Innovation from the digital microscope with Hopscotch

Draw me a scientist

At the beginning of the school year, I ask my students to draw a scientist. This allows me to have an idea of their understanding so as to be able to correct or enrich their design if necessary. In this example, one of my students drew me as a scientist. Madame is a scientist, she knows the technology well and uses computers during the time of the code. Although I like this image, including a woman, a minority, and engineering I think it is incomplete. There are other tools that scientists use and places other than the classroom where scientists work.

Did you know that Olathe MacIntyre, Resident Scientist at Science North in northern Ontario, is considered very seriously as an astronaut by the Canadian Space Agency. The scientist is one of 100 people who have been selected from over 4,000 applications to become one of two Canadians working on the International Space Station. She has extensive experience in biology, and has published a thesis on growing plants in low pressure environments.

Cryogenization We may remember Khan and his 72 cryotubes of the movie Star Trek. After hundreds of years, the most dangerous race that has never existed is awakened from their sleep to build dangerous weapons. In the film, James T. Kirk was also saved after his death through cryonization. What does science has to say? Julie Payette on the Radio-Canada Découverte gives us the answer. This is far from reality. In the laboratory, it has not yet been possible to vitrify a single organ without causing damage. How to do it with a whole brain? Why do this? They are selling you immortality by the advancement of science.

You can think of strawberries being frozen. The challenge is water. When freezing, the strawberry expands and deforms. Ice crystals pierce the cell membranes. When it thaws, the strawberry has lost all its shape. Here we see a thawed strawberry under the microscope. Solution: replace the water with medical antifreeze. This technique is called vitrification. Scientists only succeeded with a few cells, to conceive children with vitrified embryos. The water is replaced by antifreeze which does not damage the cells.

The digital microscope

A tool of choice of scientists is the microscope. The digital microscope is a variation of the traditional optical microscope. It is equipped with a camera and software to transfer images and videos to a computer. Other microscope models use the iPad or iPhone as a display using Bluetooth. In the classroom, the digital microscope is easier to use because a group of students can manipulate the microscope and view the results at the same time using the screen. The microscope memory functions like a USB flash drive. The images can be uploaded with DropBox and transferred to any other application you use, on phone, iPad or computer.

Prepared slides

Students can prepare their own slides or use the prepared slides to see specimens that are more difficult to obtain such as parts of the body or specimens requiring chemical staining. They are very easy to use and very interesting.

Making connections

Students in difficulty or students who are learning to read can read science books and make text-to-self connections because they will have had the chance to manipulate the microscope and see the blood cells from their book. This type of reading can motivate some to read even more because of the very interesting content. Gifted students can also make text-to-self connections because they have the opportunity to choose the objects that interest them and to look at them under the microscope. We give a more accurate picture of the scientist and inspire the students towards the exploration of biology.

Writing

When astronauts go into space, their whole body is affected by microgravity. The cardiovascular system becomes less conditioned due to the lack of gravity. When astronauts return to Earth, they have difficulty re-adjusting to life with gravity and suffering from loss of balance and fainting. Researchers at the University of Waterloo began the BP-reg experiment to counter the effects of space flight. The first subject of the experiment was Chris Hadfield.

With technology, like a blog, these texts can be shared with other students of the class, making their writing more authentic. Students can read their friends' blog and ask questions or make comments. In this example, the student wrote a blog about Chris Hadfield's heart when he visited space.

What is the size of the images?

This includes some mathematics. With a transparent plastic ruler, you can estimate the size of the images. The first objective of the microscope is to enlarge the image by 40 times. One can see the two lines indicating one millimeter. The image is estimated to be 1 mm in diameter. The second objective of the microscope allows to enlarge the image of 100 times, which makes it possible to see to 4 microns of diameter. The third objective allows to magnify 200 times and the fourth objective allows to enlarge the image of 400 times, which makes it possible to see at the level of the micron.

