

Cosmos with Hopscotch

Diane Boulanger

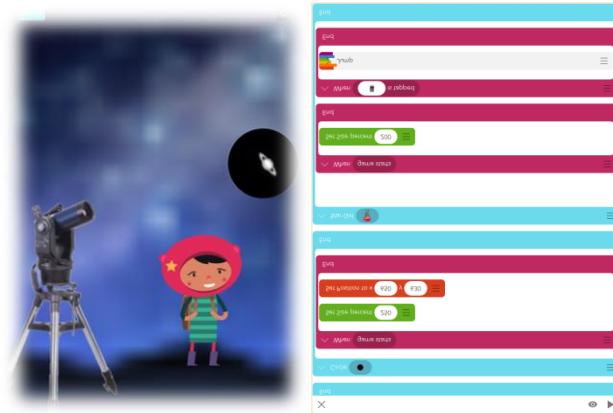
When I went to school, astronomy and space studies were not in the school curriculum. Even at the university, in the science department, astronomy was not on the agenda. What sparked my deeper interest in the cosmos was a little-known picture book I bought for my children, titled 'My Place in Space'. This book proposed a profound question and inspired a multitude of other questions. Where do we live 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 foundation of our universe? How did it evolve? Are we alone in this universe? These are all multi-generational and multicultural issues that drive scientists to understand the world in which we live.



Name of the program : Grosseur <https://c.gethopscotch.com/p/y9r6leom6>

The small telescope that I had purchased 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 develop the motivation for understanding science, with our own questions. The euphoric feeling of seeing Saturn's rings with a telescope, and not only with an image, is quite memorable and push many young children to pursue further studies in science. Instruments like a small telescope allows students to realize that science is based on real observations, on evidence. Science is not a collection of facts or beautiful images taken with the Hubble telescope.

Science is a way of thinking to understand our world and to develop a better future for all of us. Science makes it possible 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.

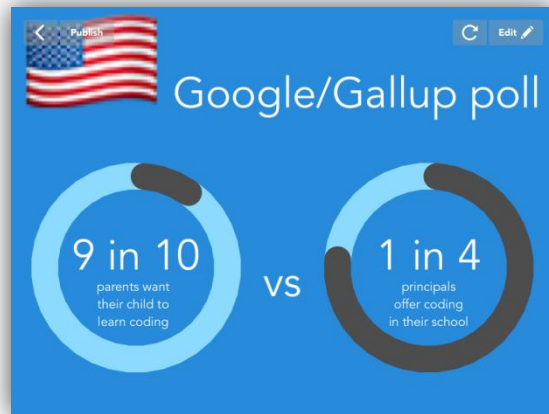
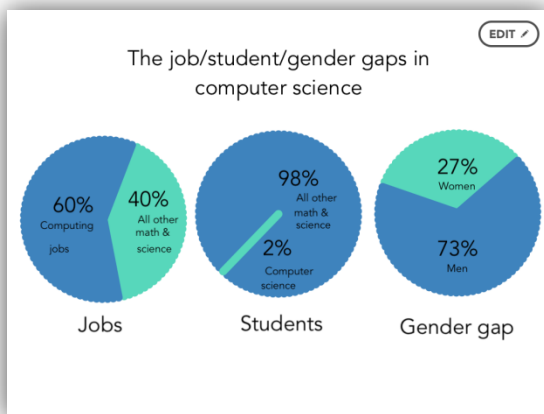


Name of the program : Saturne photoShop <https://c.gethopscotch.com/p/yomzs6jxl>

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.

Learning to Code

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?

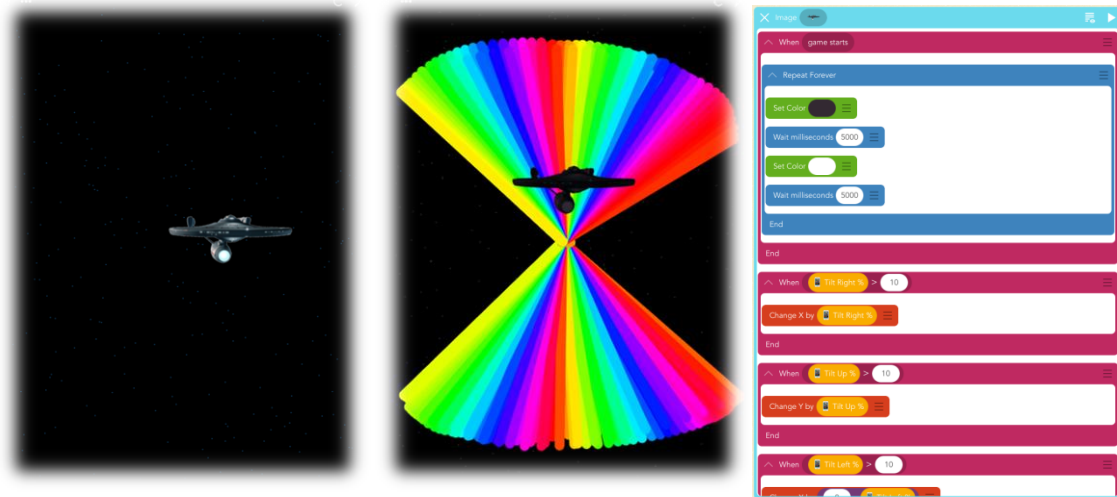


Several terrestrial and space telescopes are under construction including the James Webb space telescope that will open the doors largely to astrophysics. With the James Webb telescope, we will be able to see the cosmos 100 times better than with the Hubble Space Telescope. Astrophysicists use simulations, 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.

Genius Hour

During Genius Hour, once a week, we can challenge all our students to create something they value and 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. During a 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 excite them.

Star Trek's series and films motivate many of our young people to discover new frontiers and move into the unknown. Students focus on these ideas. Learning their imagination to take the first steps in learning programming is an innovative strategy.



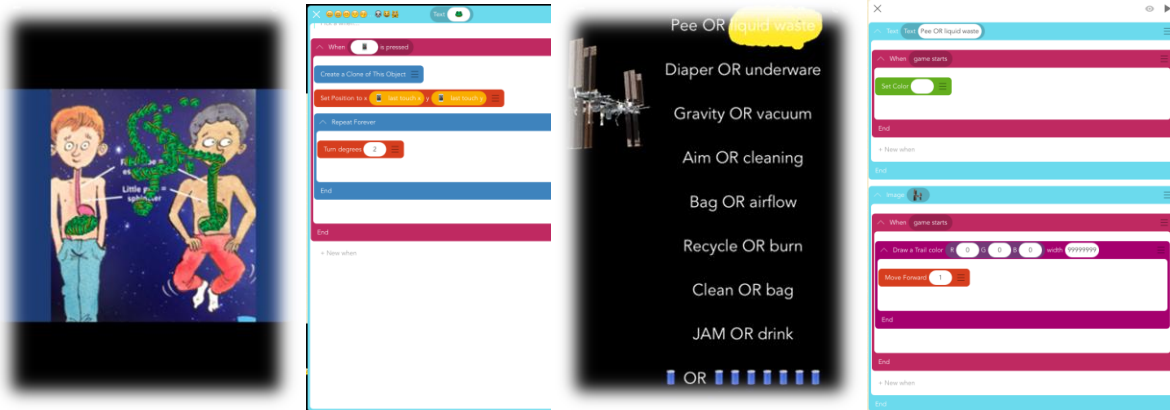
Name of the program : Face à l'inconnu <https://c.gethopscotch.com/p/yodzsslmi>

During genius hour, real examples of Canadian space missions can be coded. Canadian physician and astronaut Dr. Dave Williams demonstrated a growth mindset to become an astronaut. As a young man, when he considered the job of astronaut, 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.

The application Hopscotch offers several videos within the application to teach the beginnings of programming. Using these videos, any student can learn by themselves, the basic concepts of programming, in just a few hours. Here are a few examples.

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 the stomach!

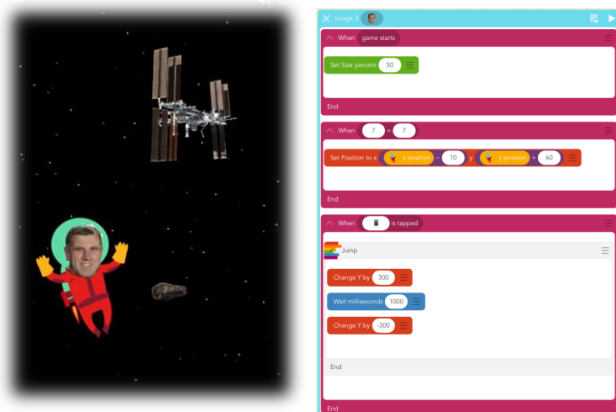
Using the Hopscotch *Quiz App* template, we can write a quiz demonstrating our knowledge of space, while learning from Dr. Dave's book. With our finger, we can emphasize the answers to the touch of the screen.



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>

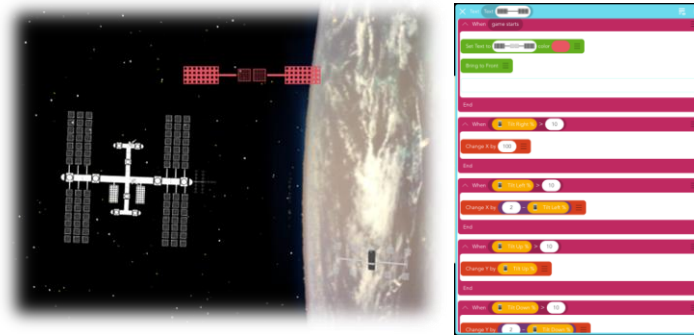
Finally, a third suggestion for Genius Hour is to write a first video game with Dr. Dave and the *Geometry Jump* model from Hopscotch. During an exit in space, called Extravehicular Activity (EVA), Dr. Dave may be called upon to avoid objects like small space debris. He manipulates his space suit, the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



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

Hopscotch also offers a wide variety of already designed programs that can be studied and modified. Here we see a program written by Real Funky 63. We added a satellite to

the program. We used a written program to write a new program. The text added is the new satellite, coloured pink, next to the International Space Station.

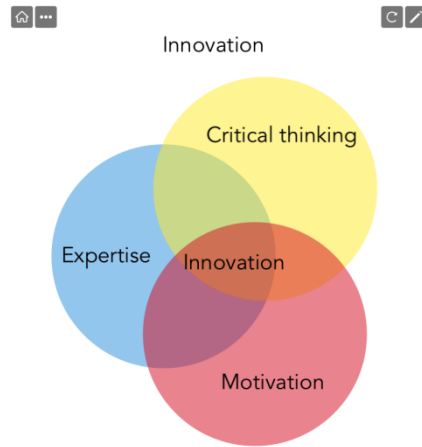


Name of the program : New SATellite <https://c.gethopscotch.com/p/yaxlb0cpc>

The challenges given during Genius Hour will motivate all students, including math students and our science apprentices.

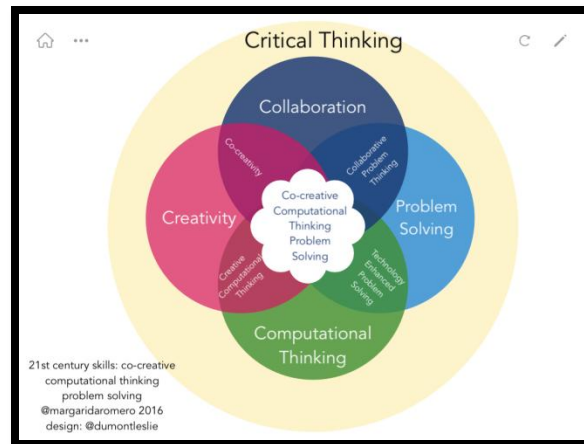
From scientific game to innovation

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 gaming 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 school 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 game can also be easily designed and played using Hopscotch.

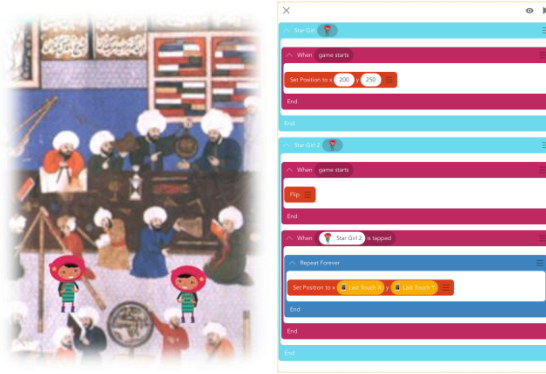
With Hopscotch, students can play games that others have created using their iPad or their iPhone. With Hopscotch, however, we add innovation. Students can create their own ideas, programs and games to promote an ideal like critical, scientific and innovative thinking and share their creation with the world. They can emulate as early as 8 years old what the entrepreneur and the most innovative scientist do as work. In the specific context of programming, student learns not only to code, but to create innovative ideas with the code (Romero, 2016). Romero also shows in her model of critical thinking how the computer thinking of programming is related to the skills of the 21st century.



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 encoded 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.

