A STEAM Resource for Educators in a Digital World
SPRING 2022 • ISSUE 5

ROOT & STEM

Skywatchers: Perspectives on Space

LIFE IN OUR GALAXY

Through Indigenous lenses

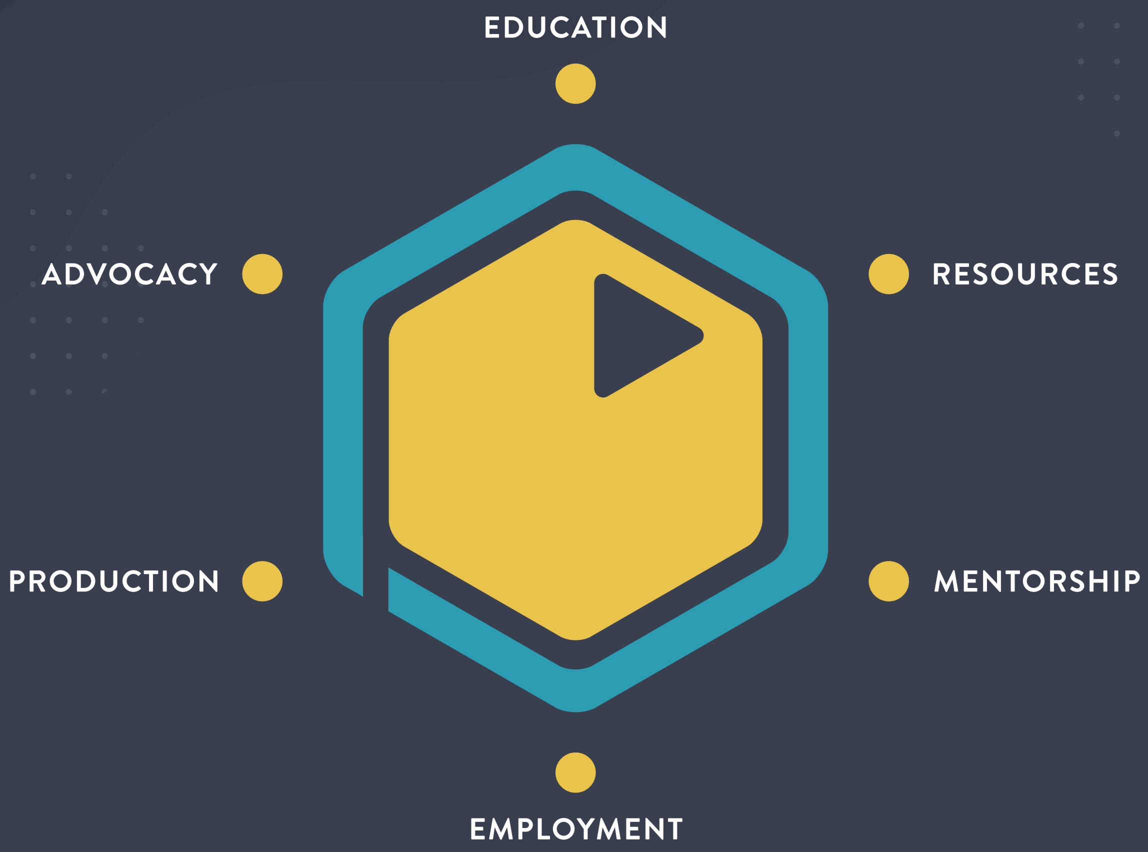
ININIW ACAKOSUK

Ininiw star knowledge shared by Wilfred Buck

SPACE CAREER PROFILE

Abby Lacson’s journey to becoming an astronaut

+ Plus comics, games, and over 10 pages of classroom-ready teaching resources



PINNGUAQ LIFE CYCLE

Pinnguaq follows a life cycle model to support the core phases of a person's learning journey in STEAM education. We strive to provide educators and students with opportunities and resources each step of the way.

To learn more about what we do, visit our website at

pinnguaq.com

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ROOT & STEM

ABOUT PINNGUAQ

The Pinnguaq Association, a not-for-profit organization, incorporates STEAM into unique learning applications that promote storytelling, health, wellness, and growth in rural and remote communities. At its core, Pinnguaq embraces diversity and creates opportunities in order to empower all people.

DIGITAL TAXONOMY

Computer Science Education is more than just coding. A comprehensive approach to it includes learning skills and competencies from each of the areas listed below. Look for the following icons at the end of each article for suggested curriculum connections. *Reference: Learning for the Digital World: A Pan-Canadian K-12 Computer Science Education Framework. 2020.* *k12csframework.ca*

- CODING AND PROGRAMMING
- COMPUTING AND NETWORKS
- DATA
- TECHNOLOGY AND SOCIETY
- DESIGN

The Pinnguaq Association acknowledges the support of the Government of Canada in developing this educator resource.

Root & STEM is printed on certified Forest Stewardship Council paper, to reduce our impact on the natural world.

Canada

Root & STEM (ISSN 2563-6979) is produced twice yearly by the **Pinnguaq Association**
87 Adelaide St N, Lindsay, Ontario K9V 4L4
STEAM@pinnguaq.com

Printed in Oshawa, Ontario, by Maracle Inc.

Publisher
Ryan Oliver

Director of Education
Jennie Cross

Editorial Coordinator
Chelsea Kowalski

Copy Editor
Nicholas Davies

Design & Layout
Hailey Bennett, Emily Canfield, Kelly Eng, Andy Guthrie, Mac Pavia

Cover Illustration
Saelym DeGrandpré

Logo Design
X-ing Design

Contributors
Ujarak Appadoo, Wilfred Buck, Chelsea Kowalski, Ilumigarjuk Kreelak, Zinnia Naqvi, Ian MacLean, Zoe Maeve, Hilding Neilson, Sofia Osborne, Chloe Phillips, Solomon Ratt, Lawrence Reeves, Ewan Reid, Laurie Rousseau-Nepton

Keck observatory on MaunaKea

PHOTOS COURTESY OF LAURIE ROUSSEAU-NEPTON

Shooting for the Stars

Looking at the starry night sky is something that connects each of us with the wonders of the universe. Our knowledge of the sky is kept alive through stories—some of them written in the stars—and helps us remember special moments, while teaching us about essential relationships between our environment, our land, and the place we hold in the cosmos.

From the summit of MaunaKea, the tallest volcano on the island of Hawai'i, large telescopes allow us to look deep into the universe and observe close-by galaxies, which contain billions of stars, in great detail. As an astronomer, I keep a close eye on the data collected by the telescope each night. I am from Canada, and I am a member of the Pekuakamuilnuatsh First Nation. I moved to Hawaii five years ago to work at the Canada-France-Hawaii Telescope, where scientists and students from around the world use the facility to look at celestial objects, from asteroids and planets to galaxies and black holes. When I observe the sky, I know I am where I should be. I have always been curious, and trying to understand our universe is the ultimate sense of curiosity.

I study the birth of stars. Stars form in the interstellar clouds of galaxies when the force of gravity pulls all the atoms together, and eventually, a celestial object in the center becomes bigger and bigger. At a certain point, something very special happens. Gravity becomes so strong that nuclear reaction ignites the heart of the object; elements start to fuse, creating larger ones. All of this generates a lot of light: A star is born.

Leading a group of 70 researchers, I developed a science program called SIGNALS, the Star formation, Ionized Gas, and Nebular Abundances Legacy Survey; a large survey of star-forming regions, where newly born stars are found. During the past four years, I used a special astronomical instrument called SITELLE to look at 40 galaxies near the Milky Way. Within these galaxies, we detected more than 50,000 regions that are actively fabricating stars. A star continuously affects its environment by producing and returning new elements to the interstellar clouds, just like humans continuously affect their environment on Earth! But for the stars, these new elements are recycled to form new stars. It does transform the generations of stars to come! Knowing how this process occurs is going to help us increase our understanding of the past, as well as the future of stars in our universe.

My goal is to make SIGNALS the largest database of information on star formation ever built. For the first time, scientists will have enough information on all the locations where stars form, as well as the kind of stars that emerge from the clouds. Each star has its own story. By listening to thousands of them, we will have a global picture of their role in the universe.

In this issue of *Root & STEM*, you'll find articles and resources that will inspire students to explore the sky above us. Whether it's thinking about life in our galaxy through an Indigenous lens or considering the unique perspectives of the stars and planets that arise in different cultures, this issue asks students to understand their connection to the sky above us and how it can impact human life.

— LAURIE ROUSSEAU-NEPTON

FEATURED CONTRIBUTORS

SAELYM DEGRANDPRÉ

Cover Illustration

Saelym DeGrandpré is a young, urban, Inuit digital artist from Ottawa. Her art focuses on themes of femininity, womanhood, and Inuit storytelling traditions. As her style and work grows, she is inspired and passionate about teaching Inuit oral history, storytelling, and traditional tattoo patterns through her artwork.