Last child in the woods

The school grounds offer a large amount of specimens that can be collected and looked at under the microscope. There are all the insects, the dust, the soil, the varieties of plants, the animals that can be observed. An inventory of wildlife diversity can be made in schoolyard habitat and some specimens can be viewed under a microscope. There are also scientists from conservation centers who go to schools to make children aware of nature. Meanwhile, children have the opportunity to get closer to nature and become attached to nature. You can only protect what you know and value. Sometimes these small visits are the only time the pupil gets closer to nature.

To differentiate instruction, and expand the field of exploration of students, I give a microscope to students. You see here, under the microscope, a hair of a raccoon and a cut of a bone.

Musical creation

Students with artistic talents are also interested in the digital microscope. We see here the project of 3 young students who during the recreations practiced the song and also composed their own music. They made a movie accompanying their music with images of the microscope. Another team of students had composed melodies directly with Hopscotch with the digital microscope as inspiration.

Hour of Code

Wondering what to do for Hour of Code? Why not use a microscope image with Hopscotch on the iPad and create a website. The image is a mosquito's leg. The Zika virus is transported by mosquitoes and transmitted to humans when they are bitten. We have seen, for example, that it causes micro encephalitis in newborns. There is no cure for the Zika virus and the only way to protect yourself from the Zika virus is to limit the mosquito population.

The Flipped Classroom

With the flipped classroom, women are encouraged to go into science. Students watch videos at home and do scientific experiments at school and research at school to answer their questions. You surely heard of the disappearance of the bees. Whole colonies disappear. Bees play an important role in the pollination of plants and the production of our food. Several scientists are working to find the source of the problem and find a solution. For example, Susan Cobey in Washington is working with her microscope to diversify the bee population. It raises new, more resilient bees with more diversified DNA. The buccal part of the bee is seen under the microscope. The results are shown on the Canadian bee loss statistics. The genetic result of bee diversification with Hopscotch is also predicted.

Encouraging women towards science

You surely heard of the disappearance of the bees. Whole colonies disappear. Bees play an important role in the pollonisation of plants and the production of our food. Several scientists are working to find the source of the problem and find a solution. For example, Susan Cobey in Washington is working with her microscope to diversify the bee population. She raises new, more resilient bees with more diversified DNA. We start in class with an interest in pollen and bees. The buccal part of the bee is seen under the microscope.

Contamination on Mars

The Rover that went to Mars was clean, but not all of its parts were sterilized. Strict international rules prevent Rover from reaching possible sources of water on Mars in order to prevent the contamination of Mars with micro-organisms from the Earth. You see what you do not want to mix with Martian water?

Growth and survival of fungi in space

Scientists aboard the International Space Station study agriculture. Would mushrooms develop in space to decompose the waste and also feed the astronauts? One can experiment with gravity too.

Where does oil come from?

We talk a lot about these days on the radio. In Canada, oil comes from the Alberta oil sands. I went around the oil sites between Edmonton and Fort McMurray with Inside Education and I brought back some samples of bituminous sand that we see here under a microscope. It's sand, filled with oil. The bitumen inside the sand is easily visible. It is extracted and refined for our cars.

Pure Water

Many people are concerned about the effect of aging pipelines transporting oil from Alberta to Quebec on drinking water. There were demonstrations in North Bay and Montreal, among others. I decided to make an experiment to see if the surrounding water is affected by the pipeline that passes Mississauga along the 403. First we have to see what pure water looks like under the digital microscope. Here we see frozen water vapor on a slide which melts under the light microscope.

Does a pipeline affect water?

Given the importance of this question, we used 5 different methods to answer this question so as not to bias our results. The infrared camera can see up to one meter under the ground. It can detect gasoline and gas leaks, if any. The pipeline is underneath the electrical wires. Nothing is noticeable. There is nothing abnormal which escapes from the vents of the underground infrastructures. The pH test with litmus paper indicates that before and after the passage of the pipeline, the pH of the water is a little basic. Water samples are collected that can be analyzed with the microscope and also with a pen that tests solids dissolved in water.