Game of the Female 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 lobbying on the Government that the history of the Middle Ages is now part of the Ontario curriculum. In the Middle Ages, during a dark 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 their people. 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.



Name of the program: Muslim woman astronomer

<https://c.gethopscotch.com/p/yonoeq096>

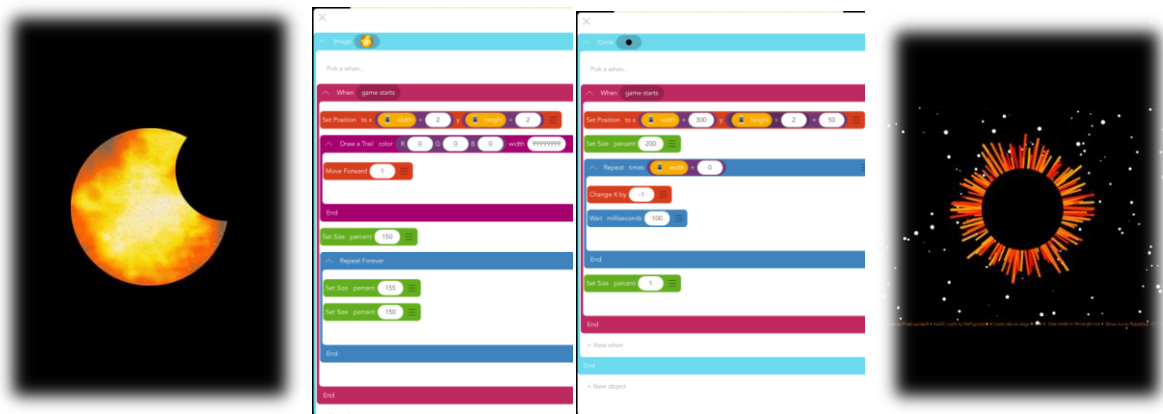
The image that students have of science and scientists affect their interests and their motivation in the study of science. Their motivation is an important element in their level of scientific literacy. It is important to include the contribution of cultures from around the world in order to introduce all our students to scientific culture.

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

In the Middle East and even today, the field of cosmological science is dominated by men. Although we have 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 female scientists who move to the observatory to the touch of the finger on the iPad are inserted in the historical image.

Games of the Eclipse of the Sun

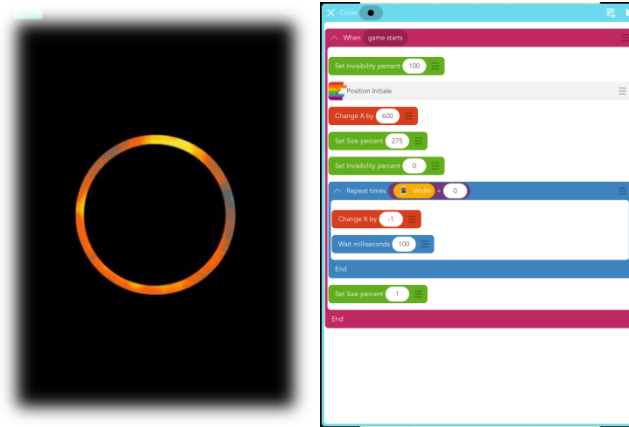
Genius Hour also allows us to explore current events in science, including the observation of natural situations. An eclipse of the sun occurs when the moon passes in front of the sun. There are at least two eclipses of the sun per year that can be seen somewhere on Earth. If the moon passes only a portion 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 whole 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.gethopscotch.com/p/y7sji2wiw>

Name of the program : Eclipse <https://c.gethopscotch.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.

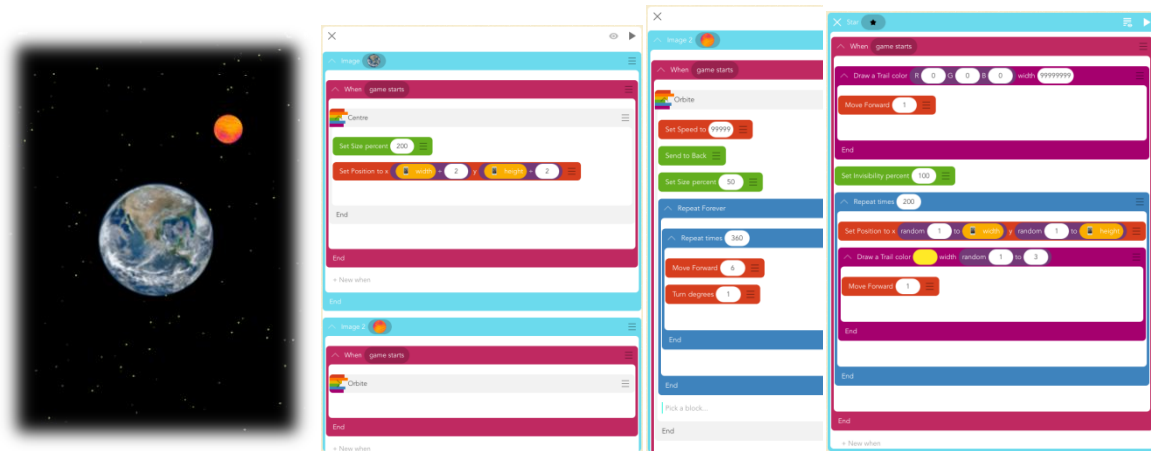


Name of the program: Eclipse annulaire <https://c.gethopscotch.com/p/yopk467g8>

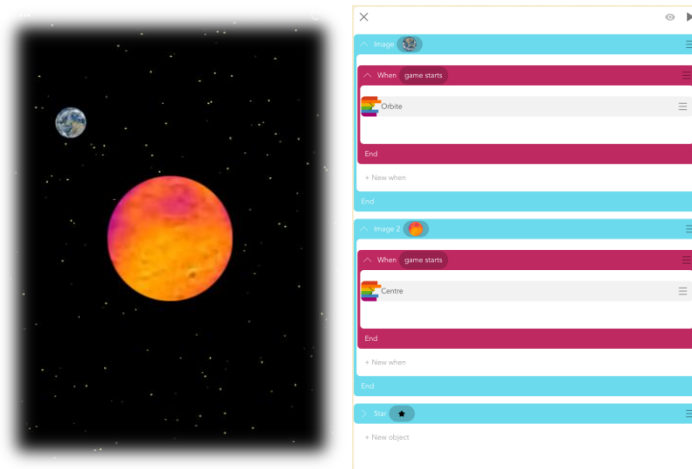
The next upcoming eclipse of the sun in North America will be August 21, 2017. The calculation of eclipses time is now published by NASA.

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 model geocentrism, where the sun revolves around the Earth, to the heliocentric 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 his 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, but only a hypothesis, but not reality.



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



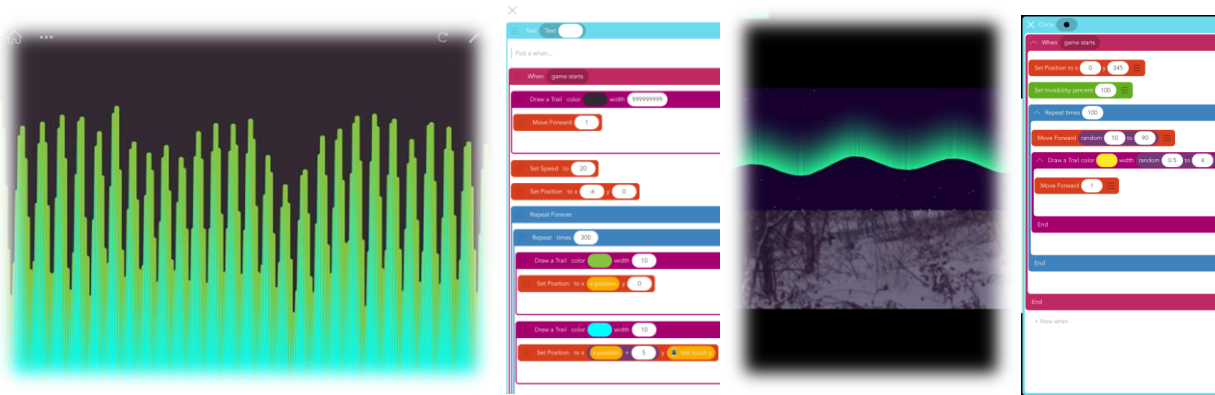
Name of the program : Héliocentrisme <https://c.gethopscotch.com/p/yba2aqs08>

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.

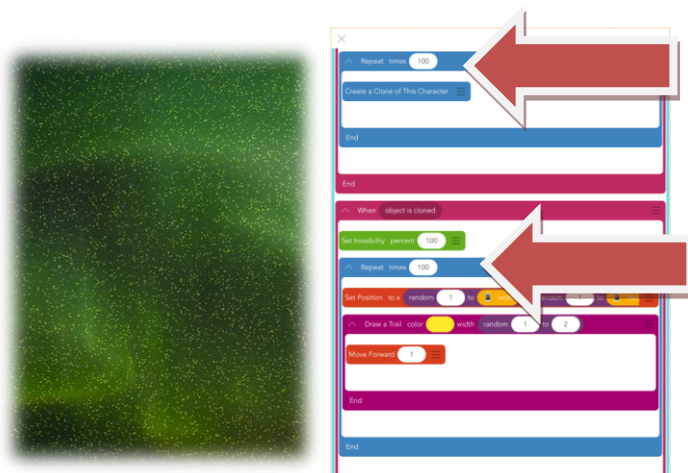
Live cameras provide the opportunity to observe what is happening in the world in real time. One can see images of nature, such as a nest of peregrine falcons, traffic on route 401 or sky for example, seen from several observatories in the world. It can be accessed at any time using the Internet. The 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.gethopscoth.com/p/yfgdii3qv>

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?



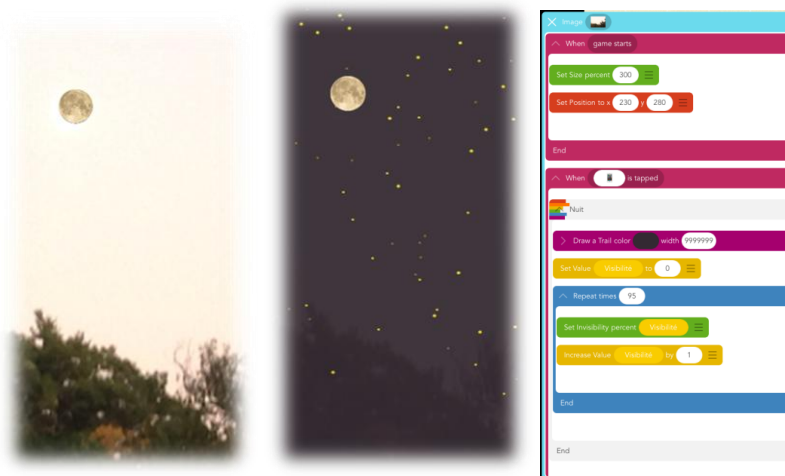
Name of the program: Nombres d'étoiles <https://c.gethopscoth.com/p/y9e8fumhr>

Using the Hopscotch code, one can interactively 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 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: 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.

Game of the Lunar Month

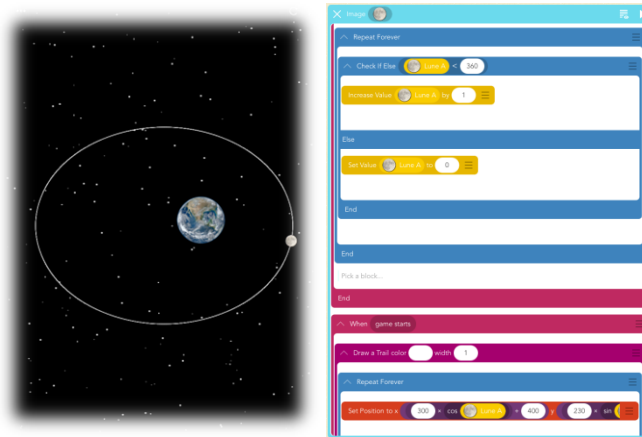
For the Muslims, the moon is important since the lunar calendar based on the movements of the moon is still used in Islamic countries. A lunar year is 11 days shorter than the solar year. For example, the month of Ramadan during which Muslims make the young from dawn to sundown is every 11 days earlier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



Name of the program: Ramadan: <https://c.gethopscotch.com/p/xoqit18qz>

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 show 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