LAURIE ROUSSEAU-NEPTON

Guest Editorial • Page 5

Laurie Rousseau-Nepton is a resident astronomer at the Canada-France-Hawaii Observatory and was a FRQNT post-doctoral fellow at the University of Hawaii from 2017 to 2019. She was the first Indigenous woman in Canada to obtain a PhD in astrophysics. Now, she leads an international project called SIGNALS, which aims to observe newly born stars in galaxies near the Milky Way.

SOFIA OSBORNE

Space Careers Profile • Page 8

Sofia Osborne is a writer, reporter, and audio producer based in Vancouver. Her environmental journalism has appeared in *The Tyee* and *The Narwhal*, and she is the co-host and producer of *Beyond Blathers*, an Animal Crossing science podcast.

EWAN REID

Mission Control • Page 10

Ewan Reid is a founder and the CEO of Mission Control, which develops software for Earth, the Moon, and Mars. He is on the board of Space Canada and is adjunct faculty at the International Space University. He is passionate about inspiring the next generation to keep exploring.

CHLOE PHILLIPS

Space Seeds • Page 14

Chloe Phillips is in her second year at Trent University, where she is studying Environmental Studies and Education. She is passionate about combining social justice and environmental education into all aspects of her life.

HILDING NEILSON

Life in Our Galaxy • Page 16

Hilding Neilson is an astrophysicist living between Toronto and St. John's. His research involves understanding the insides of stars along with how we can better understand the way planets orbit other stars. He is passionate about astronomy, space exploration, and our relationship with the night sky and the stars.

LAWRENCE REEVES

Build and Launch a Satellite • Page 22

Lawrence Reeves is the founder of the CanSat Design Challenge for high schools and manages the CubeSat Design Challenge for universities. He has worked on Canadian and international space missions for almost 25 years.

ILUMIGARJUK KREELAK

The Planet Sedna • Page 24

Ilumigarjuk Kreelak is an amateur Inuk artist who lives in Baker Lake. Her art is inspired by both popular and Inuit culture. She is working on a graphic novel based on the local superhero Super Shamou.

WILFRED BUCK

Ininiw Acakosuk • Page 28

Wilfred Buck is an Ininiw (Cree) astronomer and knowledge keeper and the author of three books. He originates from Opaskwayak Cree Nation and is a graduate of the University of Manitoba, where he obtained two degrees in Education. He has more than 25 years of experience as an educator, including 15 years as a Science Facilitator at MFNERC.

ZOE MAEVE

Chandrasekhar's Limit • Page 34

Zoe Maeve is a comic artist and illustrator who lives in Tiohtià:ke/Montréal. She has published two graphic novels with Conundrum Press: *The Gift* and *July Underwater*. In 2021, she was nominated for an Ignatz Award for Promising New Talent.

BY CHELSEA KOWALSKI

Space Exploration from the Couch

With so much unknown about the universe and space itself, students (and teachers too!) find themselves with a myriad of questions: What does life look like in space? What are the origins of the constellations? What lies beyond what we have already explored? What does zero gravity feel like? Books are an incredible way for students to explore some of these questions and inspire them to learn more about space. Below is a diverse selection of titles that shine a light on the incredible phenomena that exist both in our sky and in space. Every book offers an opportunity for readers to delve deeper into space exploration and learn more about the science behind some of the universe's greatest mysteries.

• • •

For younger readers, here are some books that provide both entertainment and education about space and what lies above us and beyond.

THE EXPLORERS CLUB

By the Canadian Space Agency

With astronaut David Saint-Jacques's personal experiences of reading stories to his children from space, the Canadian Space Agency developed an e-book about a group of young explorers who set off on a fantastical journey through space, chasing after their dog, Chewie. The book is available online, on video, and in downloadable format.

THE NORTHERN LIGHTS

By writer Diane Ellis *(Inhabit Education, 2018)* • Age Recommendation: 5 to 7

Part of the Nunavammi Reading Series, this book is all about the northern lights that come into view in Iqaluit, Nunavut, including the stories surrounding them. Available in English, Inuktitut, and Inuinnaqtun.

THE SPACE ADVENTURER'S GUIDE: Your Passport to the Coolest Things to See and Do in the Universe

By science journalist Peter McMahon, with illustrations by Josh Holinaty *(Kids Can Press, 2018)* • Age Recommendation: 8 to 12

Your very own travel guide to creating the perfect space adventure, from learning how to withstand extreme G-force, to packing the right lunch, to choosing the best time for a walk on the moon. With tons of science lessons, fun facts, and photographs, this book is key to a good space vacation.

STRONG STORIES MÉTIS: How the Moon Came to Be

By Métis artist and lecturer Leah Marie Dorion *(Strong Nations, 2018)* • Age Recommendation: 9 to 12

As part of the Strong Stories: Métis series, this book focuses on the traditional Métis story of the creation of the Moon, including how Mother Earth and Grandmother Moon got their names.

For more experienced readers, here are some books that explore questions about Indigenous star knowledge, the thrill of space travel, and the history of Canadian space exploration.

KITCIKISIK (GREAT SKY): Tellings that Fill the Night Sky

By Ininiw/Cree Knowledge and Dream Keeper Wilfred Buck with illustrations by Mistawasis Buck *(Indigenous Education Press, 2021)* • Age Recommendation: 13+

Wilfred Buck explains the origins of several constellations, including Mista Muskwa (Great Bear), Mistatim (Horse), and Ocik (Fisher). This work is complete with Cree terms and syllabics, as well as maps of the constellations and original artwork.

THE APOLLO MURDERS

By former astronaut and ISS commander Chris Hadfield *(Penguin Random House Canada, 2021)* • Age Recommendation: 13+

Set in 1973, this thriller combines technical details about space exploration with the suspense and excitement of space travel and the fight for survival among hidden dangers.

CANADARM AND COLLAB: How Canada's Astronauts and Space Robots Explore New Worlds

By space writer Elizabeth Howell *(ECW Press, 2020)* • Age Recommendation: 13+

This book provides a deep dive into Canada's role in international space exploration and how the development of the Canadarm started our national astronaut program. Inside are interviews with some of the most prominent astronauts, politicians, and key players in space exploration for the past four decades. &