Observations

Even tap water, is not pure water. With the microscope, we see particles in the three water samples. With the pen, we notice that the concentration of the particles in the tap water is 164 ppm. After the pipeline, in a small park south of Square One, the concentration of the particles in the water is 350 ppm. The concentration of the particles is lower than before the pipeline. Before the pipeline, there is a wetland on the Peel District School Board property in the center of Mississauga. The concentration of the particles is 386 ppm. The wetland provides food that attracts animals. In the wetland, there are dead plants that decompose. The wetland also absorbs carbon instead of rejecting it into the atmosphere. Wetlands help moderate the effects of climate change.

What is an oil spill like?

The DeepWater Horizon film gives an excellent idea of what an oil spill looks like on an oil platform. This accident in the Gulf of Mexico is the largest oil spill in the United States. You can do a simulation in the classroom with a bowl, water and olive oil. It can be seen under the microscope that the oil does not dissolve in water like salt. It forms small bubbles more or less large in the water.

Innovation

Tony Wagner says in his book that traditional skills such as critical thinking, collaboration, initiative, information analysis, oral and written communication, curiosity are no longer sufficient for our modern economy. We have to move on to innovation.

One cannot innovate without knowledge. Students must have advanced knowledge about important issues. With critical thinking, students can ask the right questions, make connections, observe, collaborate, and experiment. We must also have intrinsic motivation. It is passion and interest to pursue a project. Young people are motivated when their work seems like a game. The game allows students to understand the subject more deeply and develop the passion to master something. This passion evolves into a desire to "make a difference", "make history" as Jeff Bezos would say or "put a ding in the universe" as Steve Jobs would say.

Genius Hour

My students regularly get excellent results on departmental exams, so I was not afraid to try something new. The use of Hopscotch during the Genius Hour was very successful. For just over an hour a week, during Genius Hour, students receive an iPad and the opportunity to create something new that they consider important. 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. Students' creativity can be assessed. For example: ideas are combined in an original and surprising way, to solve a problem, to address a subject of litigation, or to do something new.

Environmental Innovation

With an aquarium in the classroom with aquatic plants, we naturally look at the flora under a microscope. We see algae of all kinds. We tried to see which ones reproduced most quickly. Did you know that seaweed can be used to produce GREEN oil. This oil is similar to fossil oil except that it removes CO2 from the atmosphere. Using the microscope images, one can make a website with SMORE explaining the results of the experiment.

Innovation in Artificial Intelligence

To be even more innovative, we represent our results in the form of artificial intelligence with Hopscotch. Hopscotch allows to recognize speech. Instead of saying OK Google, so that the phone or the iPad answers us, we will say OK Hopscotch and our Hopscotch program will answer us, here in text form.

Green oil, made from algae is a possible solution to global warming. A photo-bioreactor is installed next to a cement plant in order to feed the algae with CO2, in order to send the CO2 into the atmosphere. The algae develop and its biomass, full of oil, is harvested to produce fuel. This fuel can be used as fuel in aircraft to replace the current oil.

AI: Supervised Learning

Artificial intelligence will be found in all areas, including the medical field. AI can predict whether a tumor is malignant, before the radiologist with a 90% confidence level. To do this, AI must learn to see and interpret images. Supervised learning is like showing a child a picture book. We show an image and we say it is a cell. We show another image, is it a cell or not? After a few images, the AI realizes what a cell is. To be really useful, the AI must be able to recognize that what she sees is really a cell, that it is healthy and not cancerous.

IA: Deep Learning

To predict what will happen in the future of a tumor, we must find abnormal pixels among healthy images. Deep learning allows images to be represented. The higher the level of representation of these images, the more the artificial intelligence will be able to interpret what it sees.

AI: Predictive Learning

Artificial intelligences have a very specialized intelligence, like calculators that make very elaborate calculations, very quickly, but have no general intelligence. Artificial intelligence is not yet able to do unsupervised learning, as we humans do. With predictive learning, we learn to predict the future, as how the blocks will fall. One has to invent, for example, the rest of the image to predict things that are reasonable. Here we see under the microscope a flat green Taenia Pisitormis found in spoiled meat and predicted AI, using quite complex mathematics, which will happen to your cells if you eat them.

IA: Learning by Reinforcement

With learning by reinforcement, one learns by trial and error in real time. We are able to choose our actions and apply actions on their environment and observe the effects of these actions. This allows you to choose the best actions.