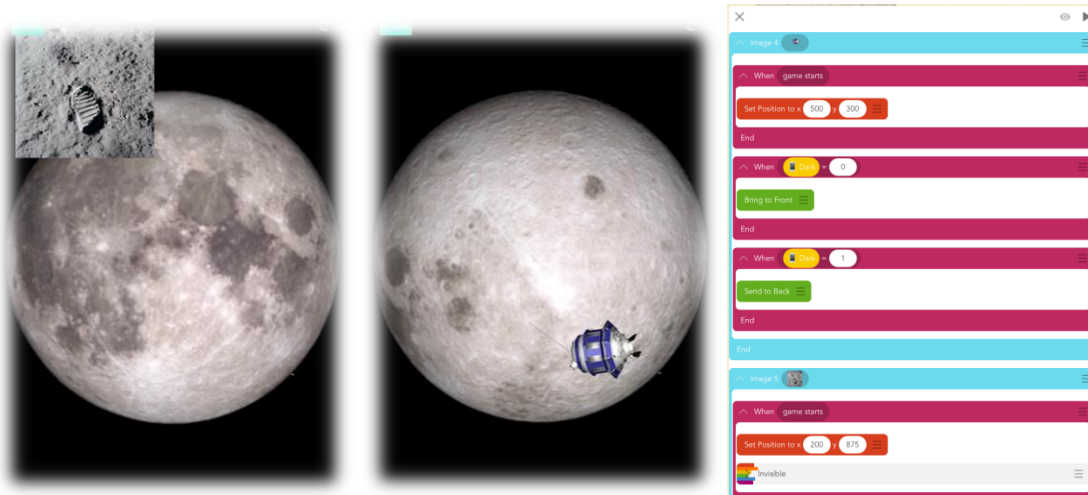
<https://c.gethopscotch.com/p/xl5bn30wt>



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 does exactly one turn on its axis every time it makes a rotation around 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>

Mercury Project Game

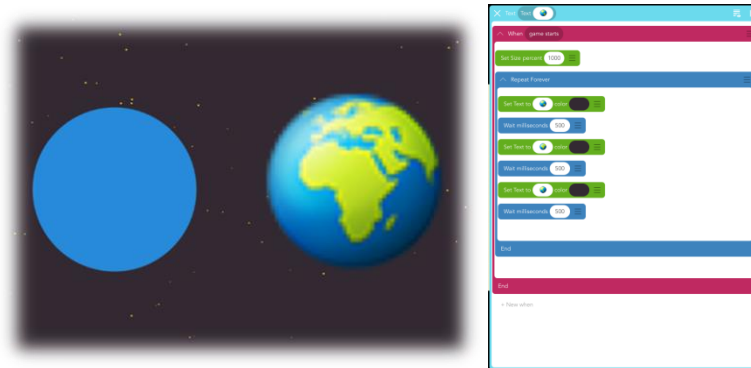
Radio enthusiasts will have many ideas for programming. For example, the death of John Glenn (RIP) was recently learned by listening to the radio. Looking for more information on the Internet, one can discover the impact of this astronaut who in 1962 piloted the Mercury capsule, the first American capsule 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 shape.



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 difficult to explain 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. How can we interpret that there are still people who believe that the Earth is flat and does not have the growth mindset necessary to realize that the Earth is round?

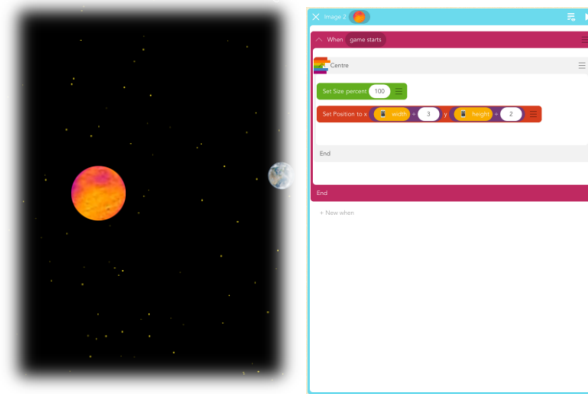


Name of the program: Modèle de la Terre plate

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

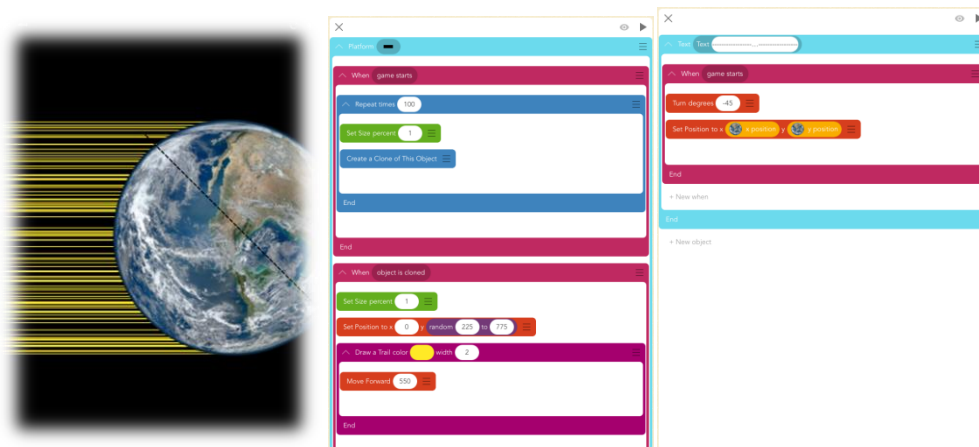
Games of the distance between the Earth and the Sun

In his book, Micheal Allan (2014) offers many ideas of common mistakes 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 a 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. Towards what other problems, does this problem lead us to?



Name of the program: Hiver – idée fausse <https://c.gethopscotch.com/p/yba70eq35>

In discussing this mathematical interpretation, one may wonder whether our idea works in all cases. Students who have travelled 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 Celcius, while on Mars, the average temperature is - 63 degrees Celcius. Is there any other way of explaining what is happening? Is there a model that we can fear?



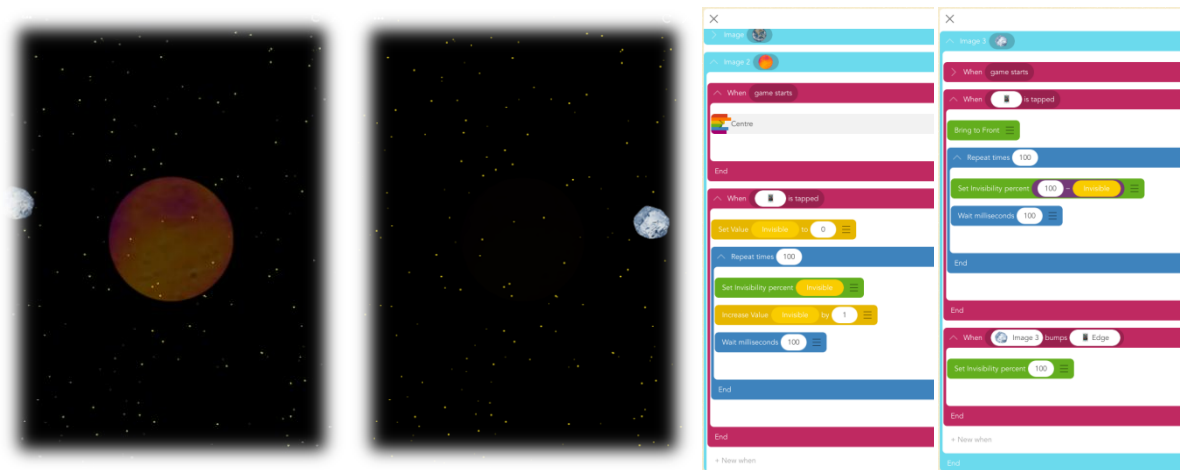
Name of the program: Lumière du soleil sur la Terre
<https://c.gethopscotch.com/p/yba8r9so0>

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.

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. We see here a simulation of the death of the sun and the loss of the Earth that follows.

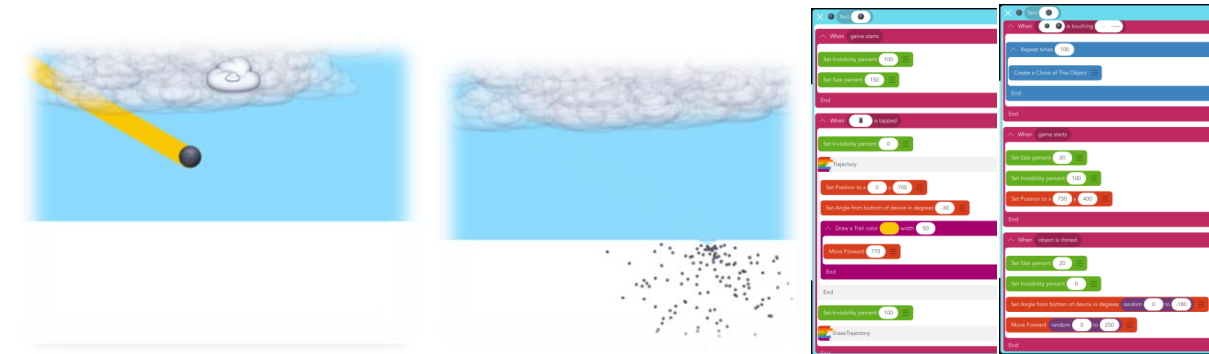


Name of the program: Mort du soleil <https://c.gethopscotch.com/p/ybfekclf6>

Game of the meteorite

Sometimes rocks fall from the sky. These meteorites are difficult to differentiate from land rocks only by looking 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 the 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 wrote 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

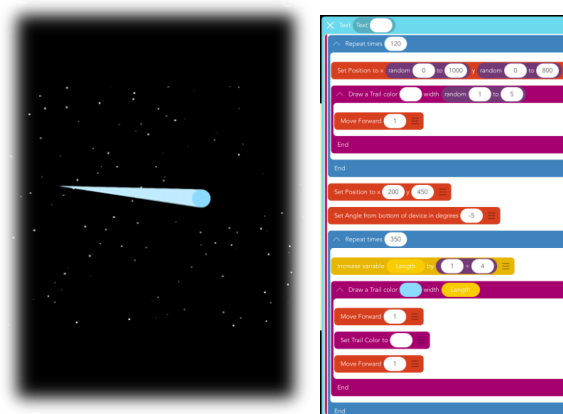
to detect potentially dangerous meteorites.



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

Game of the Comet

Comets are small pieces of ice that are mostly found in the Kuiper belt. 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 kilometres.

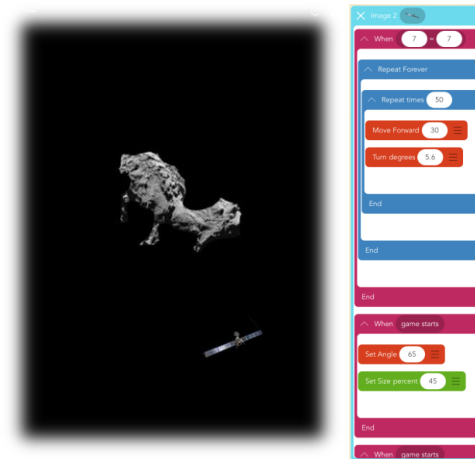


Name of the program : Comet <https://c.gethopscotch.com/p/xogm3376t>

Rosetta spacecraft game

The European Space Agency's Rosetta Space Probe went to the 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

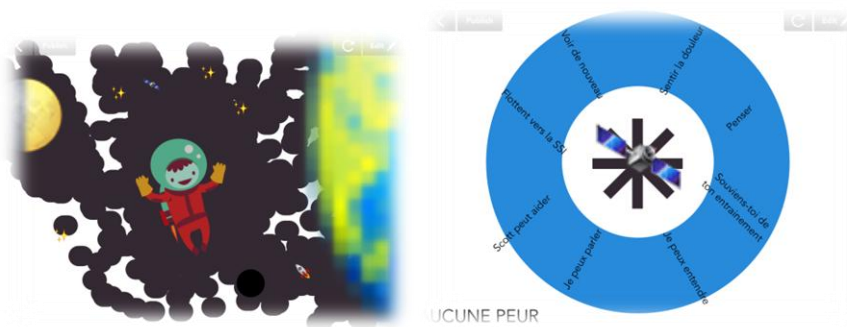
probe allowed to see its shape and its rock surface. The probe has also collected data of the chemical composition such as methane, ammonia, amino acids that make up living beings. This probe was able to collect data bringing us closer to the origins of life (25.03.1017, Science and Life).



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

Games of emotional intelligence

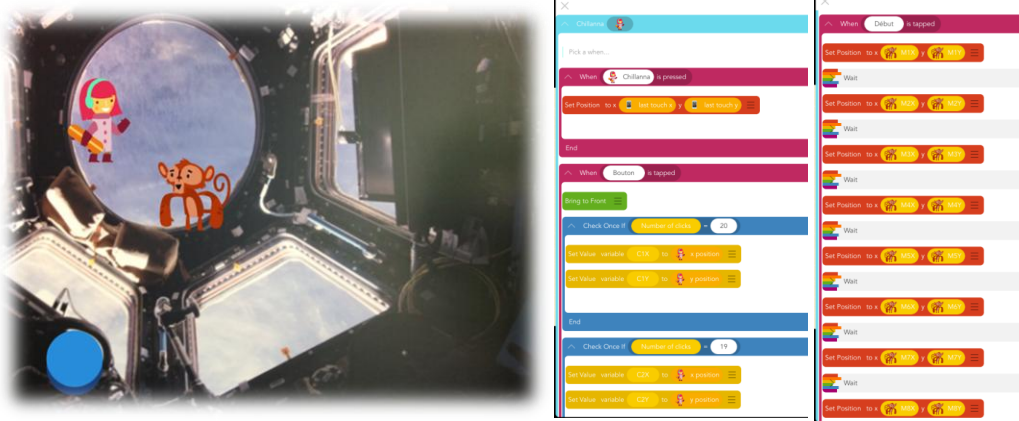
One cannot become an astronaut, or an effective member of society without having superior emotional qualities. Chris Hadfield sets an example. In a walk in space, his tears did not flow normally and he lost sight. What were his options? What could he do, blind in space with his tools? To fear? Never. 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 press 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 : Pour: <https://c.gethopscotch.com/p/xop5ffgn3>

Movement Game in the International Space Station

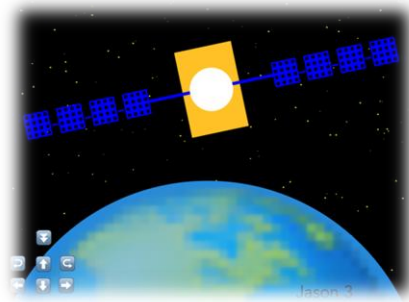


Name of the program: Stop motion ISS <https://c.gethopscotch.com/p/y8zokh8er>

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. 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.