TECHNOLOGY AND SOCIETY

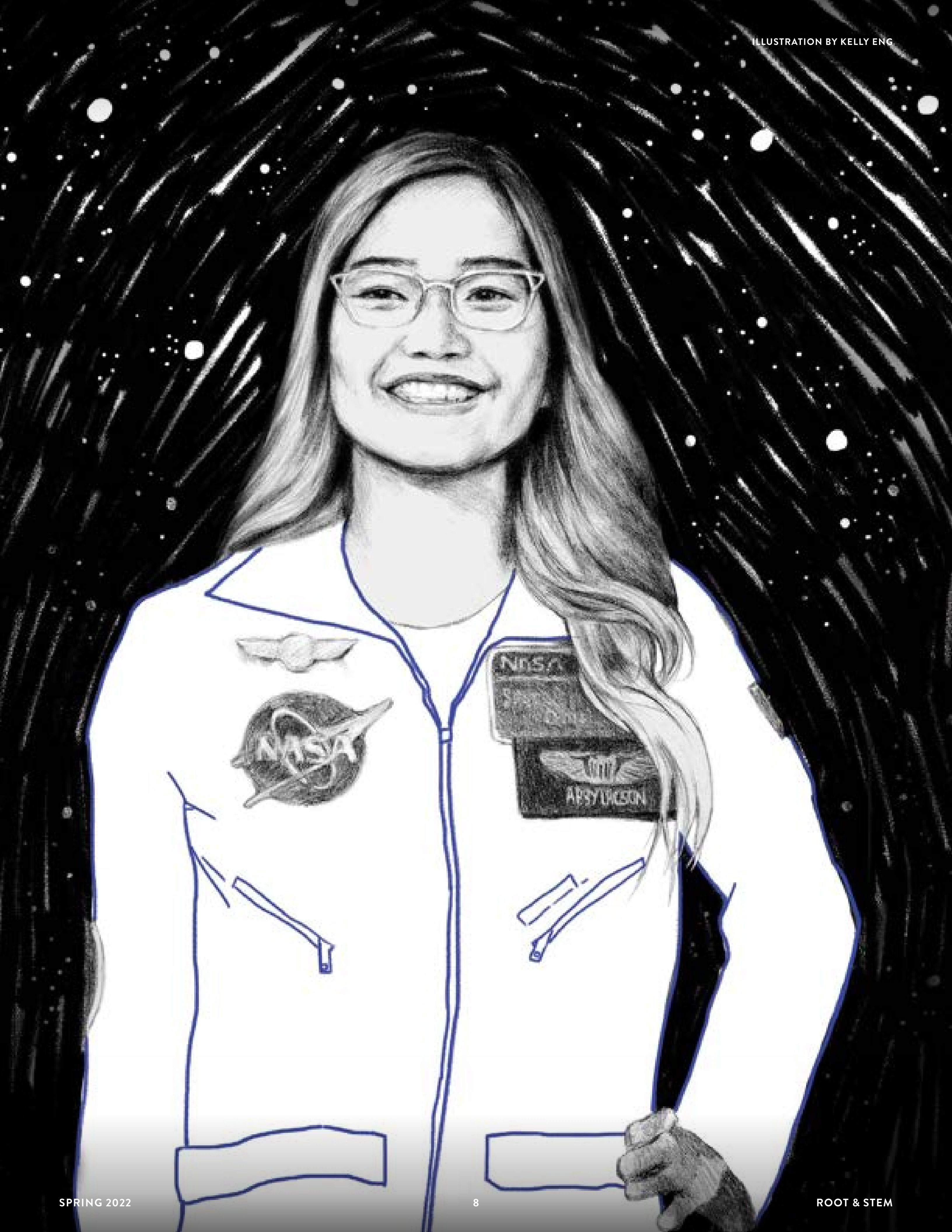

ILLUSTRATION BY KELLY ENG

Abby Lacson participating in a simulation as a crew member maneuvering the Canadarm 2 around the ISS

PHOTO COURTESY OF ABBY LACSON

BY SOFIA OSBORNE

Space Careers Profile:

Abby Lacson

When Abby Lacson was in Grade 10, she knew she wanted to be an engineer. But it wasn't until she went camping in the Rockies and saw the night sky, free from light pollution, that it finally clicked: she wanted to become an astronaut. Now, at 24, Lacson is a junior space operations engineer with MDA Space, the Canadian space technology company behind the Canadarm, a series of robotic arms used on the space shuttle.

Once she finishes training for her new role, Lacson will be working with the operations team at the Canadian Space Agency to provide engineering support for the back room of Mission Control in Houston. When the Canadarm2 is in use on the International Space Station, Abby and her team will monitor their movements and make sure the Arm is operating within its working range, address wear and tear issues, and check clearances to avoid collisions.

"We're like the back room of the back room of Mission Control," Lacson says. "It's super exciting. I get to see things happening in real time soon."

But in Grade 10, this was all a dream for Lacson. To work in the space industry—and ultimately become an astronaut—she knew it would take planning and hard work.

Over the course of her research, Lacson found that a lot of Canadian astronauts had done military training, so she joined the Air Cadets, where she experienced survival training, learned about planes, and dipped her toes into flight training.

"It was also kind of a testing ground [to see] if I actually wanted to pursue trying to be an aerospace engineer [and] trying to work in the space industry," Lacson said.

At the University of Alberta, Lacson majored in mechanical engineering. After her first year of university, she attended a space camp in Alabama, where she experienced a simulated space mission, did scuba training, and even took Russian language courses.

Back in Edmonton, Lacson joined the AlbertaSAT team, a student group that built the first satellite made and launched in Alberta. She also started a new student group, the Student Team for Alberta Rocketry Research (STARR), which aims to launch amateur rockets in competitions.

"Working with AlbertaSAT and also creating STARR, they were really ... the founding stones," Lacson said. "They were basically how I got my job, because they were the most relatable experience that I had coming from university."

While Lacson works incredibly hard toward her dream of being an astronaut, she also knows how to have fun. As an Instagram micro-influencer, her page is full of videos of her roller skating around Montréal.

"I do all these cool tricks, but it takes hours of practice," Lacson said. "And I fail all the time ... But it's also about being resilient, and taking that skill from roller skating and putting it into the work that I do in my career."

The reality of becoming an astronaut means lifelong learning, but it also means being a role model and a team player.

"I think hobbies are super important, and they make you a more well-rounded person," Lacson said. "And I definitely think a lot of astronauts are that way as well."

Besides getting involved in extracurriculars like cadets or space camp, and paying attention in math, physics, and computer science classes, Lacson's advice for aspiring astronauts is to find relatable role models in space science. This is especially important for young women, as the space industry has long been dominated by men, with only 11 per cent of astronauts so far being women.

"What helped me when I was younger was trying to find astronaut examples for myself. So I would search [for information] about the women who had gone to space or were working as astronauts. And I read their stories online, and tried to relate them to my life," Lacson said. "And telling yourself that it's really just about what you want, and not about what the world wants and what they see. It's what you see yourself as." &

TECHNOLOGY AND SOCIETY

Students learning how to operate a rover on Mars during a production demonstration from a MCSS-Pinnguaq collaboration

BY EWAN REID

Mission Control

Humans Are Going Back to the Moon

Humans are going back to the moon. Life on Earth is feeling its way out of its den. We first went to the moon in 1969. Twelve American men walked on the lunar surface and another four orbited Earth's satellite over a series of nine missions. Since then, only two other nations—the former Soviet Union and China— have successfully landed a robot on the moon. But now a new race is on. Many different countries—at last count, eight—and countless companies are planning new lunar missions and Canada is set to play a role in one of the first.

Why go to the moon? Why leave the planet at all? To explore. We need to know where we came from. We need to look ahead and see where we're going. The moon is a stepping stone—the closest to our shores—from which we can explore farther afield. It's a logical first step to test the technologies we'll need to do that.

There are more stars somewhat like our Sun in the universe than there are grains of sand on Earth. There must be life out there. Intelligent life. While we can't see clearly how we can communicate with it/them now, the advances that life on Earth, most recently human life, have made, indicate that anything is possible. Human spacecrafts have left our solar system, been sent toward other stars, and recently, with the launch of the James Webb Space Telescope, we have a tool to look back in time to the earliest days of our universe.

With the moon as the next step, Canada has set out to be a part of lunar exploration. Mission Control, a company that focuses on developing advanced software for space, has built an artificial intelligence (AI) that will be demonstrated on the moon in the early part of 2023—less than a year from now. By validating this technology now, with the support of the Canadian Space Agency, Canadian industries and academia—thousands of people across Canada—are positioned to play an important role in this new frontier of discovery.

Our AI system is a series of algorithms, implemented in software, and integrated

PHOTO COURTESY OF MISSION CONTROL SPACE SERVICES INC

The Mission Control Space Services Rover in motion for practice lunar mission

on a computer or circuit card, and will use images from a small rover to classify lunar terrain. On future missions, the output from this AI will let robots navigate more safely, let them conduct more experiments faster, and, ultimately, help human operators back on Earth prepare for when humans themselves return to the moon. This computer will be installed on a lunar lander built by a Japanese company. The images will come from a rover built in the United Arab Emirates. This lander and rover will launch together on a US rocket, built by SpaceX. Canada is joining a truly international mission.

Looking ahead to the future, there are enormous opportunities for everyone to be involved in exploration and discovery; to participate in the space sector. In a short couple of years, a Canadian will be one of the first humans to return to the moon and fly around it on the Artemis 2 mission. One of the four current candidates will be the first non-US citizen to see the Moon from only a few hundred kilometres away. But beyond astronauts, there are so many other jobs to do to help us move into the future. Artists are some of the first humans to work on exploration missions, to visualize the possibilities for investors. We need engineers. We need scientists. We need technicians and doctors and lawyers and team builders.

Who can say what the future holds? Life on Earth is only now feeling its way beyond the small part of the cosmos where we've lived since something sparked our creation many years ago. As we take the next steps into this future, Canada, and Canadians, can play a part. You can play a role as we go to the moon and beyond. &

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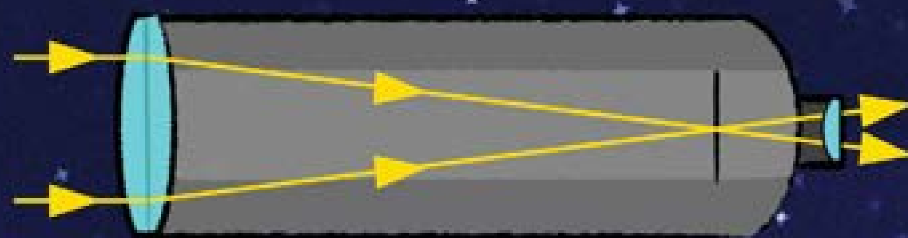
Refracting Telescopes

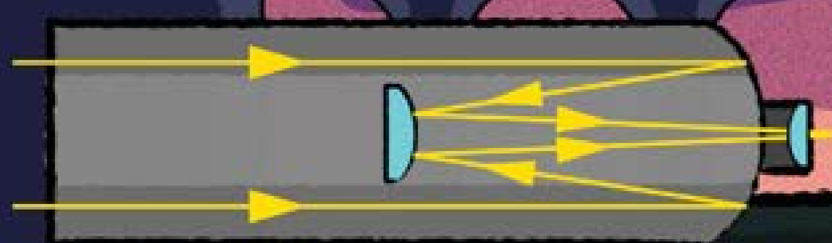
The earliest telescopes formed the basis of all others, and are still used today. A tube, fitted with a convex glass lens in one end, collects light and bends (or *refracts*) it towards a focal point, where those light rays converge. The collected image is viewed through a second lens with a focal point complementary to the aperture lens. The focal length affects the magnification and determines the tube's required length, while the size of the lens (*aperture*) determines the amount of light collected and the brightness of the image. Some telescopes have a focus adjustment, which moves the eyepiece to match the focal points of the two lenses.

