on the Hopscotch forum or sending emails. The student is able to set individual goals, as to how involved his projects and code can be. The student is able to select and review other programs and codes that will help him achieve his goals. The student is able to reflect and be critical by reflecting on the suggestions provided by the app when publishing a project and use those ideas to improve his learning.

Conclusion

I am as stunned as (Dnews, 2014) was to realize that 1 out of 4 Americans still do not know that the Earth revolves around the sun and that only 42% of young people between 18 and 24 know that astrology is not at all a science. At the conclusion of his book 'Mapping the heavens' the astrophysicist Priyamvada Natarajan (2016) indicates that the endemic denial of science does not come from the lack of knowledge of scientific facts, but rather from ignorance of how science and scientific thinking work. This thinking is also shared by the community of educators who offer leads to address this problem (Grant, Lapp, 2011).



Grant and Lapp (2011) suggest four strategies to help teachers. First, interesting subjects of science must be found in order to show the relevance of science and its application in real life. The emotion and interest engendered by the relevance of the subject are intended to convince students to want to experience science. Second, after choosing a topic, students must read the research and make connections with their personal experiences in order to have basic knowledge and nurture their passion. Third, they must be taught to read as a scientist, with all the critical thinking that this entails. Fourth, learners should be guided to analyze the data. Where do the data come from, how are they collected and what do they mean? These strategies will critically allow students to form their own conclusions and ask new questions.

Seeing the extent of the whole universe, we realize that we are small in this extent and that our galaxy is only a galaxy among an infinitely large number of galaxies. In the

radical issues confronting scientists, what is ultimately at stake is defining and finding our place (Natarajan, 2016).

Astrophysicist Neil Tyson deGrasse (2017) reminds us that many people kill and get killed because they have a different conception of God. Others kill because of personal needs or political dogma. Faced with the vastness of the universe, the multitude of galaxies, the possibility of encountering other intelligent forms of life outside our planet and our tiny size in this extensive place, we are forced to revise our perspectives, our identity and to become much more humble and even, taking into account our human nature, become aware of the deepest values and meanings by which we live. With a larger and deeper vision of our universe and our place in the universe, it becomes much easier to see beyond our immediate problems and circumstances in order to explore and think about what is facing humanity.

Accountability is with each of us. What can we do to participate? We must establish the conditions for increased accountability, even when the hierarchy in which we find ourselves does not want to move. We have a vision! What are we going to do? What are our solutions?

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