

Success in Math

Hello. My name is Diane Boulanger and I am a French immersion teacher in Mississauga, Ontario. I find that using technology and especially code, programming with Hopscotch, to teach mathematics is quite exciting and fascinating. Here is an example.

Look at the title in blue and the name in black. Raise your hand. Who prefers the text written in blue? ... Who prefers the text written in black? ... The black text was written with Prezi, the software I used to write this presentation. The blue text was written with the Hopscotch code. You can see the Hopscotch code on the screen. Here we use very advanced concepts to draw these letters. Hopscotch works with an iPhone or iPad.

A good math instruction must have 3 elements.

First. Good math instruction should pay attention to mathematical thinking. In fact, code is basically a tool for developing mathematical thinking. This type of thinking requires us to understand what mathematical problems can be solved using technology and how to develop and test solutions to the problem.

Secondly. Math work must be visible at school. With Hopscotch, all shared programs are available not only to the classroom and the school. We inspire the whole world with our work when we share it with the Hopscotch community or with social networks.

Thirdly. Students feel comfortable with math and want to do more. Working with Hopscotch is like playing a game. It's fun. It's stimulating. We love the results especially if we know that we are developing a big project that fascinates us like looking for extraterrestrial life.

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Select topic of study that applies to the whole school

In order to obtain major changes, we must choose subjects that apply to the whole school. For example, the Canadian Space Agency launched the junior astronaut program. This program allows students to discover aspects of life in space. There is an aspect of fitness, nutrition, communication and teamwork. We can make the link between a space mission and all the subjects taught at school. Our mission here is to develop an artificial vision for the rover.

The photo was taken with a FLIR infrared camera. Infrared is part of the science program from the grade 4. This is a photo of the Cheltenham Badlands. The Badlands strangely resemble the planet Mars with its red-orange surface. There, we really feel like we are on Mars! You can easily get there by school bus. Astronauts can, however, get there by bicycle. That's what I did. It is 85 km round trip. Teachers must also be able to have the physical form of an astronaut.

The rectangles in the Hopscotch code are the area where a rover, the artificial intelligence, is looking at the surface of the planet Mars. We see two ways to write the code. The first, at grade 4 level, draws a rectangle by drawing a line and turning 90 degrees to complete the rectangle. The other example is at grade 8 level. We use the variables. We touch the two opposite vertices of the rectangle on the screen and draw a rectangle where we touched, and the size indicated by our finger.

Our mission is a very fascinating and differentiated mathematical problem, which can be conceived in several ways.

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Analysing the Data

During the process of assessing student work at school, student work is analyzed by all math teachers several times during the year. Here we have a unique and innovative example of mathematical reading from real life: reading an infrared image.

Infrared is used by many professionals in the construction and maintenance of

buildings and constructions of all kinds. Infrared is used by firefighters, police, in medicine and also, of course, in the space industry. Reading the infrared image tells us about the temperature of what is taken in the photo. The colors represent a different temperature, according to a scale given by the camera. We see the colors, the temperature of our planet Mars during the warmer months on the left, and the colors, the temperature of our planet Mars during the colder months on the right. It's in the same place. Blue is for colder temperatures while yellow is for much warmer temperatures. In summer, the summit is very hot, warmed by the sun while in winter, the snow-covered summit is colder than the base. The student can read and articulate all the temperatures of the image, using precise temperatures given by the scale of the camera. In your school meetings, do you see innovative examples of math like this?

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Making Professional Learning Decisions

After evaluating the students' level of learning on the mathematical side, we can see if the student has benefited from this type of learning. Are there any concepts that we need to review? Is the student ready for more independent or more individual instruction? Can we integrate math with science?

Here we see our hill on the planet Mars in visible light and infrared. The visual aspect of the project allows the student to immediately realize his errors in mathematical thinking. Imagine the result if the position of the visible light image was at (24, 150) instead of (380, 470). The rock would not be in the right place at all. Imagine if the size percentage was 1450 instead of 145. We would no longer see the infrared image. The pupil can immediately realize his errors and correct them in order to have a mathematically correct project.

My pupils, even the weakest, have always been passionate about technology and these great projects, which enabled them to work at their level. They worked harder because the project seemed to them much more interesting than the

worksheets. Even in the years when I did not teach math, I integrated the code with another subject such as science or art, to the delight of the students. Because code, math with code, it's a game. It's fun.

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Dealing with your Own Discomfort with Math

In our schools, we put a lot of emphasis on reading because we are very skillful, even if it is mathematics that needs our attention. Hopscotch offers many tools and support to help teachers and students cope with the discomfort of mathematics. All the programs I have personally written are available on Hopscotch for you.