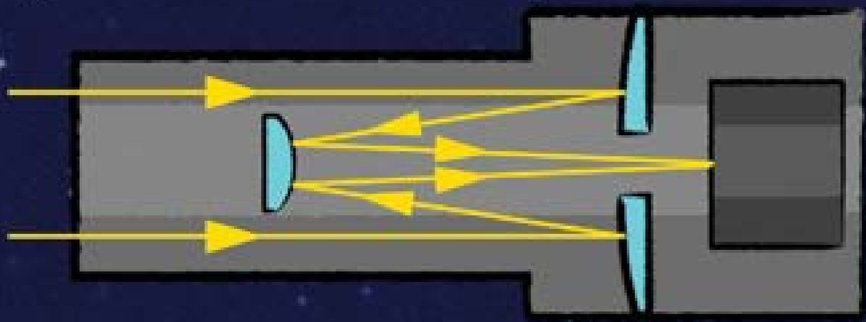
How Telescopes Work



Reflecting Telescopes

Building on the core concepts of the *refracting* telescope, *reflecting* telescopes use a *concave* mirror at the rear of the tube to bounce light back toward a secondary mirror, which directs the light toward the eyepiece. Mirrors are easier to manufacture and lighter than glass lenses, so telescopes can be built at a larger scale without a big increase in cost. The bounce distance of the collected light means these telescopes generally require a shorter tube. Because their larger apertures allow them to collect more light, they are better suited for viewing objects at greater distances. Isaac Newton is generally credited with building the first one in 1668.





Space Telescopes

Because Earth's atmosphere interacts with incoming light, observing space from its surface can be troublesome. Light can be absorbed by molecules, scattered by dust and mist, or altered by pressure changes (*turbulence*) in the air. Orbital satellites, being outside the atmosphere, aren't hampered by these factors, and can capture more accurate images. The Hubble Space Telescope's reflecting mirror has a 2.4-meter diameter, as well as an array of instruments to measure other spectrums of light, which allows for the capture of extremely detailed images of deep space.

Multi-Mirror Telescopes

Deep space observation is made possible using many mirrors within a telescope. Rather than one large reflective surface, their primary mirror is made up of multiple hexagonal segments. These are connected to computer-controlled motors that can adjust their angles continuously. This avoids distortion of the light path (known as *aberration*) and delivers more accurate images. The reflected light is collected by a suite of cameras and spectrometers. The Keck Observatory, located on the top of the MaunaKea volcano on the island of Hawai'i, uses this type of telescope.

BY CHLOE PHILLIPS

Space Seeds

The Tomatosphere™ Experiment

Tomatosphere is a free program that encourages students to investigate the effects of outer space on food to support human space travel. The program uses detailed experiments conducted on tomato plants. One group of seeds has been to space or treated in a simulator that represents the unique conditions of space, while a second group, considered the control group, has not been treated with anything. Students explore the differences between plant growth under stressed space conditions through various experiments available on the Tomatosphere website.

Students of all ages can benefit from these lessons and experiments, which can be tailored to meet their needs regardless of age or ability. The program also offers many educational resources, such as tutorial videos, to help students get started. Because students cannot take a field trip to outer space (at least, not yet), this program creates an opportunity to connect with our faraway galaxy in a personal, rewarding way. To get started, use the following steps.

STEP 1: REGISTER AND ORDER SEEDS

You can order seeds at no cost and create an account through Let's Talk Science at **tomatosphere.letstalkscience.ca**.

STEP 2: REVIEW MATERIALS

Let's Talk Science offers various accessible lesson plans on their website. There are also videos to encourage engagement and further learning.

STEP 3: INTRODUCE TO STUDENTS

The Tomatosphere program provides more than 20 learning strategies for educators to consider (available on their website) to introduce and monitor the experiment with their students. From prediction guides to inquiry summary strategies, there are a number of guided approaches to learning.

STEP 4: PLANT SEEDS

If space in your learning environment is limited and you have access to a garden area, you can plant the tomatoes outdoors. Just make sure that friendly neighbourhood critters are not able to munch on the leaves or fruits as that can impact the results of the experiment.

STEP 5: OBSERVE AND RECORD GERMINATION

Tomato growth can be tied in with STEAM practices by developing journals for students to monitor, observe, and record plant growth.

STEP 6: SUBMIT RESULTS ONLINE

To take your experiments to a cosmic level, take photos of the process and share them on the Tomatosphere website. A specific section on the website's main page allows you to upload your students' observations easily!

How cool would it be to enjoy some out-of-this-world tomatoes with your students?

• • •

Let's Talk Science, a national, charitable organization that creates and delivers science, technology, engineering and math programs to preschool through Grade 12 classrooms, operates Tomatosphere in Canada. Let's Talk Science education specialists create and maintain the Tomatosphere educator resources found on the Tomatosphere website and ship seeds to educators at no cost. The consortium of partners who oversee Tomatosphere include the Canadian Space Agency, HeinzSeed, Let's Talk Science (operations in Canada), First-the-Seed Foundation (operations in the United States), Stokes Seeds, and the University of Guelph.

Watch the videos mentioned above on how to complete each part of the seed investigation, including tutorials called "Planting your Tomato Seeds" and "Completing the Seed Investigation" at **tomatosphere.letstalkscience.ca/resources/library.aspx**. &

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PHOTOS COURTESY OF LET'S TALK SCIENCE

BY HILDING NEILSON

Thinking about Life in Our Galaxy Through Indigenous Lenses

The night sky offers a majestic view, filled with millions of tiny lights, each from a distant star. Throughout our galaxy, there are billions of stars, each orbiting the centre of the galaxy, each emitting its own light and sharing its own story.

As far as scientists can tell, our Sun is not a particularly special star, yet it is the only star we know of that hosts life. But, that view is changing. Thanks to satellite missions, like the Kepler Space Telescope and the Transiting Exoplanet Space Satellite, astronomers now know of thousands of planets that orbit other stars. Across the galaxy, exoplanets appear common.

While there are a lot of exoplanets, we still don't know how many, if any, support life as we know it. But, the search for life and intelligent life began long before we knew about those exoplanets. More than 50 years ago, this search began with the growth of radio astronomy—the study of the universe via long-wavelength radio waves. We see only a small fraction of light with our eyes, but telescopes observe X-rays, and ultraviolet, infrared, and radio light in the sky. In the 1950s, humans were broadcasting television and radio signals to homes around the world and soon realized that those signals were being broadcast into space too. Since the broadcasts travel at the speed of light, by today, those radio signals have reached potentially hundreds of nearby stars. However, at those distances, the signals are very weak, in the same way a wifi connection gets weaker as you get farther from the source.

This realization led to a question: What if beings on other worlds emit radio signals? Could we detect them? If so, how many might there be? In 1958, Professor Frank Drake devised a thought experiment to try to understand the issues around the search for extraterrestrial intelligence (SETI). We know there are hundreds of billions of stars in the Milky Way galaxy and, in Dr. Drake's time, astronomers only knew about planets in our solar system and life on planet Earth. So, with very little information, he developed the Drake equation to calculate the number of advanced civilizations in our galaxy, which is:

$$\mathbf{N = R^* \times N_p \times N_h \times N_l \times N_i \times N_c \times L}$$

This is a big equation, but one way to look at it is like a nesting doll. This is a doll within a doll within a doll and so on. On the outside lies the largest doll, which is *the number of stars in the Milky Way at any time*—but stars are born and die constantly.

> ***"When we ask about life in our galaxy, we can look to Indigenous knowledge and find a completely different view, particularly about what it means to have life, intelligent life, as well as the length of time for which civilizations exist."***

What we really need to know is how often stars are born. In our galaxy, the equivalent of about three stars like our Sun are born every year, so at any time, we can estimate there are about one hundred billion stars in our galaxy. That's R*.