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. 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.

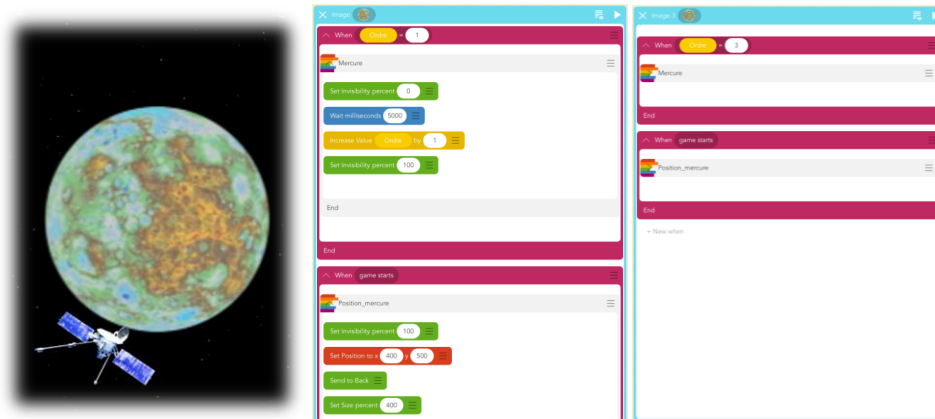


Name of the program : Solar System <https://c.gethopscotch.com/p/xzzru5mwu>

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. With no more fuel, it 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.

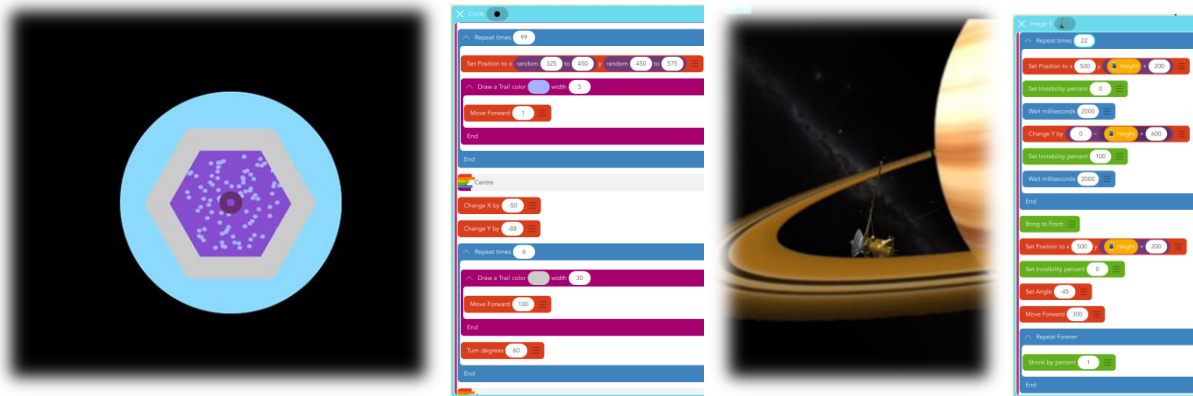
Mercury almost certainly also has a liquid core, which produces a magnetic field as on Earth. The surface of Mercury could be seen in a very detailed way, and is covered with craters caused by the collision of asteroids and meteorites. The temperature at its surface varies between -170 and 420 degrees. 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>

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 kilometres in diameter, but only 90 km deep. Saturn has 60 moons and Cassini has discovered that some are suitable for 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 northern pole of Saturn. Cassini will probe the active geysers of the Enceladus moon, and 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>

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 areas indicate where the light is most intense in the city of Montreal. As the students touch the screen, a yellowish light appears at his fingertips.

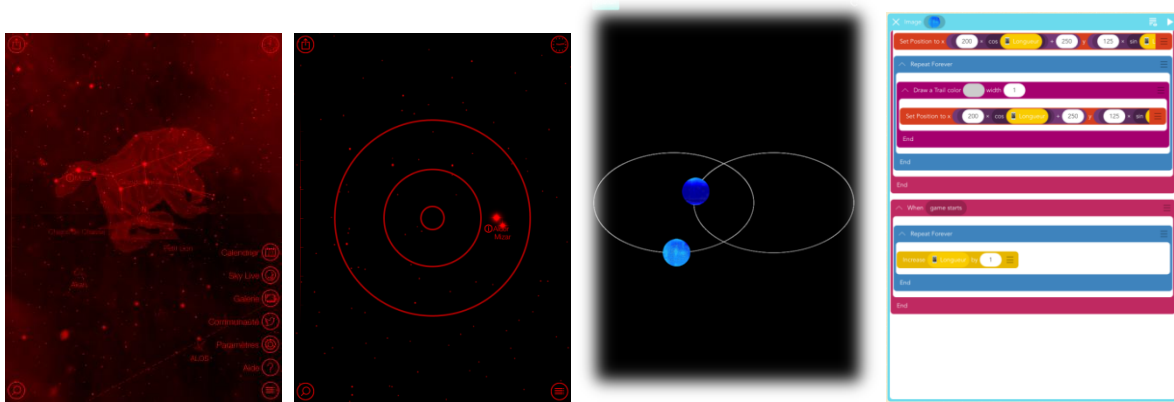


Name of the program: Ville de la SSI : <https://c.gethopscotch.com/p/xyn5p7q8a>

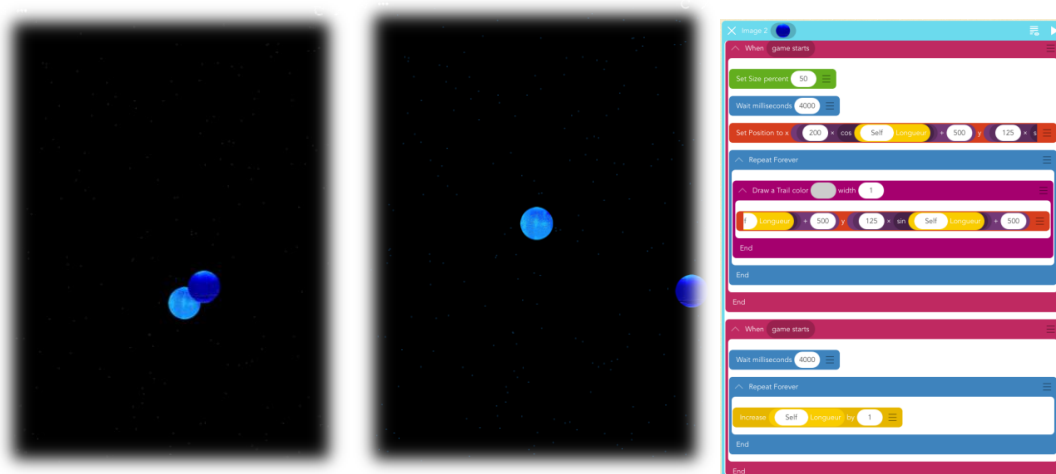
Games of the binary stars

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.

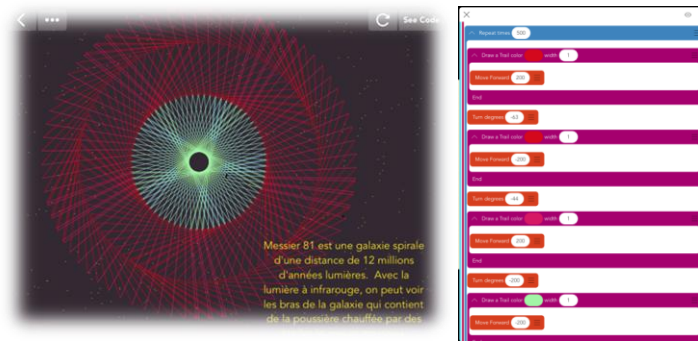


Name of the program: Simulation étoile double <https://c.gethopscotch.com/p/yod0u7uks>



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

Game of the Messier galaxy



Name of the program : Messier 81 Galaxy <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 in infrared. Infrared allows us to see the heated dust not from the massive young stars.

Games of the Telescope

It is possible to take wonderful pictures with a telescope. The book "Turn Left at Orion" provides 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 was 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.

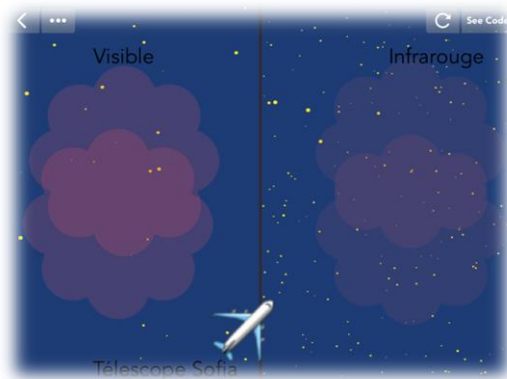


Name of the program : Télescope focus <https://c.gethopscotch.com/p/yfgg8r2ra>

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

Sofia telescope game

NASA's new Sofia telescope, mounted on a Boeing 747 aircraft, was designed to study space with the help of infrared technology to see objects that are difficult to see in the visible spectrum. Scientists gather information while travelling 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 : Infrarouge : <https://c.gethopscotch.com/p/xmqig22om>

Space elevator game

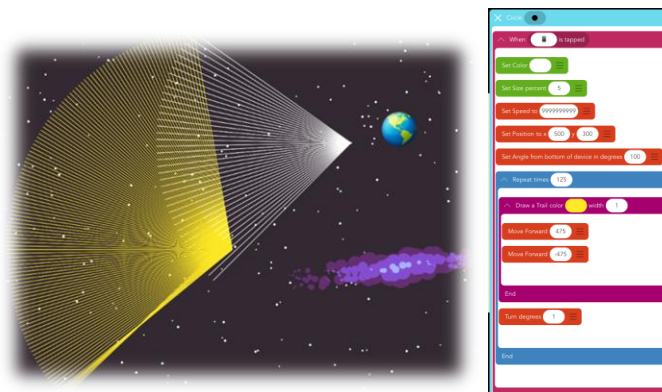
What is the future of space exploration? In the movie "The mysteries of the invisible world", we talk about nanotechnology and how carbon nanotubes can be used to build really solid materials. These solid materials could be used to make a space elevator. This space elevator could make enormous savings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



Name of the program: Space elevator: <https://c.gethopscotch.com/p/xxe9ws9ml>

Game of the NANO ship

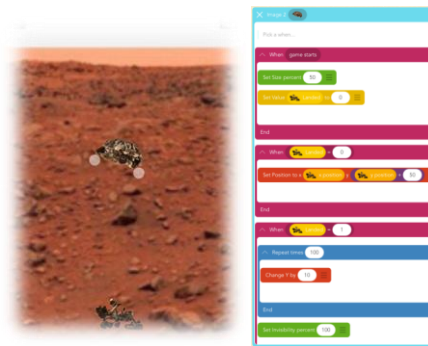
There is a new project, led by billionaire Yuri Milner, which proposes to send a tiny vessel to the Alpha Centaur system. He proposes to send a NANO ship, which can be held between two fingers. It may take 20 years to develop this radically different technology. A normal ship would take 30,000 years to travel the distance of 4.37 light-years. But the StarShip 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 the rover on Mars

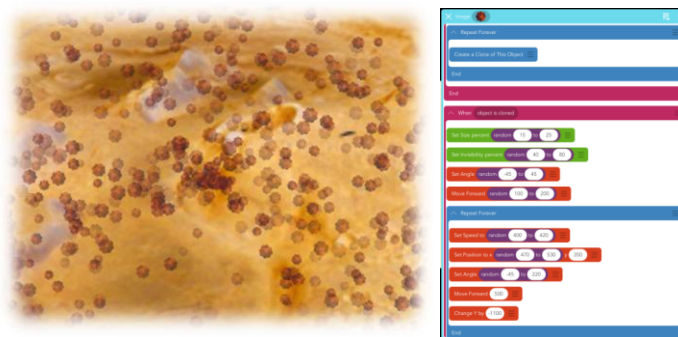
After a journey of 60 million km from Earth, the rover sends us images of the surface of Mars. The mobile laboratory analyzes the Martian soil. There was evidence that water existed on Mars. We have also found evidence that Mars has already been able to endure life. Martian soil analysis has identified 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.gethopscotch.com/p/y9mwdsa4t>

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).