You teach French? No problem. We can integrate math and French. Use the program I wrote. You just have to modify it for your needs. It is an artificial intelligence program that responds to the sound of your voice. Instead of saying "OK Google" and the artificial intelligence answers you, you say "OK Hopscotch" and the code will answer you. The answer will be what the student has written, his French text. The teacher does not need to create all the programs that would be useful in a classroom. If my 4th graders are able to code, to do math in French for fun, I think an adult can too.

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Getting Teacher Buy-in

I can see that you are among those who want to make a difference in the lives of your students. This is why you are here.

We saw in the results of the exams of the Ministry, there is an urgency in improving the results of students in mathematics. Our current methods are no longer up to par. Why code and math? We use technology everywhere. There are

a lot of high paying jobs out there that use code and we are short of people to fill existing positions.

Is it difficult? It is not difficult with Hopscotch. We start from the beginning by dragging blocks to write algorithms. There are videos showing us how. There is a lot of support, a lot of ideas, a lot of motivation for the students. We feel competent right away. Besides, it's really fascinating.

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Getting Parent Buy-In

When parents are involved and support your efforts, students work harder. Inform them of the work you do in class. They can talk to their child about their class work or even buy an iPad so they can continue their passion at home. Some parents of students came to me and said, "I have a master's degree in math. What you do in class with Hopscotch is really great." Others said, "My son is studying to become an engineer. I want my daughter, who is having trouble right now, to also have the chance to become an engineer. "This girl has worked hard to be successful. She put great interest and great effort in her work. Parents' buy-in allowed her to change her attitude toward math. She understands now that it is her personal effort that will make the difference.

Here is an example from NASA. When you send a rocket to Mars to drop a rover on the planet, a lot can go wrong mathematically. The rover here went through 7 minutes of terror and settled on the planet Mars.

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Math Talk

Hopscotch contains thousands of code samples of all kinds. We don't want the student to come up with a beautiful copied project that he doesn't understand. It becomes necessary to speak with the students and to verbalize their

mathematical understanding. This can be done in group discussion or with the teacher. Students can also work in pairs as a class and discuss their mathematical thinking with each other during the development of their project.

It is also possible to combine another application like ExplainEverything which allows you to create short films using the project designed by the student and to explain it using his voice and text. These short films can also inspire other people if they are published on YouTube.

Here you see a real infrared photo of the planet Mars. The photo is taken from the Internet. The Hopscotch code consists of moving the image using the buttons.

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Model the kinds of questions students might ask

You must be prepared to model the types of questions that students may have. This is a good sign when students ask more difficult questions.

Here is an example. Students use an iPad in the classroom to program with Hopscotch and others use their personal iPhone. A student wants his program to look nice and work on both devices. We are facing a problem because the screen of the iPad and the iPhone do not have the same dimensions. What to do? At this point, we can introduce the concept of variable. The width of the screen is placed in the variable WIDTH by Hopscotch. Each device has a different number for WIDTH. If we use the variable WIDTH created by Hopscotch instead of a fixed number like 1024, it will be possible to make adjustments for the width of the screen.

Understanding this allows dust to be placed on the entire screen on the iPad and iPhone in our dust storm simulation on Mars.

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Student Engagement with Math

Students will do what you ask them to. You will be more successful if the students are enthusiastic and committed to their project.

Raise your hand if you've ever seen and touched a sample of Martian rock?

Earth has received several asteroids from the planet Mars. Scientists are able to identify them. There are samples at the Royal Ontario Museum. You can also get them from Amazon. Here you see a photo of a sample of the planet Mars. The Hopscotch program simulates the rover that makes a hole in Martian soil. We really see Mars !!

If your students are excited about the idea of building the next spacecraft to go to Mars to bring samples, they will spend a lot more time and effort fulfilling their mathematical dream than if they have no interest in their mathematical task.

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Posing problems that pique curiosity

You have control over the selection of math projects that students can complete. Questions that arouse curiosity can contribute to the understanding of great mathematical ideas.

For example. Can you move the rover on the planet Mars? To make the rover move in 2 opposite directions, one must necessarily understand positive and negative numbers. We are going forward. It's $+ 1$. We go back. It's -1 . We will also understand the logic of the code that responds to touching on the touch screen. I slide my finger up, the rover moves. I slide my finger down, the rover is moving in a different direction.

These few lines of code require a very thorough mathematical understanding and is very interesting for the student.

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Demand appropriate support

You don't have time to prepare personalized and differentiated code for an entire class? I understand. Hopscotch offers lots of program ideas to help the teacher and students. There are thousands of them, of all levels. There are several subtitles to organize the large amount of programs with which you can learn math or organize a new project. You can learn new mathematical concepts by reading an already written program and trying to make a similar one. An already written program may give an idea for writing another different, but similar, program.