The second layer, N_p, is the *percentage number of stars that can have planets.* In Drake's time, we only knew of one star, our Sun, that could host planets but, thanks to recent missions, we're pretty sure that about 20 per cent of stars host planets. The next layer, N_h, asks: *Of all of these planets, how many have the ability to host life in any way?* Looking around in our solar system, astronomers are pretty sure that Mercury cannot host life; neither can the gas and ice giants like Jupiter and Uranus. Scientists have speculated about microbial life on Venus and there is evidence Mars may have once hosted life—and may still do so today. So, we can guess that perhaps two or three planets per host star have the potential to host life. Of course, we haven't even mentioned the idea of life on moons of planets, like the ice moons, Europa and Ganymede, or on Titan. The reality is that scientists don't really even know this number.

We have the same problem for the next layer, N_l, which represents *planets that could host life and will go on to do so.* In our solar system, we really only know of one such planet, so at best, there are one in three planets that do support life—or that number might be one in a hundred because, again, scientists just don't have enough information. The next step, N_i, is for the *planets that do host life and how many will have intelligent life*—whatever "intelligent life" is defined as—possibly the ability of a species to communicate, or self-awareness, and so on. In Dr. Drake's time, however, intelligent life meant humans. In that case, the number is maybe 1 in 10, or 1 in 100, or 1 in 1,000,000. We simply don't know.

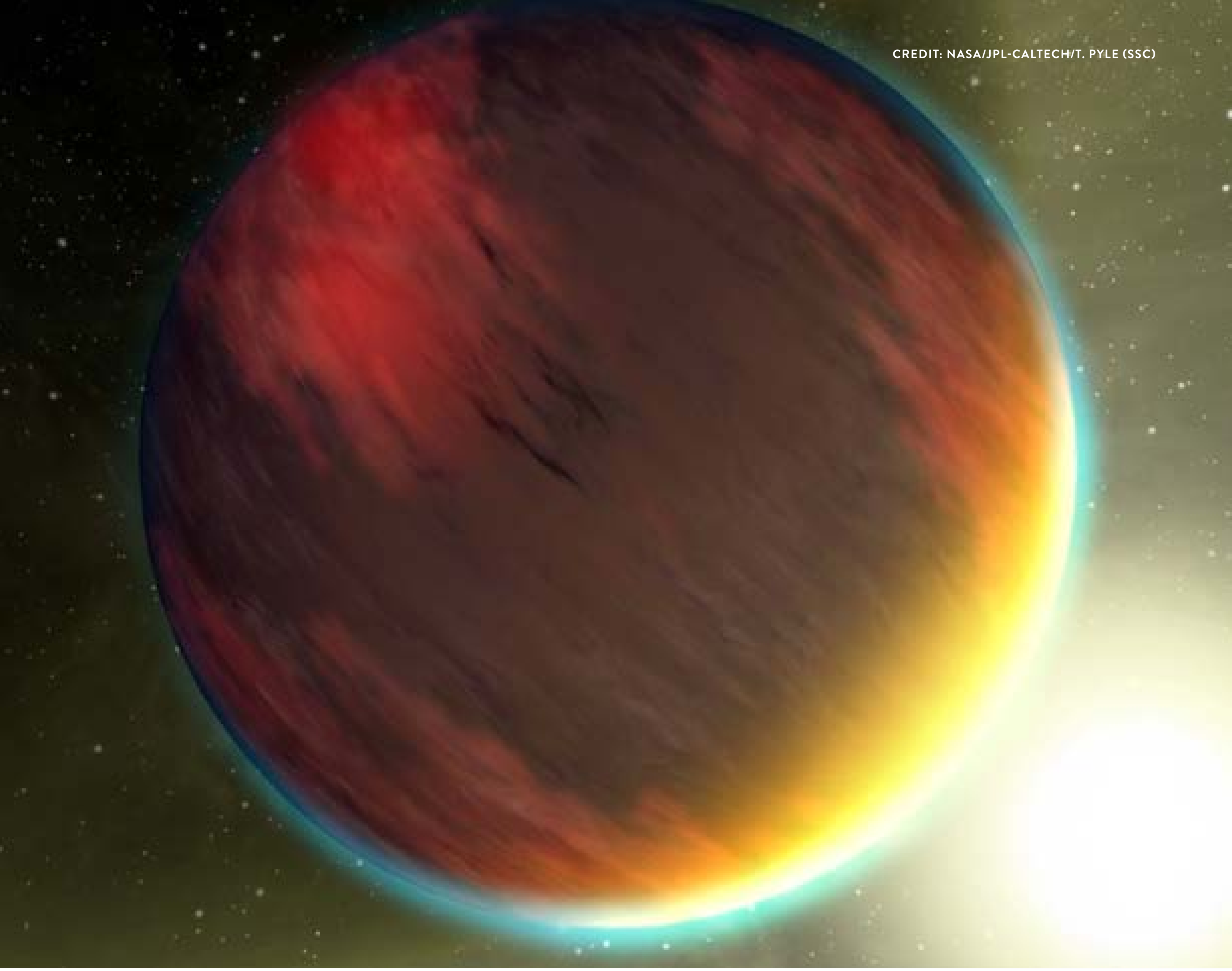
If a planet hosts intelligent life, what are the chances that "civilizations" capable of interstellar communication will arise? That question is N_c. Again, we only know that humans are capable of such communication through radio transmissions. There could be many other ways for life in the galaxy to make itself known, but in Dr. Drake's time, there was only radio communication. In this case, we have the same issue: it could be 1 in 10 or 1 in 1,000,000.

The final layer asks *how long these civilizations last.* Civilizations can end because of asteroid impacts, like the one that led to the extinction of the dinosaurs here on Earth, or war—a prime concern in Dr. Drake's time. Today, we fear runaway climate change could end human civilization. This length of time could also relate to how long civilizations broadcast detectable signals into space. Again, we don't know—the timescale could be 100 years or 1,000,000 years. Most scientists tend to think the number is closer to 100 years.

As we can see, there are a lot of unknowns when we ask about alien life in our galaxy—and there are a lot of things to explore. However, one thing we can see is that our view of this equation is based on our understanding of humanity and life on Earth. More than that, Dr. Drake assumed that "civilization" meant the specific technology of the Western world and that "intelligent life" meant humanity. From that viewpoint, scientists predict only about ten or so civilizations. But, that is not the only perspective. We live in a land where Indigenous Peoples have been around since time immemorial and every First Nations and Inuit community has its own views of the universe and nature. These views are not necessarily the same as those of Western science, nor is it necessarily true that different First Nations and Inuit perspectives even align with each other. But, different Indigenous knowledge can tell us a lot about nature, the world, and the universe.

When we ask about life in our galaxy, we can look to Indigenous knowledge and find a completely different view, particularly about what it means to have intelligent life, as well as the length of time for which civilizations exist.

These are difficult questions. NASA defines life as something that undergoes Darwinian evolution; that is, life is something that adapts to its surroundings over many generations through



CREDIT: NASA/JPL-CALTECH/T. PYLE (SSC)

An artist's rendition of a planet, similar to Jupiter, with an orbital path very close to a nearby star

evolution. Even though this is a very broad definition, for many Indigenous Peoples, life is defined by relationships; be they our relationships with bears, salmon, moose, or with plants like sage, dandelion, or pine. It is also defined by our relationships with the land itself, and the air and the water. Does this mean land is a life form as well? In some respects, the answer is yes. In 2017, the Whanganui Māori in New Zealand fought and won a court case through which they received the recognition of human rights for the Whanganui River. In the territories known as Canada and the United States, many Indigenous Nations fight, as their protectors, for the rights of water and land. If we define life by its relationships with its surroundings, Indigenous knowledge accounts for Darwinian evolution and potentially more. We cannot say whether this would mean the number of planets that can support life and have life would be much greater, but is, at least, the number as suggested by NASA.

When we ask about intelligent life, the results might be very different. In Western astronomy, we assume "intelligent life" really means "humanity" because no other life on Earth creates technologies like humans do. But, Indigenous nations tend to live in good relations with nature, and respect animals and planets as equal to humanity. Indigenous Peoples tend not to define intelligence in other species, but consider intelligence intrinsic to species, whether it is the social nature of wolves, the use of tools by crows, and so on. This occurs more in Indigenous cultures because people are not above the animals and the plants and live in relation with each other. Since humans are not above the natural world, then we can think intelligent life is common and not rare, as it is defined by Western science.

The greatest difference might lie in how we view what a civilization is. In Western science, we would call a civilization the group or culture that is more advanced than other nearby groups. For the Drake equation, we consider the Western world with its technology, internet, radio telescopes, billboards, light pollution, etc., to be the civilization. But, this is also a narrow definition.

An artist's rendition of the Jovian moon Europa ejecting a steam plume off its surface

"If we only consider the Western perspective, then our search for extraterrestrial intelligence is simply looking for ourselves: a society that creates pollution and climate change, a society that is expansionist. That is a narrow view when so many other civilizations on Earth have lived in balance with and in support of nature, but the Drake equation would not predict that."