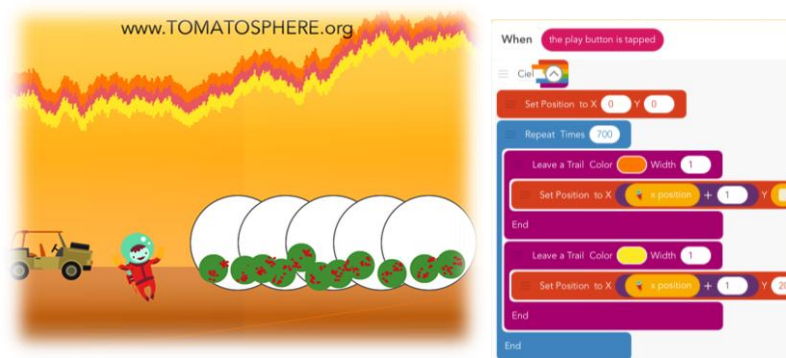


Name of the program: Volcan sur Mars <https://c.gethopscotch.com/p/yocyeqf0q>

Games 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 a one-way trip, 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 study in public schools.



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

American President Donald Trump supports space exploration. At the beginning of his term, he authorized \$ 19 billion to NASA, to include a focus for the exploration of deep space and a new goal of a manned mission to Mars (RT, 22.03.2017).

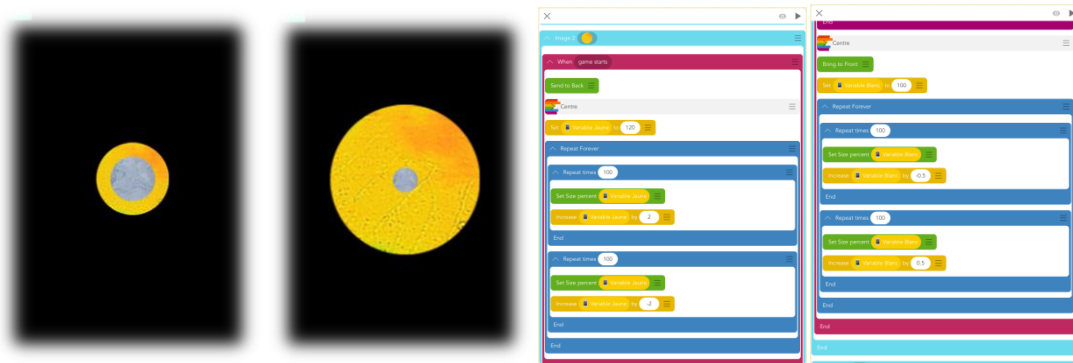
Deep Space Exploration

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 the primary and secondary levels, 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

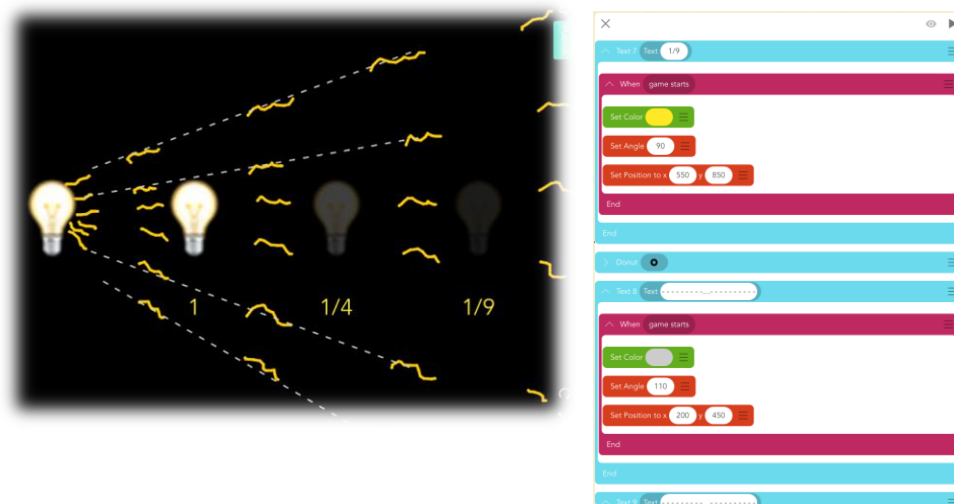
In 1912, Henrietta Swann Leavitt of the Harvard Observatory, was doing a crucial job in developing our current knowledge of the cosmos. She calculated with her team the position and brightness of the stars. In order to make comparisons, we needed stars of references. Leavitt found these stars of references, 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 her to measure the distance from the star to the Earth. None of these Cepheids were in the Milky Way. Her computational techniques have become a standard cosmic measure (Natarajan, 2016).



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

Simulation of Hubble's Law

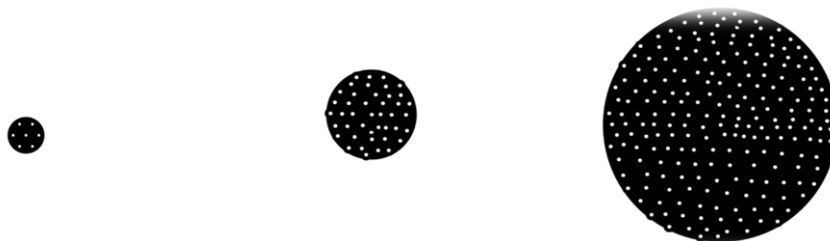
Edwin Hubble used the Cepheids to develop his new radical theory of the universe. By doubling the distance, the brightness of a star decreases by a quarter of its value. It is the law of the inverse of the square. There are situations where stars were less brilliant because of the dust that lay before 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.gethopscoth.com/p/yncvqx0gg>

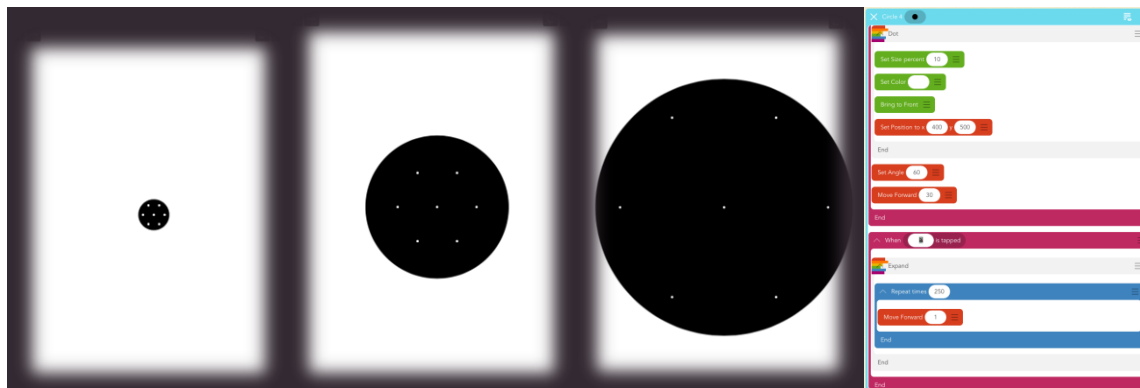
Simulation of the models of the universe

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



Name of the program: Steady state universe model

<https://c.gethopscotch.com/p/ync9f804h>



Name of the program: Expanding universe model

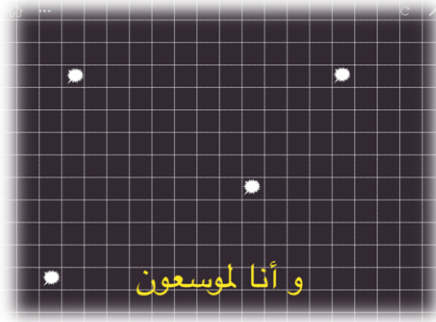
<https://c.gethopscotch.com/p/ynccgsf27>

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 supports 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 sources of knowledge and Islamic experience. 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 the

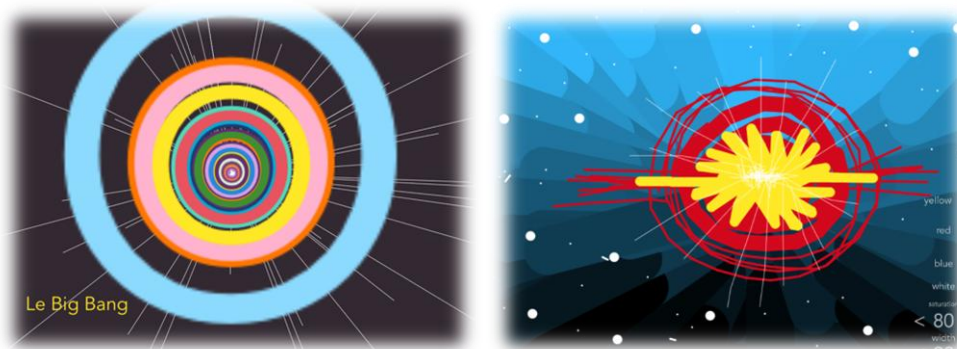
expansion of the Universe is found in the Qur'an (51:47) which was written more than 1400 years ago. How do they compare to the expansion of the universe as calculated by NASA? What is the accuracy of this information? As is the case with most deep and valuable discussions, there will be red and yellow 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 Simulation

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

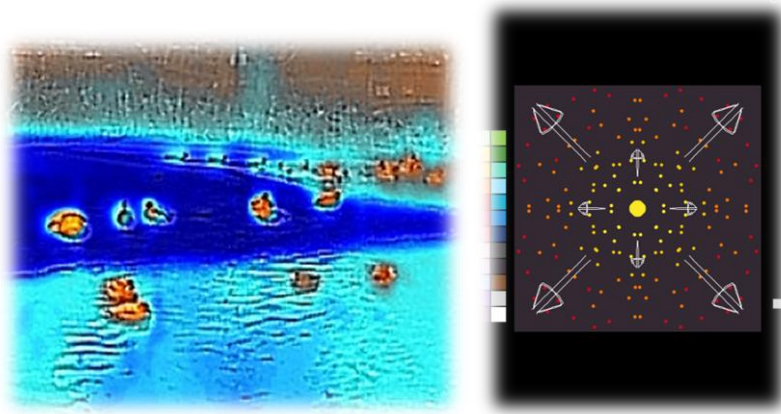


Name of the program: Big bang <https://c.gethopscotch.com/p/yfjnxusux>

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

Simulation of the Doppler effect

Understanding the Doppler effect is important to understand 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.



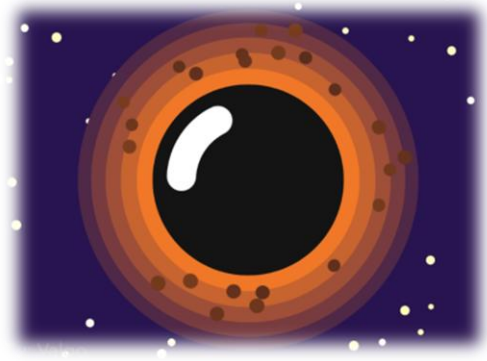
Name of the program: Drawing <https://c.gethopscotch.com/p/xo85h9n5e>

In the cosmos, when the light moves towards us, its wavelength decreases, producing a shift of the wavelength towards blue. In contrast, when the light moves away from us, we see a change of wavelength towards red. 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 micro metre (or microns). It varies between 8.0 and 30 microns in the middle infrared and between 30 and 300 microns in far infrared.

Black Hole Simulation

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 centre of almost all galaxies. Our Milky Way contains a black hole four 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

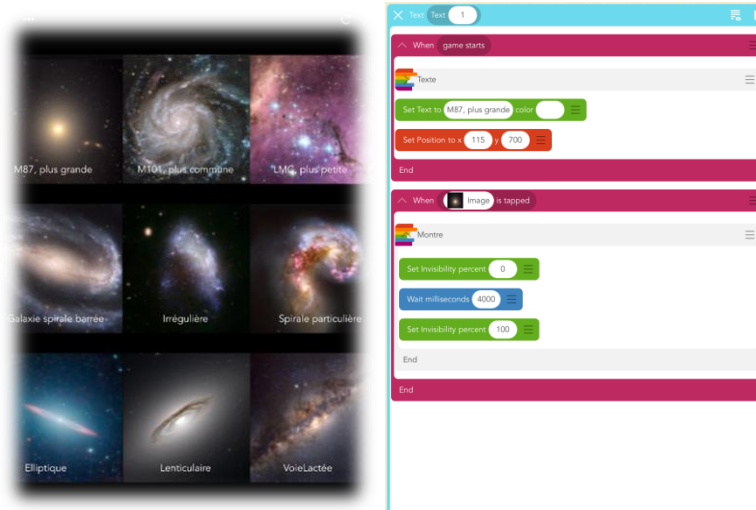
black holes, one can detect them by observing the material moving around. You see here a simulation vibration around the black holes.