Here we see fat cells, which make the Storage of our lipids, our fat. These cells are a reservoir of stem cells that could be used to make specialized tissue such as bone tissue, cartilage. It is also believed that they could be used to make other tissues such as heart muscle tissue. The AI could do in a few seconds what the human does in several hours of work.

IA: autonomous learning

Autonomous learning combines the efforts of deep learning and reinforcement learning. It is no longer enough to understand one's environment. You also need to be able to apply control and choose a trajectory. In health, this allows to personalize the treatments and to detect and treat cancers for example. The AI can draw up a detailed map of the areas to be treated and reduce the planning time required by cancer radiotherapy.

Virtual Reality Surgery

It is no longer necessary to have all the surgeons in the same room to do an operation. With virtual reality, one can have general surgeons performing the operation and the specialist surgeon leading the team from another country. In addition to camera and live audio communication, virtual reality simulates the movement of the surgeon's hands in direct time that the general surgeon can follow in order to perform the delicate operation.

Myscopeoutreach.org

You do not have a microscope? You can still use microscopes online. With myscoreoutreach.org you can watch several specimens under the light microscope and also under the electron microscope. Here we see a hair under the electron microscope.

For example, the FBI used microscopic analysis from 1973 to 1999 as evidence for the conviction of people for crimes such as murders. In some cases, evidence by microscopic hair analysis was the only evidence available for belief. Many people maintained their innocence before this science. Much later, DNA was used to re-examine the evidence presented. It was found that in 95% of the time, the evidence was faulty. 95% of innocent people were imprisoned with this evidence that was scientifically invalid. This evidence was developed by the FBI and not by scientists. Although you can see enormous differences between the hair of different individuals (my hair and my boy's), the FBI had not compared the distribution of hair in the population. That is to say how many people have the same type of hair, the same size and the same color. Having a good knowledge of science and these applications is quite fundamental. The jury had decided to put their trust in the FBI people who could be convincing instead of the innocent young man, even if he was telling the truth.

Even if we decide not to become scientists, each of us must have fundamental knowledge of science in order to understand what is going on around us.

Innovation in Criminology

Now, with a DNA sample of the suspect found on the crime scene, specific genes are identified from this sample. With the technology, the identified genes can help sketch the suspect's physical traits into a robot portrait. This is the technique of the genetic portrait robot. We do not even need witnesses to do the portrait. For example, it is known that the X and Y chromosomes indicate whether it is a woman or a man. One can know the type of skin, the shape of the eyes, the nose, the mouth, whether he has freckles or not from the genes. With further research, it will also be possible to know the age of the person and also his relative size. It is still being developed, but within 5 to 10 years, we will have the knowledge of the real faces of the most enigmatic criminals.

The thermal microscope

Have you ever bought computers that get really hot when we are using it? Companies can solve this problem with a thermal microscope. The infrared camera can be attached to a microscope. These microscopes are used to study the temperature of the microprocessors and to check the thermal performance of each of the components of the computer. The thermal microscope can measure the temperature to within 3 microns.

Metallic Hydrogen

Scientists like Isaac Silvera from Harvard University use this microscope to look at atoms with blue, green, red and infrared light. They have succeeded in creating solid hydrogen. They compress hydrogen between 2 diamonds at a temperature of -258 Celcius or 15 Kelvin to convert gaseous hydrogen into solid hydrogen. Once it has returned to room temperature, the solid may remain very stable.

Do you always want faster and faster computers? There are limits to the laws of physics we are currently using. We must find new ways of proceeding, with quantum computers, with the physics of the microscopic world. Isaac Silvera wants to create a semiconductor that does not lose heat at room temperature.

It will also be necessary to develop quantum programming languages and libraries to manipulate quantum physics. There is already Microsoft's **Liquid** quantum language for quantum programming, but in the classroom, you can use **Hopscotch** to draw hydrogen atoms.

The tunneling microscope

The tunneling microscope is a microscope that works at the quantum level, at the molecular level. This new nano technology solves several environmental problems. Looking at the scale ratio, a nanoparticle is 130 million times smaller than an orange, which is 130 million times smaller than the Earth.