The Mi'kmaw, Ininiw, Inuit, Salish, and others are all civilizations. Instead of just one civilization on Earth, Indigenous nations and cultures are also civilizations.

Similarly, how long do civilizations last? Again, scientists only know about us and the current civilization that is still here. Dr. Drake and others suggested that, for the purpose of detecting aliens, our civilization began in the 1950s with radio telescopes and TV signals. He also guessed that our civilization might only have this capability for about a century, either because humanity would move on from that radio technology or humans might be destroyed. Today, astronomers use telescopes to search for life, along with other methods, so we are not reliant on just one option. Even though we are still searching, it's more than possible that aliens could be searching for us too.

Aliens could have many more methods and tools to find us. They could have been searching for a lot longer than a century, like us, and might have achieved that capability long ago. And if they did, they likely would have detected Indigenous civilizations. Many First Nation Peoples would say they have been here since time immemorial, but archaeological evidence shows First Nation peoples have been in the Americas for more than 20,000 years.

In these four different layers, we see that there are a lot of differences between Indigenous and Western knowledge. Through a Western lens, the Drake equation would suggest there are very few civilizations in the galaxy, whereas, through an Indigenous lens, there could be tens or hundreds of thousands more civilizations in our galaxy. That is, through an Indigenous lens, the galaxy is teeming with civilizations. This is important because when we explore the Drake equation, there are so many things we don't have a good understanding of, so our view of life in the galaxy is a reflection of whatever lens we are looking through. If we only consider the Western perspective, then our search for extraterrestrial intelligence is simply looking for ourselves: a society that creates pollution and climate change, a society that is expansionist. That is a narrow view when so many other civilizations on Earth have lived in balance with and in support of nature, but the Drake equation would not predict that.

What is even more interesting is that having a lot of civilizations in our galaxy is a more hopeful prediction that we are not alone and that we are part of a galactic ecosystem. It is inspiring, as a scientist, to explore and search for planets orbiting other stars and wondering if we are seeing an empty planet or a living planet. We can learn from Indigenous perspectives, combined with the Western concept of the Drake equation, to see a galaxy rich in life that is much more diverse. Perhaps, a galaxy that is entirely Indigenous. &

CODING AND PROGRAMMING

TECHNOLOGY AND SOCIETY

DATA


CREDIT: NASA/ESA/K. RETHERFORD/SWRI

CanSats ready for launch! These CanSats were deployed from a helicopter in June 2021, at the conclusion of the inaugural competition

BY LAWRENCE REEVES

Build and Launch a Satellite

With a sudden, loud "whoosh," a small rocket darts up into the sky, leaving a thin column of smoke behind it. The rocket quickly burns out yet continues to coast ever higher. When it reaches its apex (approximately one kilometre), a small, blackpowder charge disengages the rocket's nose cone and ejects its cargo: a CanSat—a pop-can-sized satellite containing equipment for one or more science experiments. A parachute soon opens, and the CanSat's mission begins as it collects data while on its descent back to Earth.

The Canadian Satellite Design Challenge Management Society (CSDCMS) has been managing a university-level "CubeSat" satellite competition for over 10 years, and has recently expanded to offer the CanSat Design Challenge to high school students. The competition is a Canada-wide STEM development program in which teams of high-school students design, build, and launch their own CanSat, a simplified version of a satellite. The CanSat contains a small computer, a battery, and one or more sensors, along with other technology to conduct experiments during descent. The primary mission is to collect and record air temperature and pressure data every second.

From a small, mid-pandemic start with only six teams in the 2020-21 school year, the CanSat Design Challenge has grown to include more than 40 teams this year, hailing from British Columbia to Nova Scotia. Teams comprise up to six students, and combine the knowledge of several STEM-related disciplines (electronics, physics, software), as well as communica-

CanSat Design Challenge organiser Lawrence Reeves deploys a CanSat from a helicopter in June 2021, at the conclusion of the inaugural competition

PHOTOS COURTESY OF LAWRENCE REEVES

tions skills (writing and presenting). The CanSat competition contains an Educational Outreach component, and teams are required to give space-related presentations to younger students in order to pique their interest and inspire them to pursue STEM education further.

The CanSat Design Challenge has two levels to accommodate as many interested students as possible. In the Beginner level, the CanSat records the data on a memory card on-board; at the Advanced level, the CanSat transmits the data by radio to the students tracking it on the ground. Teams in the Advanced category will travel to Lethbridge, Alberta, at the end of April to have their CanSats launched, while the Beginner category CanSats will be deployed out of a helicopter from wherever they are located. The winner of the Advanced level then has the honour of representing Canada in Europe at an international CanSat competition organised by the European Space Agency.

Taking part in a CanSat project gives student teams the opportunity to experience the phases of a real space project, from selecting the mission objectives, designing the CanSat and parachute, integrating the components, testing the system, preparing for launch, and analysing the data obtained. Through this process, students learn through hands-on experience while working on a fun and interesting challenge. The CSDCMS provides every team a CanSat kit with most of the required components, and has created a number of online video tutorials to guide the students through the development process.

The CSDCMS would like to welcome any interested schools—no matter how large, small, or remote—to contact us to participate in future competitions. Please feel free to contact the CanSat Design Challenge organiser, Lawrence Reeves, at: **lreeves@csdcms.ca**. **&**

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CSDCMS Website. ***csdcms.ca***

CanSat Tutorials. ***youtube.com/channel/UClWbhWHrUk8rMpSCAlgNEhw***

European Space Agency's CanSat Resources Website. ***esa.int/education/cansat***

CODING AND PROGRAMMING

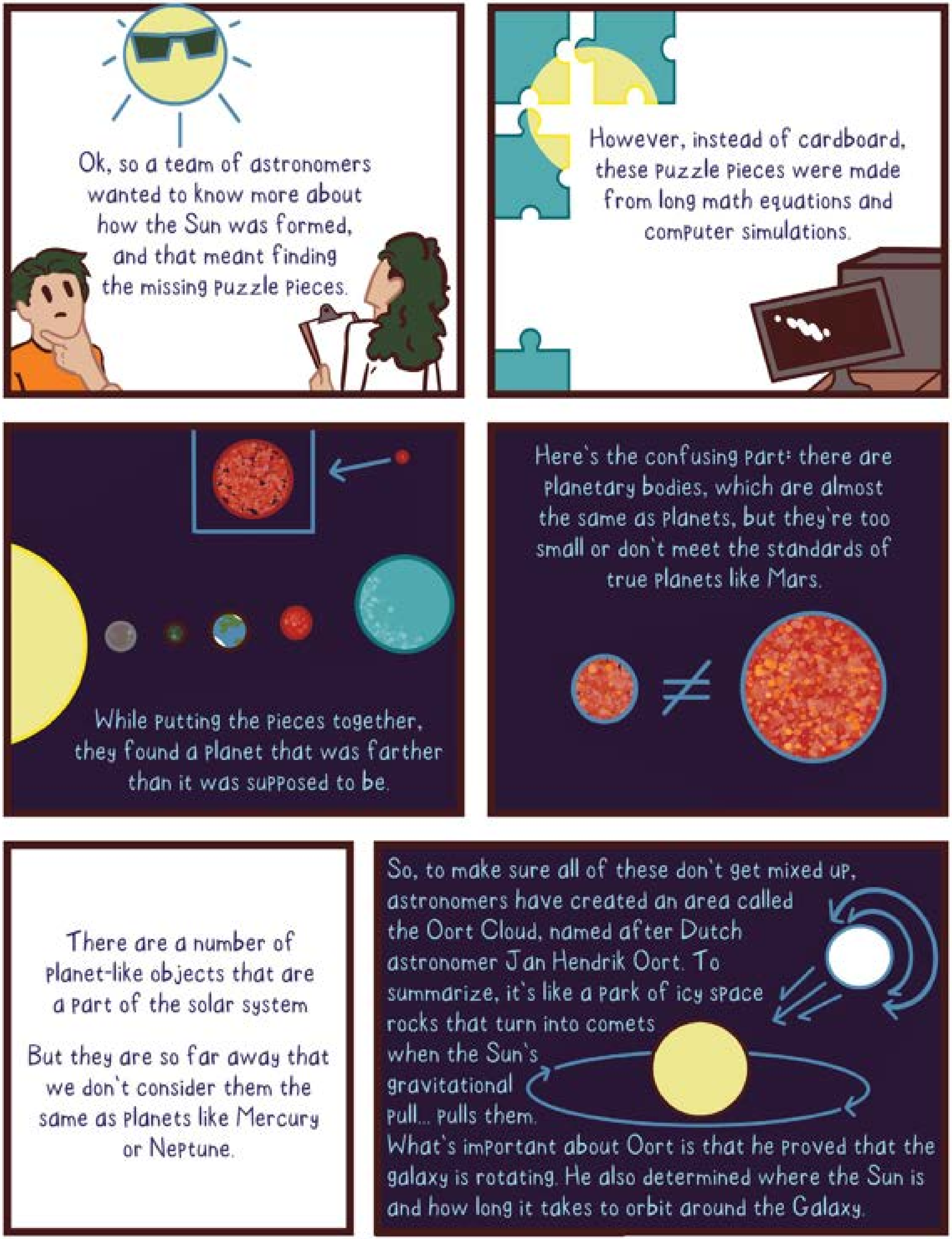
COMPUTING AND NETWORKS

DESIGN

DATA


THE PLANET SEDNA
Presented by Smidge
2022
Oh, OK.
So, do I read this?
Yes.
...
You have to read it out Loud.
Oh!
My bad. I didn't-
I wasn't-
Sedna. The Inuit goddess who brought the Arctic sea mammals to life.
Literally.