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

Simulation of the Sloan Digital Survey

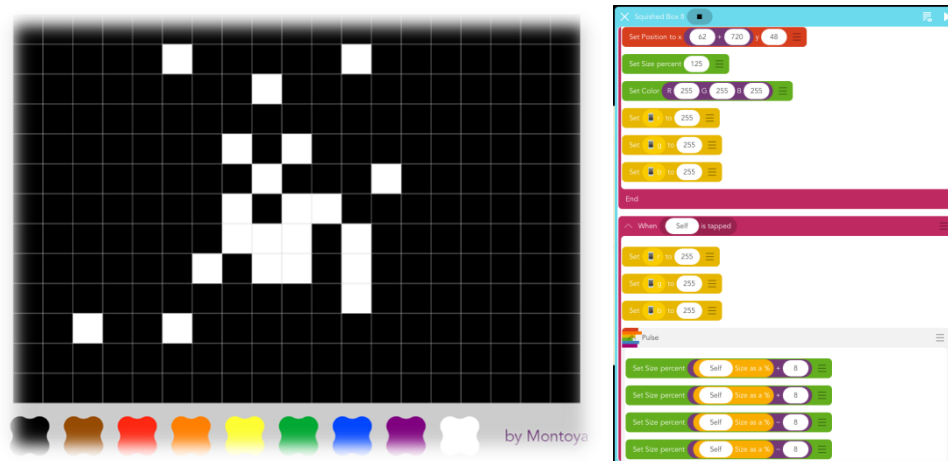
Here are some images of the Hubble Space telescope, our most powerful telescope. One can see, for example, in the Sloan Digital Sky Survey, a catalogue of galaxies that can be seen from our backyard. One sees for example M87, the largest galaxy, M101, the most common and LMC, 1000 times smaller.



Name of the program: Sloan Digital Sky Survey
<https://c.gethopscotch.com/p/yhpddgnmf>

Simulation of the galaxy GN-11

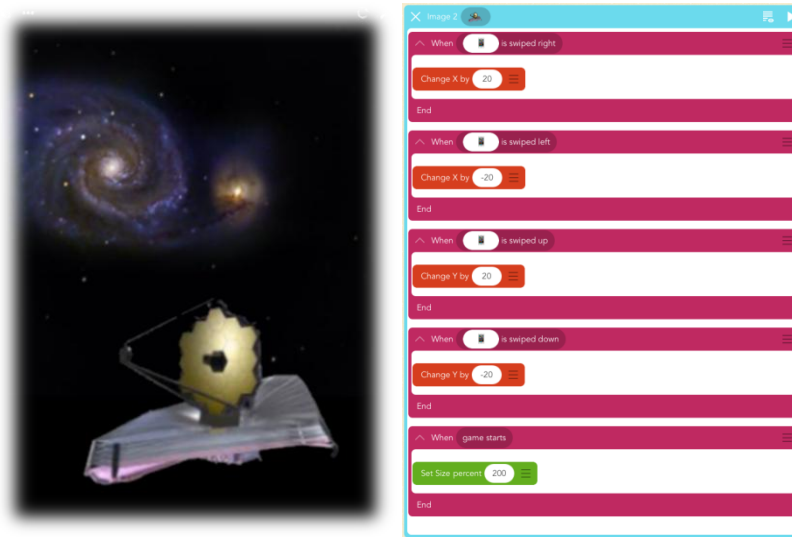
We use Hubble at the limit of his vision. GN-11 is the place where you can see the farthest galaxy with the Hubble telescope. It takes a full day to see it. It's just a fuzzy form. We have trouble seeing it. Dr. Adam Muzzin said that for the press release, astrophysicists do like President Trump, they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



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

James Webb Space Telescope Simulation

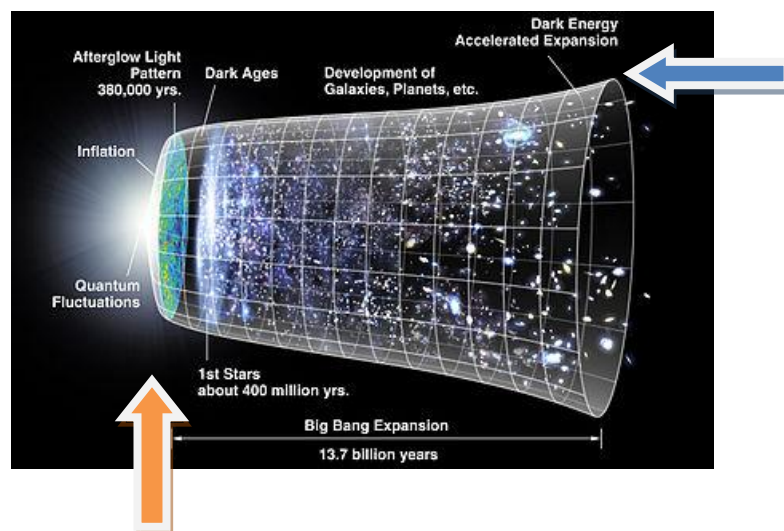
The James Webb Space Telescope will be launched in October 2018. The cost of the James Webb Space Telescope is \$9 billion. The mirror is about the size of a tennis court. The white part is the thermal shield of the telescope that protects it from the sun. This telescope will only work with infrared. It is too big to be placed in the biggest rocket available. It will be necessary to send the parts in several rocket launches in order to be assembled in space. It will be placed in orbit at 1 501 517 km from Earth. The deployment will last 1 month. It was built to last at least 5 years.



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

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 our eyes. The light of the beginning of the universe took 13.8 billion years to reach our eyes. The region of space (with the orange arrow) is called inflation. It is in this region of space that we seek to understand the beginnings of our universe, the big bang, 13.8 billion years ago.

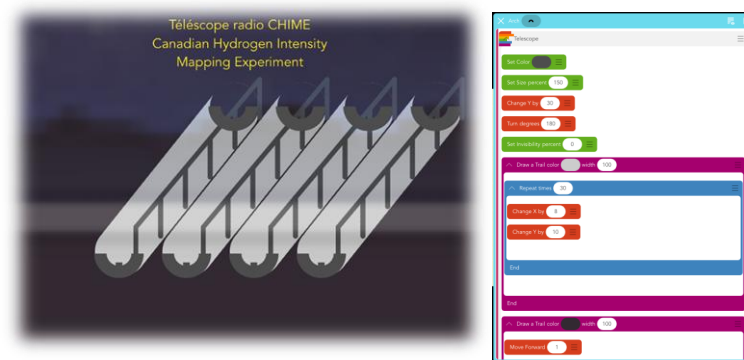


In the more curved region (blue arrow) of the expansion of the universe, more recent calculations show another phenomenon that allowed Dr. Adam Reiss to receive a Nobel

Prize. He discovered that the universe is not only expanding, expansion is accelerating instead of slowing down. This acceleration would work with dark matter.

CHIME Radio Telescope Game

The first telescope was built in Baghdad, Iraq in 828. Four hundred years later, China was building one. Then another in Germany in 1558. It was not until 1935 that we got a telescope in Toronto and in 1978 at Mont Mégantic. A new fixed telescope is under construction in British Columbia. It will document the acceleration of the expansion of the universe.



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

Simulation of the primordial universe

Dr. Tyler Natoli of the University of Toronto, participated in the construction of the South Pole Telescope, collecting and analyzing its data. Observation in the Antarctic has advantages since it is night 6 months a year and it is located in a very high altitude. You can see the same stars 24/7/52. With the cold weather, 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. It is a picture of the universe 380,000 years after the Big Bang, in the first 3% of the formation of the Universe.

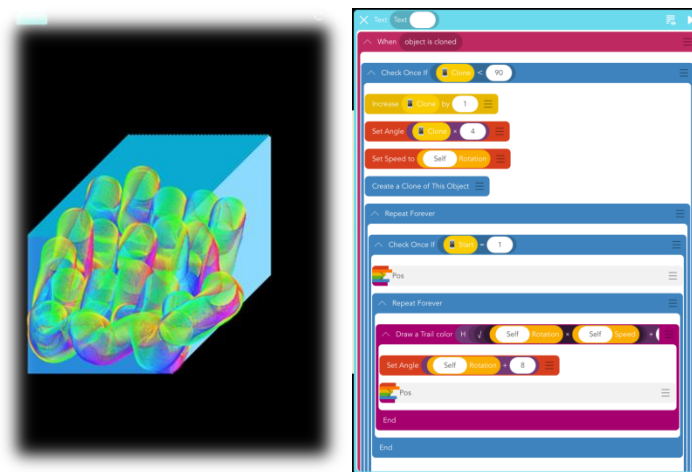
In the primordial universe, at 6,000 Kelvin, one can see particles, protons and neutrons. After some time, the temperature cools down to 3000 K, allowing the particles to assemble and form atoms. With the cooling, one also sees the light which generally goes in a straight line, except when it meets particles that reflect the light.



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

Simulation of the inflationary world

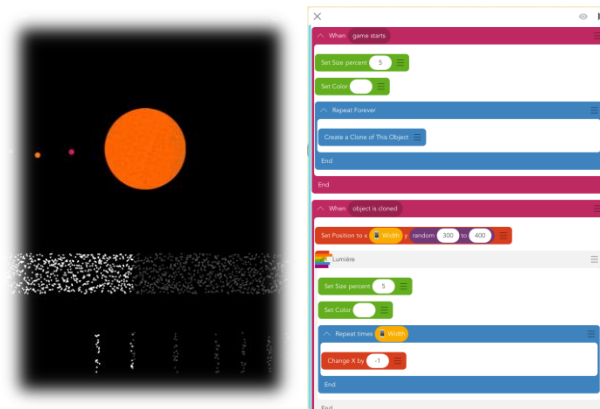
It is Dr. Andrei Linde of Stanford University who is behind the theory of inflation. He spoke with Al-Jazeera. He is worried about the students' scientific and mathematical knowledge. He says that if we use old books, old methods, we will do a good job, but not a great job. Discoveries, innovation will only happen when doing a great job.



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

Simulation of TRAPPIST-1

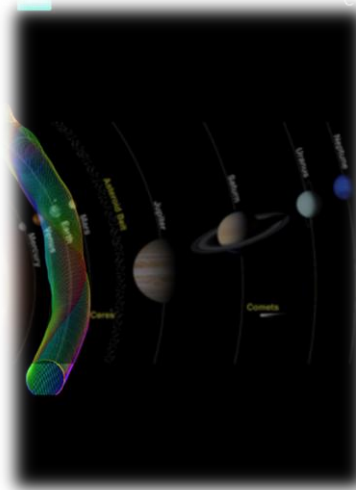
In February 2017, Dr. Michael Gillon of the University of Liège gave a press conference at NASA about his discovery of 7 rocky planets circulating TRAPPIST-1 at only 39 light years in the Milky Way. It is a record for the largest number of planets that are in the living area, orbiting a single star. 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>

Game of the habitable zone

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. 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 exoplanet, temperature is one of the important criteria.

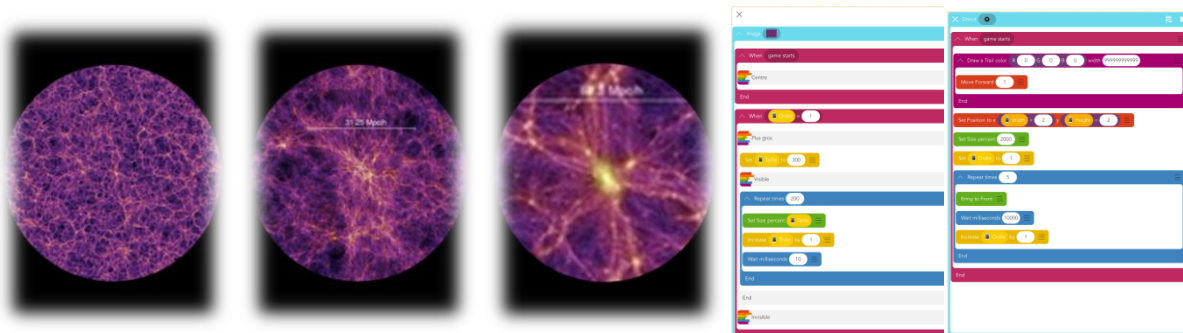


Name of the program: Zone habitable <https://c.gethopscotch.com/p/yodj2flny>

Simulation of the Millennium Race

The Millennium Race is the most precise and detailed simulation of the 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.

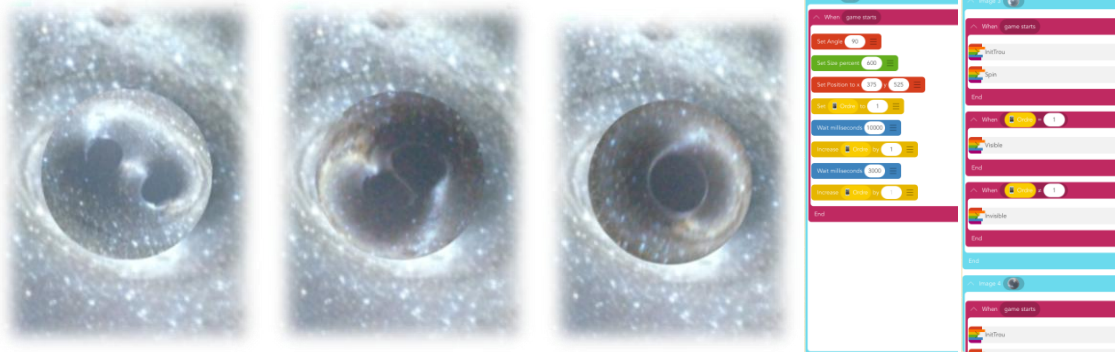
When you travel a little and see the sky on the other side of the Earth, you feel like citizens of the whole world. But by travelling to distant planets at only 39 light-years away or looking at the bottom of the universe, at its very beginning after the big bang, one can begin to feel like citizens of the universe.