Innovation in Nanotechnology

The Nobel Prize in Physics was awarded to two Russian researchers for their work on graphene. Graphene is a carbon sheet with a thickness of a single atom. It is produced from graphite which is the carbon of our pencil mines.

These very thin graphene sheets will help to manufacture other products including the next generation of solar panels.

Environmental Innovation

Many parts of the world simply do not have enough water to survive. There is not enough fresh water for crops that support human life. 97% of the water on Earth is salty. Is there a way to use that water? Current water filtration plants use large amounts of energy to filter water with boiling. Can we save energy by using a different filtering method? Scientists are researching filtration using nano filters. It is a passive system that does not require a large amount of energy. The filter does not let the water molecules pass, preventing pollutants and salt from passing. We could get fresh water quite easily, in order to solve the problems of water scarcity.

Aviation Innovation

Boeing invented a lightweight metal structure, consisting of 99.9% air. This structure is lighter than styrofoam. If an egg of this microstructure is surrounded, the egg may fall from a high edifice without breaking. This is good equipment to use to build an airplane. This material is so light that it can settle on a dandelion flower without moving.

Innovation in surgery

One can observe the geckos that cling to the ceiling with their feet covered with nanometric-sized hair. With biomimicry, this observation can be used to construct surgical tape that could replace sutures and staples in hospitals.

Medical innovation

There are new technologies such as CRISPR - cas9 that allows the modification of DNA to cure genetic diseases.

Innovation in 3D printing

In medicine, 3D printers are used to regenerate the skin and can be used in the future to regenerate whole organs, such as the kidneys or bones, from stem cells. When stem cells are removed from the patient in need of the transplant, anti-rejection drugs are not required. 3D printing removes the ethical problems that physicians sometimes face in their practice such as not having to recover an organ from another person or using stem cells from embryos.

Innovation in the textile industry

Adding nano fibers in the textile allows to give it different properties. Antimicrobial textiles can now be manufactured with silver nanofibers which greatly reduces or eliminates the need to wash the fabric. Other textiles with zirconium nanofibers are made to be heat resistant, useful for keeping you warm in the winter.

Innovation in agriculture

Agriculture is one of the biggest problems we face. To my knowledge, this type of drone has not yet been invented, a drone covered with nanofibres. This drone allows to capture the solar energy in order to be energetically independent. The role of the drone is to monitor the performance of our land. The drone obtains information about each plant and tree and explains to the farmer how to take care of each plant individually in order to maximize yield.

Innovation in Computer Science

To find new remedies to cure cancer, to program artificial intelligence, or to find black holes in space, the computing speed of our most powerful computers is no longer enough. The necessary calculations take far too long to complete. The NSA makes innovation in computer science using the microscopic world physics, developing a quantum computer. We now have quantum chips but we must also invent quantum programming, a library of quantum algorithms. Physicists at the Université de Sherbrooke indicate that there are already about 60 quantum algorithms already available.

Innovation in Space Exploration

In the private sector, billionaire Yuri Milner is launching a $ 100 million research project to prove an interstellar travel concept using a small satellite powered by a laser sail. The craft, which can be held between two fingers, sets sail to Alpha Centauri. Milner plans to send not only one, but hundreds, even thousands of these tiny gear into space for exploration. He is looking for engineers to put this project in place. If the government does not have enough money for space exploration, the private sector will do it. Some entrepreneurs are more than willing to employ other innovative people looking for new ways to explore space. We can start by building a StarChip model.

Creating a Culture of Innovation

Tony Wagner says that to create a culture of innovation, it is necessary to encourage teamwork, interdisciplinary problem solving, and intrinsic motivation as with exploration, gaming, and self-reliance.

For example, exploration with the microscope, playing with Hopscotch and the autonomy of wanting to make a difference are at the heart of our culture which is the source of this presentation.

BOOK

All the presentations that I have prepared for this summit and all my books would not have been possible without Twitter and the community I meet on Twitter every day.

If you are interested in using the digital microscope with programming with Hopscotch, you can always consult my book available on my Twitter account.