This is a lot of information.
The planet Sedna had the second largest orbital period of any known object in the solar system of comparable size or larger, calculated at around 11,400 years.
Sedna's orbit is extremely eccentric with an aphelion estimated at 937 AU and a perihelion at about 76 AU.
I feel like the script is too...jargon-y. Nobody will understand unless they do an internet search at the end of every sentence.
I'm from space and this doesn't make sense.
So, you want to use layman's terms? Is that what you're saying?
Exactly! This is an infomercial, but we're selling facts instead of cooking pot sets or light bulbs.
Who wrote this anyway? It reads like an encyclopedia.
We'll cast someone else if you don't do your job. We have the right to- you signed a contract.


Ok, so a team of astronomers wanted to know more about how the Sun was formed, and that meant finding the missing puzzle pieces.
However, instead of cardboard, these puzzle pieces were made from long math equations and computer simulations.
While putting the pieces together, they found a planet that was farther than it was supposed to be.
Here's the confusing part: there are planetary bodies, which are almost the same as planets, but they're too small or don't meet the standards of true planets like Mars.
≠
There are a number of planet-like objects that are a part of the solar system
But they are so far away that we don't consider them the same as planets like Mercury or Neptune.
So, to make sure all of these don't get mixed up, astronomers have created an area called the Oort Cloud, named after Dutch astronomer Jan Hendrik Oort. To summarize, it's like a park of icy space rocks that turn into comets when the Sun's gravitational pull... pulls them.
What's important about Oort is that he proved that the galaxy is rotating. He also determined where the Sun is and how long it takes to orbit around the Galaxy.


Since its discovery in 2003 at Palomar Observatory in San Diego, the planet Sedna has made Inuit mythology a part of astronomy.


From the sea...


...to the stars.

PHOTOS COURTESY OF WILFRED BUCK

WILFRED BUCK

Ininiw Acakosuk

The Cree Stars

All cultures on Nikawiy Aski (Mother Earth) have looked into the night sky with wonder and awe. Each culture has its own perspective of the sky and its own particular understanding of how that awesome sky connects to its world views. Different cultures have always looked to the sky to make connections, seek order, and pursue an understanding of identity.

An artist's conception of several constellations in Acak Sipi (the Milky Way), including Kokominakasis (Grandmother Spider, the net-maker)

We roam the cosmos as beings of light/energy/spirit. We transcend realities.

Prior to the Industrial Revolution, intimate knowledge of the sky was common. Star patterns and orbital paths were recognized. Lunar, solar, and planetary phases were identified and environmental occurrences within these patterns were noted. Pattern recognition was used as a directional indicator for travelling far and wide. By combining this recognition with prior knowledge, predictions could be made.

To have a better understanding of how Indigenous People see themselves connected to the sky, we must first understand what happened to those original belief systems. When Europeans first made contact with the fully functioning, established belief systems of Indigenous understandings—which were radically different from their own—the settlers determined that these "alien understandings" had to be subdued and discredited because they threatened their Christian ideology and base of power. Thus, the Indigenous worldview was subjugated, as was a self-sufficient way of life. Through the violence of colonization, whole worlds were destroyed, long-established thought processes eliminated, and genocidal practices began.

For Indigenous People, perspectives of the sky and our place among the stars have changed through the process of colonization, as have our world views and belief systems. As colonized peoples, Indigenous People took on the perspectives, world views, and beliefs of the colonizer. We were conditioned to see the world through a different lens. We were indoctrinated into believing in a totally different spiritual, religious, self-conscious, and intellectual understanding of who we thought we were. We were—and still are—brainwashed into thinking Indigenous People had no intellectual capacity, scientific methodology, self concepts, or depth of knowledge. We were told we were savages who needed to be "saved" and rescued from ourselves. It has only been in the last 20 years that Indigenous People have begun to look into the vast cosmos and wonder about their place in it... once again.

With the shroud of colonial propaganda slowly dissolving, Indigenous People are once again looking into their ancestors' understanding of Misiwa (all that is [known and unknown]), and how humans fit into Paimatisiwin (life). We are in the process of healing our historical traumas.

We are beginning to connect with the depth of knowledge our ancestors held and through that understanding, we are beginning to realize our connection to Kisik Aski (the sky world). This worldview tells us everything is connected... the known and the unknown. This understanding tells us everything is energy. There is a term in Cree—Kisikookuk, which can be translated as "beings of light/energy/spirit."

My People, the Ininiw (Cree), call the stars by the name "acakosuk," derived from the root word "acak," which can be translated into the term "spirit." One basic understanding is that everything is made by Kitcimanito, the Great Spirit made of energy/light/spirit. Creator had a thought and that thought came into being. We assume the first thought was of energy and energy came into being. Thus everything has a spiritual base and we all emanate from one source... Kitcimanito.

For the Ininiw, Kitcikisik (the great sky), was an indicator of unfathomable immensity where only your Pawamiuk (dreams) could offer glimpses of the infinite possibilities the sky represented. As Ininiw, we are told the connection we have with Kisik Aski is through Pawamiuk. Dreams tell us of our origins in the sky world and give us the foundation to our methodological steps for coming to knowledge. One of the main directional indicators in our Northern Hemisphere is Polaris, the North Star. My people call this important star Kiwatin. The root word for this term is Kiwi, meaning "home," thus Polaris is recognized as "the going-home star." Another designation it goes by is Ikakacit ("standing still"), since it is the only star in the Northern Hemisphere that does not move.

The thing people will come to see in regard to Indigenous astronomy is that Indigenous People have a number of names for any given topic of discussion. That is to say, there are multiple acimowinuk ("narratives/tellings") to any particular thing, event, place, or instance.

An example of the depth of knowledge that connects us to Kisik Aski is the "telling" of Acakos Iskwiw ("Star Woman"). This narrative tells us we are Kisikookuk ("star beings ... energy/light/spirit"). It also makes us aware of the concepts of particle theory, quantum theory, and thermodynamics. We are told that we are Kisikookuk and we travel through Misiwa. Our journeys take us in search of new experiences, sights, sounds, smells, textures, and feelings. We roam the cosmos as beings of light/energy/spirit. We transcend realities.

As the Acimowin goes... one particular being of energy we have come to know as Acakos Iskwiw was travelling the cosmos and came upon a spatial anomaly, which happened to be in what we now call the Milky Way galaxy. This phenomenon was a portal, a doorway from one reality to another... a wormhole.

Acakos Iskwiw happened to gaze through this portal and saw Nikawiy Aski. Acakos Iskwiw was intrigued and decided to go to this mysterious place. Acakos Iskwiw understood that to navigate the portal, assistance was needed and Acakos Iskwiw knew of the door-keeper, Okunowiskatopiw, who was in charge of this function. This particular Okunowiskatopiw was called Kokominakasis ("Grandmother Spider," the net-maker).

Acakos Iskwiw approached Kokominakasis and asked for assistance to navigate the portal. Acakos Iskwiw was told there were three conditions that needed to be met if the portal was to be navigated.

1. A physical form was to be used as a means of interacting with the physical world.
2. A gift was to be taken through the doorway to act as a reminder of where Acakos Iskwiw originated.
3. Acakos Iskwiw could not stay too long on the visit.

Acakos Iskwiw agreed to these conditions and Kokominakasis sent a single strand of webbing through the doorway and Acakos Iskwiw used the strand to climb down into this reality and reach Nikawiy Aski. When Acakos Iskwiw touched the Earth, she took a physical form... a human form. This is how we humans arrived on Earth. We are energy, then change form, and finally, return to energy when our visit in the physical world has ended.