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

Simulation of Collision of Black Holes

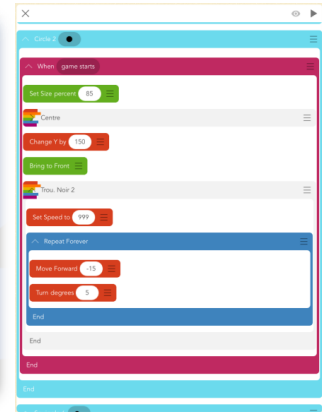
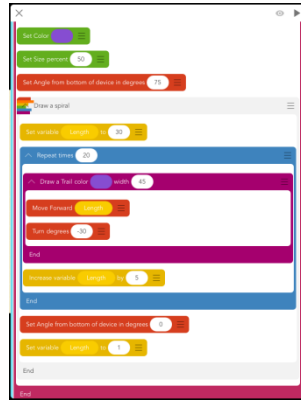
Dr. Harald Pfeiffer defines black holes as: a lot of matter in a small place. Their size is 100 times smaller than Earth and has 15 times the mass of the sun. The black holes are so compact that even light cannot escape. Newton's gravity laws do not apply with black holes. One must use Einstein's physics. Einstein tells us that space-time is curved. This space-time curvature tells spatial objects how to move. 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

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 metres (0.000.000.000.000,001m) by the passage of gravitational waves. The gravitational waves were measured by MIT's LIGO instrument (11.02.2016, Al-Jazeera).

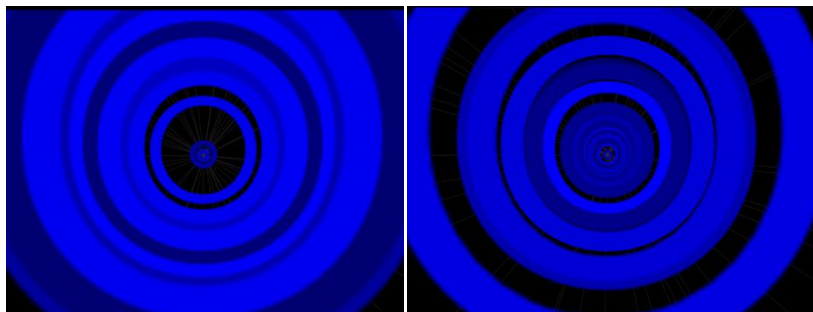
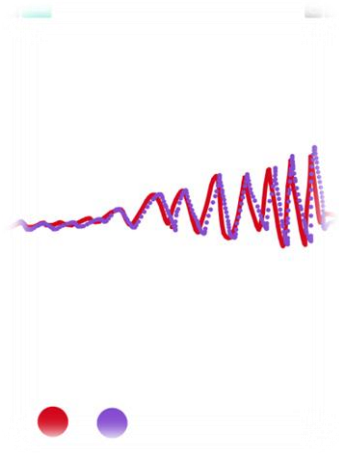


Name of the program: Ondes gravitationnelles <https://c.gethopscotch.com/p/xt065tirn>

Name of the program: Ondes gravitationnelles <https://c.gethopscotch.com/p/ynugpt77n>

Graphic simulation

The LIGO instrument consists of two independent measurements. One in Hanford, Washington, and the other in Livingston, Louisiana, United States. They use 4 km 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.



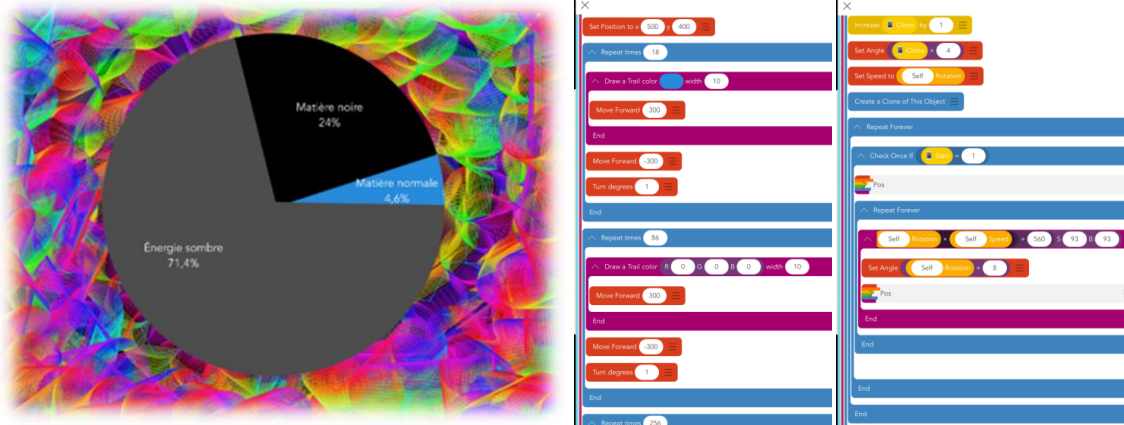
Name of the program: Graphe de comparaison <https://c.gethopscotch.com/p/ynsbfwqg9>

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

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

Dark energy graph

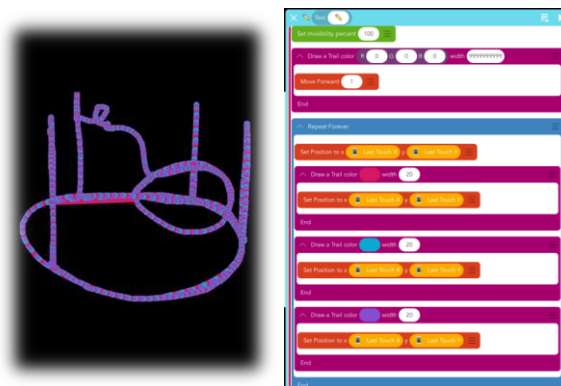
When one looks into the cosmos, we see only a tiny part, 4.4%. The rest of the universe is composed of dark matter (24%) and dark energy (71.4%).



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

Particle Accelerator Simulation

Scientists from CERN in Switzerland are doing experiments that could find the Higgs boson which could give more information about the beginning of the Universe. These experiments which would make it possible to find out 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).

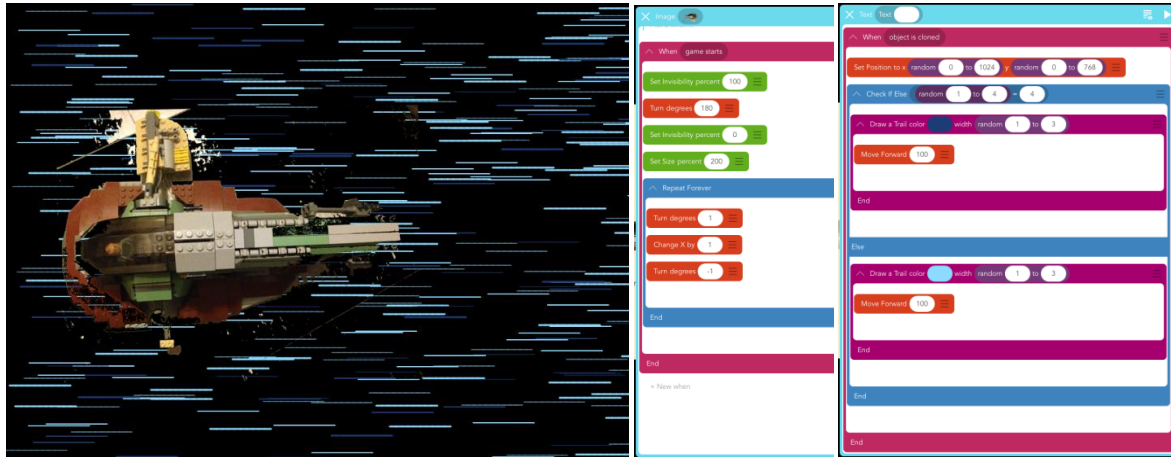


Name of the program: Accélérateur de particules

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

Simulation of the speed of light

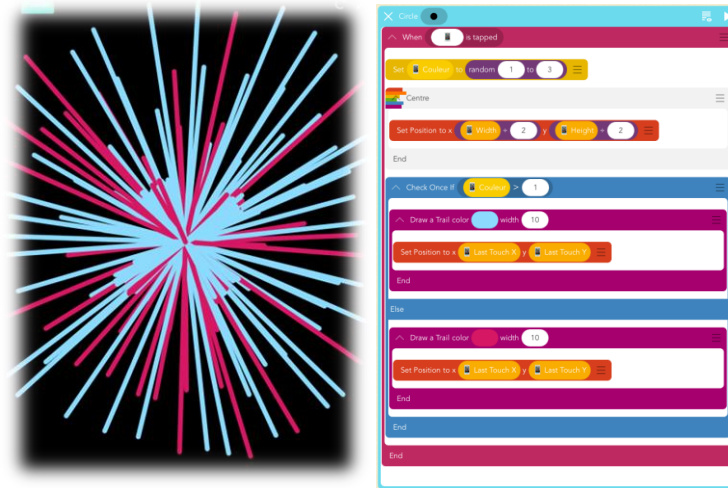
Another experiment at CERN, the Opera experiment demonstrates that some particles travel faster than the speed of light. A fundamental point of Einstein's theory is that the speed of light is constant. According to Einstein, nothing can go faster than light. If these experiments can be repeated and confirmed,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

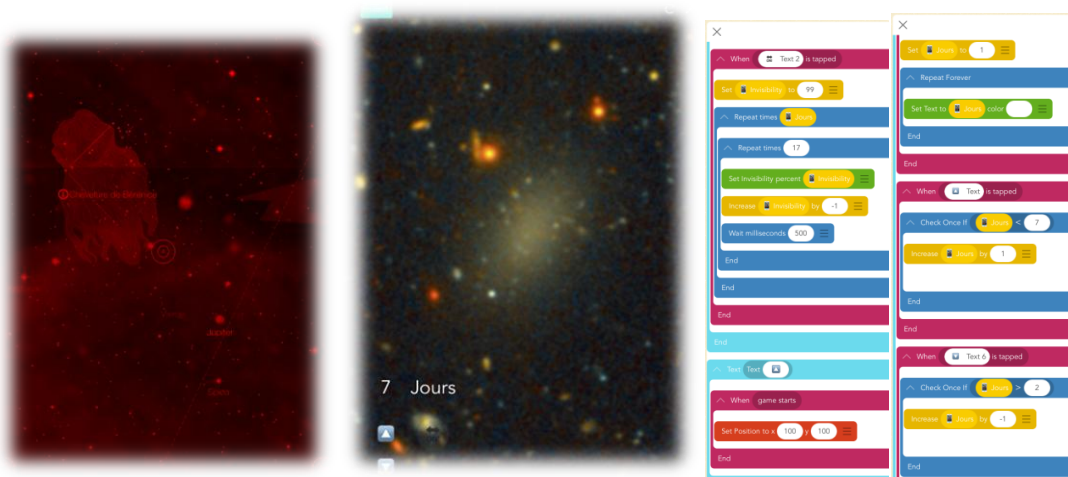
The atoms are formed of particles. There are protons, neutrons, electrons, quarks, and now Higgs bosons. The Higgs boson is the last particle discovered with the aid of the CERN particle accelerator. The Higgs boson generates the mass of all other particles. It is perhaps one of the most important building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



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

Simulation of taking the photo of the black galaxy

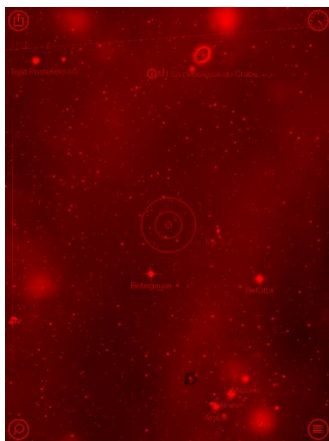
In the constellation of Berenice's Hair that we see here with STAR WALK, we find the galaxy Dragonfly 44. It is a black galaxy. It is populated only by a few billion stars, a hundred times less than the Milky Way. This black galaxy consists of 0.01% of material. The rest, the 99.99%, would be dark matter. 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 STAR WALK stellar map near the star Betelgeuse, is one of the most beautiful regions of the Earth's sky. There is 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