In the IDEAS subtitle in the Hopscotch application, you can see different bubbles and clouds. It gave me the idea to make a simulation of the wind on Mars. Art with code has become a mathematical and scientific concept.

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Highlight Important Math

The end of each lesson is to emphasize what is important in the lesson. We need to consolidate the lesson. The mathematical side is well understood but we must also emphasize the scientific side. When looking for life on Mars, you are not looking for animals that walk on the surface. We are looking for evidence of past life. This evidence is shown, among other things, in the form of methane gas. If we find methane, we will find a path that will allow us to understand life on Mars.

Note. Each program published with a photo is checked before being distributed in the Hopscotch application. Some are rejected if they do not meet the Hopscotch criteria.

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Providing Extensions for Strong Students

Our classes are mainly based on the curriculum. There are strong students who already work beyond the concepts offered by the curriculum. They already understand everything! These strong students also need support. They need challenges.

Hopscotch offers in-app videos allowing strong students to learn on their own. There are videos showing how to create games, for example. Here we created a game based on the Whaka-Mole video where methane moves randomly in the Martian atmosphere responding to touch. The methane concentration also appears to be changing. It shows in the color change of the gas. A whole game !!!

Do you have students who would like to do more?

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Deep understanding of curriculum

The teacher must have an excellent understanding of the curriculum to be taught. The resource being used may not be 100% curriculum-compliant. We need to know when Hopscotch is an excellent choice of resource and when it is not a good choice. Hopscotch does not meet all of the curriculum expectations in the 5 areas of curriculum study. Hopscotch does, however, allow you to explore all of the big ideas in the curriculum. In addition, a project written by the student can use concepts from the 5 areas of study of the curriculum. When assessing AS learning, you need to choose which curriculum elements you want to emphasize.

If you have any doubts, you can always look for specific concepts on the app. For example, there are several ways to create graphs while using code. You can choose the most suitable way for your students with the large choice of examples offered by Hopscotch.

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Confidence in students

Hopscotch is really a tool where students learn by solving problems. It's a way of showing them that we trust them. We don't show them what to do like following a recipe. They are given challenges. They must understand what they are doing to meet these challenges. The teacher's role is more to give feedback for improvement. This feedback allows the student to improve. We do not document what the student does not know how to do. Suggestions are given on how to improve the project. Constructive comments have a positive impact on the development of students' mathematical thinking.

Here we see a helicopter moving in the very thin atmosphere of Mars. Depending on the student or the mathematical concept to be explored, one could suggest adding a larger or multicolored motor. We could suggest adding a counter that measures the distance traveled by the helicopter. We could suggest changing the size of the helicopter or adding artificial intelligence that describes what the helicopter does. We could also suggest adding music to the project. Each suggestion involves mathematical challenges of very different complexity and levels. Assessment AS learning provides regular feedback to improve student practice before the final assessment of learning.

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High Expectations in Assessment of Learning

The assessment of learning takes into account the complete portfolio of the student. Hopscotch allows you to see all the projects that each student has written. The teacher chooses the most relevant section for his students. Here we see a section emphasizing creativity in problem solving.

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Differentiated Instruction

By offering a range of projects that can be solved in a variety of ways, Hopscotch is an ideal tool for differentiated instruction. Videos, project ideas, code reading, problem solving, and the trial and error nature of programming with Hopscotch supports student learning that learns differently. Hopscotch also supports the different pace with which students learn. Projects can be designed very differently, which shows a very open way of doing math. With a project whose result seems the same, we can have students who work with two-digit numbers while the other group works with three-digit numbers. Hopscotch allows students to work in the classroom, at home, or anywhere that inspires and motivates. Hopscotch is truly a tool of choice for differentiated instruction.

If you don't have an infrared camera, you can still use pictures from the Internet. Here we see a panorama of the planet Mars, composed of 1000 images taken with the Curiosity rover. The Hopscotch program manipulates this image of Mars.

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Monitoring and Sustaining Improvement

Students can work on their own, without a teacher, finding inspiration in books they read from the library and the Hopscotch app. They can follow a professor online who has a similar interest. You will find all my programs under the name SlickJudge on Hopscotch. If they are older, they can find great ideas for projects online with TED videos for example. The motivated student can learn on his own. However, I think that each student will learn better and faster with their teachers to guide them.

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Certificate of achievement

I would like to highlight the contribution of Marian Small whose book allowed me to organize this presentation. I would also like to thank my brother who gave me the FLIR camera and the FLIR company for their numerous conferences at

Niagara Falls. I would like to thank the people who gave me online feedback to improve this presentation. I would also like to thank all the people who encouraged me to cycle to the planet Mars and, of course, the people at Hopscotch who have developed a truly remarkable application.

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