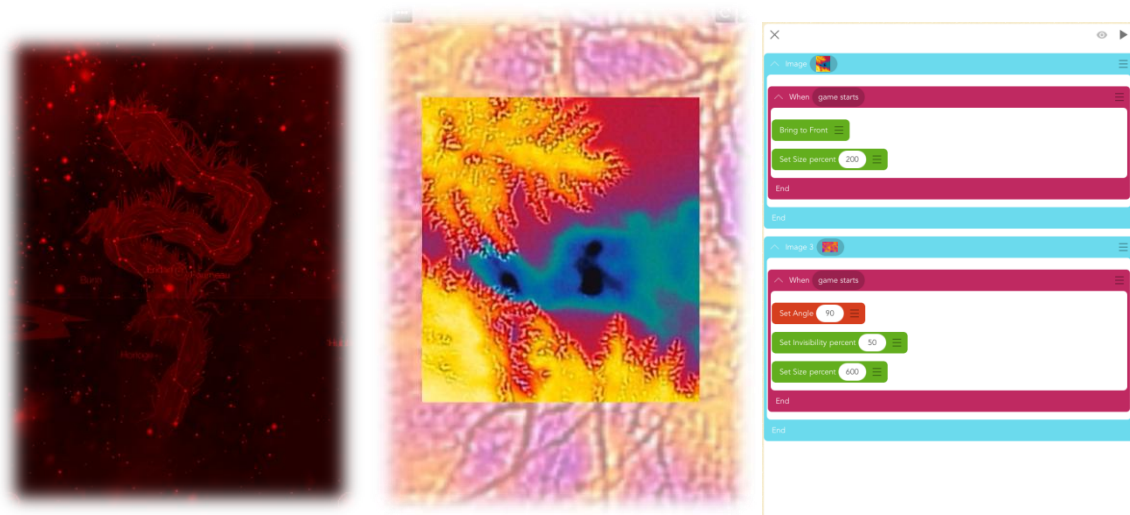
In the Orion's arm is a star that does anything. Teams of different scientists have tried to explain the phenomenon but none of them have succeeded until now. The random jumps of KIC 8462852 always remain without explanation regarding the data received (03.2017, Sciences & Vie).



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

Cold Spot Simulation

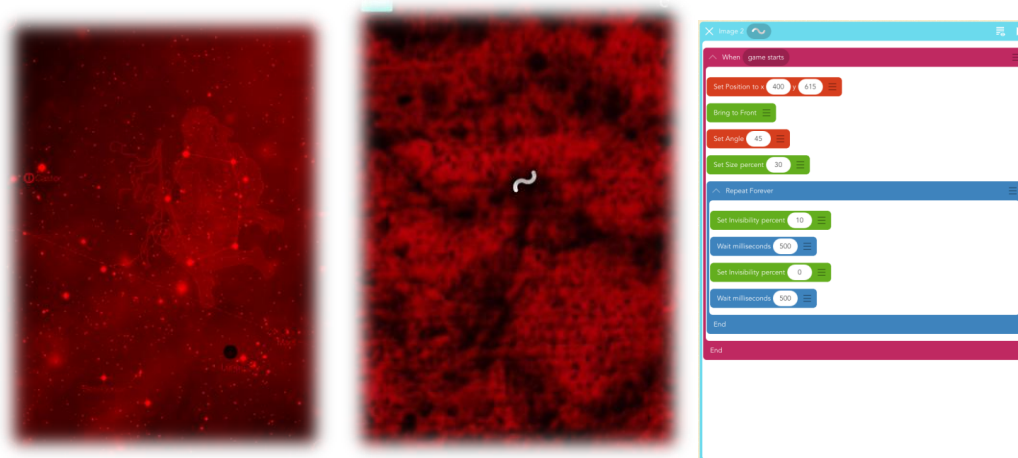
In the deep cosmos, the particles are uniformly heated to 3000 Kelvin. In the constellation of Eridan, however, one notices an area where the particles are slightly colder. There is a difference of -70 micro Kelvins. One wonders what happened so that this cold region is present in a burning universe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



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

Simulation of the flashing galaxy

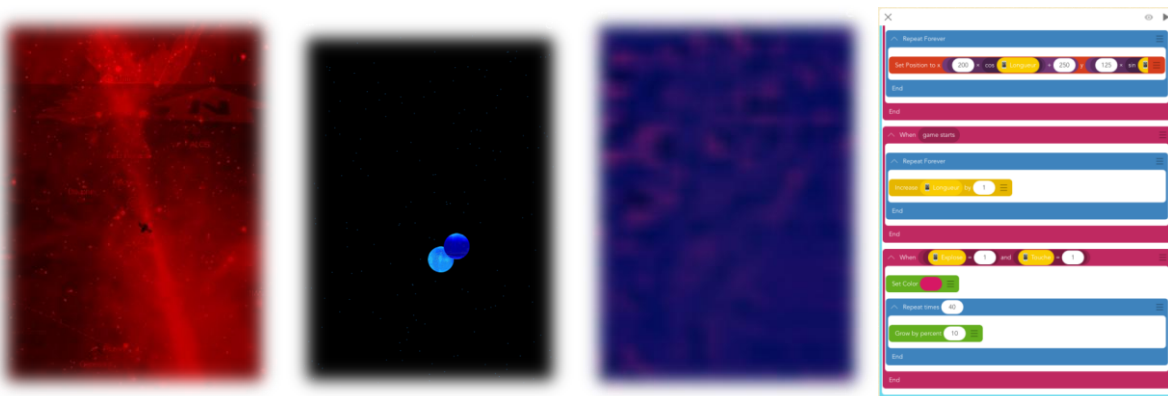
In the Auriga constellation there is a galaxy that blinks. The intensity of its signal is one million times more intense than expected. This phenomenon is still unexplained (03.2017, Sciences & Vie).



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

Simulation of the explosion of double stars

In the constellation of the swan, we now notice a double star, two stars that revolve around the other. Their pulsation is becoming faster and faster. Scientists calculated that the two stars would merge and explode. This would give birth 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>

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 game 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 programme : Google Earth: <https://c.gethopscotch.com/p/yauw5k57b>

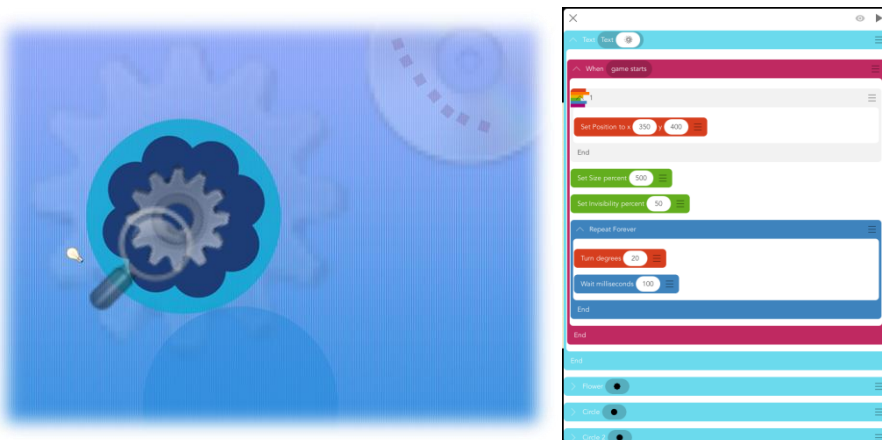
Assessment using Hopscotch is especially effective in the STEAM area: Science, Technology, Engineering, Art and Mathematics. It reflects what professional scientists, technologists, engineers, mathematicians use on a daily basis while including a strong element of art. Hopscotch provides the safe support 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.

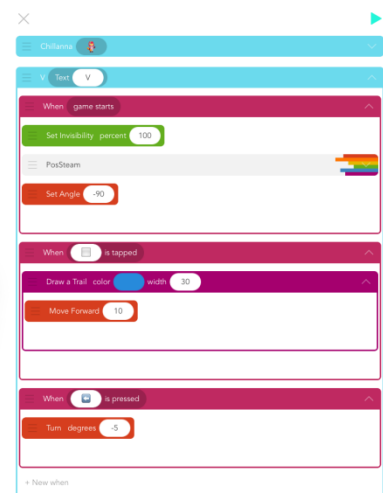
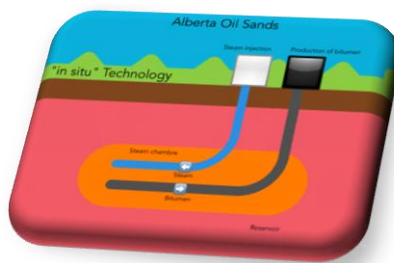
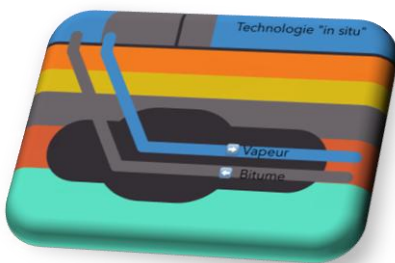
Portfolios

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>

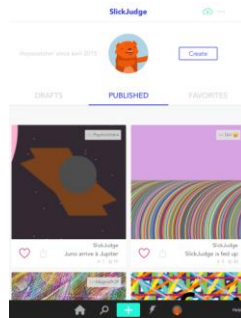
Hopscotch can be used with other apps such as **ExplainEverything** to explain the student's thinking. Such explanations can be published on a YOUTUBE channel. We can see here, an explanation of an intermediate version of the program :

<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. I also created over 150 videos explaining some of my programs. They are available by searching **Diane Boulanger YouTube** on the internet or by looking at the #girlswohopscotch hash tag on Twitter.



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 StarWars or StarTrek 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>

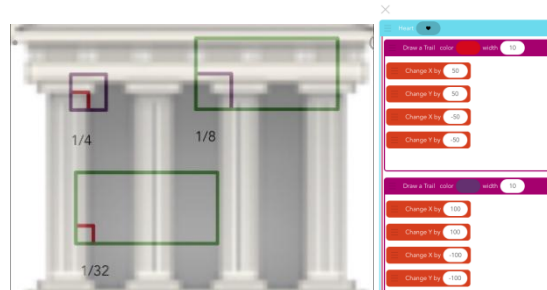
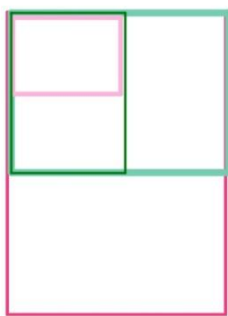
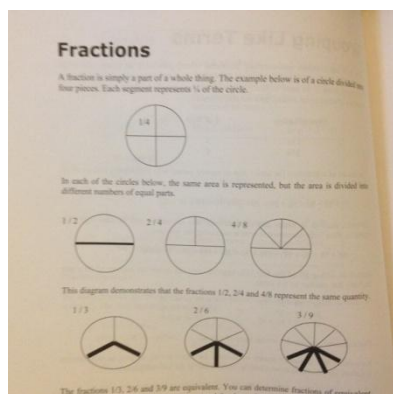
Teacher Moderation

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 <i>The use of critical and creative thinking skills and/or processes*</i>				
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>

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">• fulfils 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;• perseveres and makes an effort when responding to challenges.

2

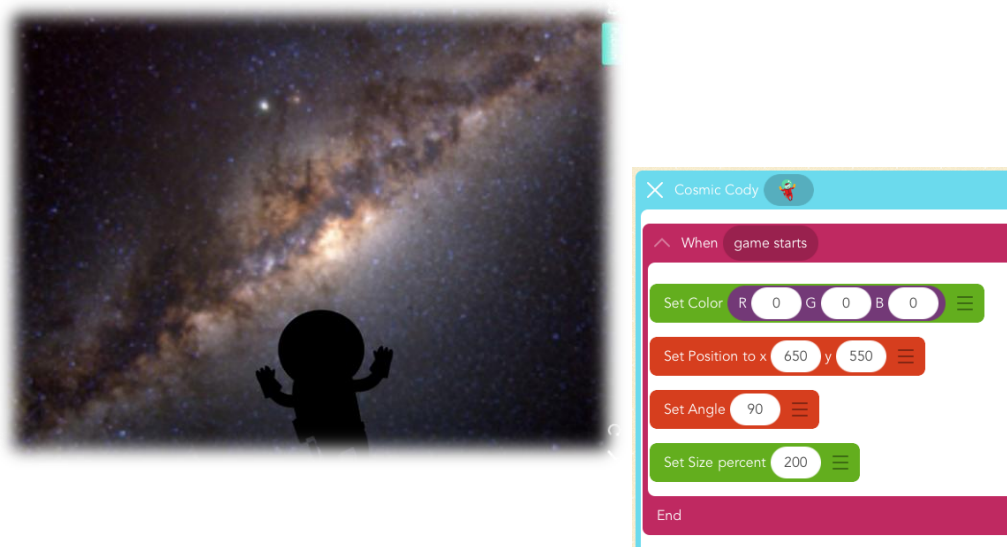


Name of the program: WikiLeak: <https://c.gethopscotch.com/p/xyewpx09y>

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) 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 her book 'Mapping the heavens', the astrophysicist Priyamvada Natarajan (2016) indicates that the endemic denial of science does not stem from a 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 suggestions 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 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).

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