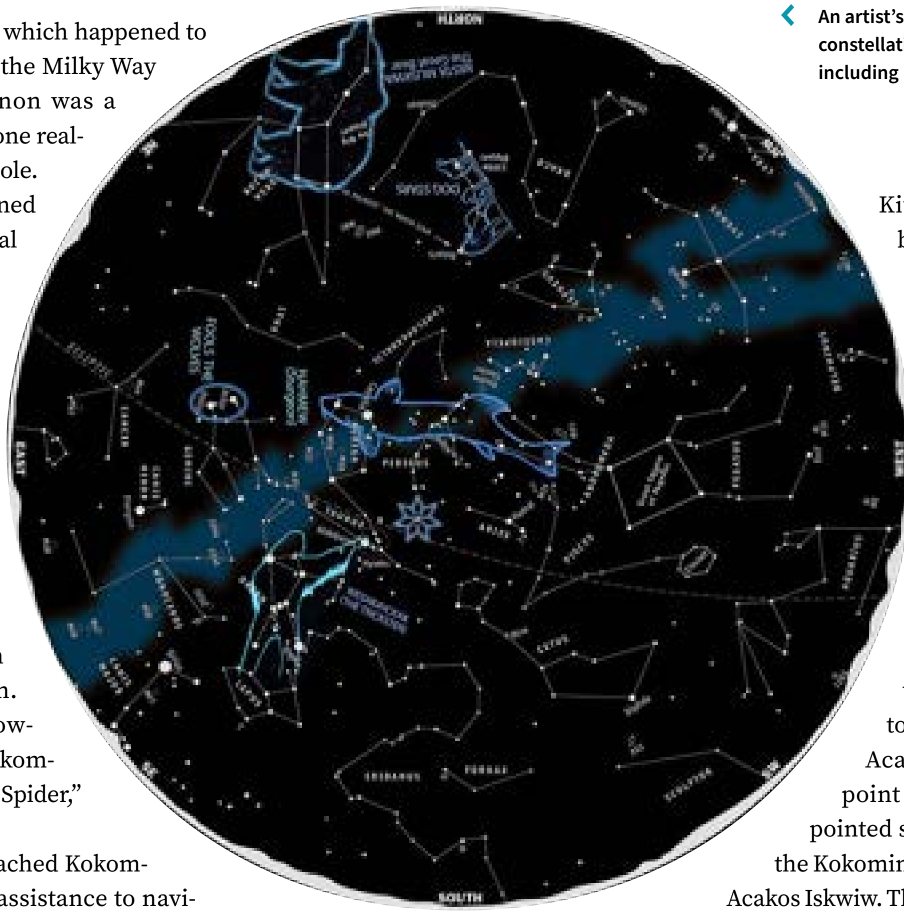
The gift that was brought into this reality was Acakosahakoop ("the Star Blanket"), to remind us that we come from the sky world... from the stars.

As for not staying long on the visit... how long is long for a being of energy? Acakos Iskwiw stayed a lifetime, then returned to the cosmos.

So through Acakos Iskwiw, we all arrive here. We change form from energy to physical beings as we are lowered by a single strand of webbing we call the umbilical cord to Nikawiy Aski. We come for our visit, experience, teach, learn, feel, and age... then we leave.

Our elders always remind us that we are spirits learning how to be human... not humans learning how to be spiritual... then the cycle continues. Energy changes form... solid, liquid, gas, plasma.

We were given Acakosahakoop to remind us we come from Kitcikisik and that sacred blanket of stars is symbolic of a special place in the sky called Pakwon Kisik ("the Hole in the Sky"—widely known as the Pleiades). The original blanket had Tipahkop Acakosuk ("seven stars") on it to symbolize the stars of the Pleiades. As more and more humans arrived here to visit, there was a decision made to honour the first one here, Acakos Iskwiw, so an extra point was added to the seven-pointed star blanket to remember the Kokominow ("first grandmother"), Acakos Iskwiw. Therefore, today we have an eight-pointed star blanket.



An artist's conception of several constellations in Acak Sipi (the Milky Way), including Nahmew (the Sturgeon)

On a side note: Kokominakasis is the being who gifted humans the Dreamcatcher, which filters energy that transcends realities. We also understand that there is a connection from our dreams to Pakwon Kisik, which gives us glimpses of infinite possibilities, like the ones explored in quantum theory. We constantly dream when we sleep, no matter if we remember those dreams or not. We dream... we make connections, get inspiration, direction, guidance, healing, understanding, and broaden our possibilities.

This is one of the sacred tellings from the perspective of the Ininiw but this telling is told across Mikinak Ministik ("Turtle Island") because Indigenous Nations understand that we are part of a greater whole that originates in Kitcikisik.

We come from the stars and understand that misiwa is energy/light/spirit. &

Ninanaskomitinan (I am humbly grateful)

— Pawami Nikitititicikiw (the Dream Keeper) a.k.a. Wilfred Buck

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To listen to Wilfred Buck share Cree Star knowledge, please visit **pinnguaq.com/learn/canadian-space-agency-game** to visit an interactive environment filled with a selection of constellations.

TECHNOLOGY AND SOCIETY

DESIGN

Glossary

CREE WORD
CREE SYLLABICS
[*Pronunciation*]
English Meaning

• • •

NIKAWIY ASKI
NIKÂWIY ASKIY
ᓂᑳᐎᐩ ᐊᐢᑭᐩ
[*neck-away as-kee*]
Mother Earth

MISIWA
MISIWÊ
ᒥᓯᐍ
[*mees-wa*]
All that is (known and unknown)

PAIMÂTISIWIN
PIMÂTISIWIN
ᐱᒫᑎᓯᐎᐣ
[*pay-mah-tis-e-win*]
Life

KISIK ASKI
KÎSIK ASKIY
ᑮᓯᐠ ᐊᐢᑭᐩ
[*key-sick-as-kee*]
The sky world

KISIKOOKUK
KÎSÎKÔKAK
ᑮᓰᑯᑲᐠ
[*kee-see-coo-cuck*]
Beings of light/energy/spirit

ININIW
ININIW
ᐃᓂᓂᐤ
[*in-in-niw*]
Cree (“the four-bodied” or “of the four”)

NIWO
NIWO
ᓂᐓ
[*nee-you*]
Four

ACAKOSUK (PLURAL)
ACÂKOSAK
ᐊᒑᑯᓴᐠ
[*ah-cha-kos-uk*]
Stars

ACAKOS (SINGULAR)
ACÂKOS
ᐊᒑᑯᐢ
[*ah-cha-kos*]
Star

ACAK
AHCAHK
ᐊᐦᒐᕽ
[*ah-chak*]
Spirit

KITCIMANITO
KIHCI-MANITOW
ᑭᐦᒋ ᒪᓂᑐᐤ
[*kit-chi-man-it-oo*]
The Great Spirit made of energy/light/spirit

KITCIKISIK
KIHCI-KÎSIK
ᑭᐦᒋ ᑮᓯᐠ
[*kit-chee-kee-sick*]
The great sky

PAWAMIUK
PAWÂTAMOWINA
ᐸᐚᑕᒧᐎᓇ
[*pah-wah-mi-uk*]
Dreams

KIWATIN
KÎWÊTIN
[*kee-way-tin*]
The North Star

KÎWÎ
ᑮᐍᑎᐣ
ᑮᐑ
[*gii-wai*]
Home

IKAKACIT
ÎKÂ KÂ-ÂHCÎT
ᐄᑳ ᑳ ᐊᐦᒌᐟ
[*eh-kah-kah-chet*]
Standing Still
*Also known as the North Star

ACIMOWINUK (PLURAL)
ÂCIMOWINAK
ᐋᒋᒧᐎᓇᐠ
[*ah-chim-oh-win-uk*]
*Also known as âcimowina
Narratives/tellings

ACIMOWIN (SINGULAR)
ÂCIMOWIN
ᐋᒋᒧᐎᐣ
[*ah-chim-oh-win*]
Narrative

ACAKOS ISKWIW
ACÂHKOS ISKWÎW
ᐊᒑᐦᑯᐢ ᐃᐢᑹᐤ
[*ah-cha-koos-is-kew-wew*]
Star Woman

OKUNOWISKATOPIW
OKANAWSIKÂTAPIW
ᐅᑲᓇᐤᓯᑳᑕᐱᐤ
[*oh-cun-now-wisk-ahtwo-pew*]
Doorkeeper in charge of…

KOKOMINAKASIS
KOHKOMINAHKÎSÎS
ᑯᐦᑯᒥᓇᐦᑮᓰᐢ
[*ko-ko-min-ah-kah-sees*]
“Grandmother Spider,” the net-maker

ACAKOSAHAKOOP
ACÂHKOSAKOHP
ᐊᒑᐦᑯᓴᑯᐦᑊ
[*ah-cha-coos-ah-ha-coop*]
Star Blanket

TIPAHKO ACAKOSAK
TÎPAKOHP ACÂHKOSAK
ᑏᐸᑯᐦᑊ ᐊᒑᐦᑯᓴᐠ
[*teh-pah-coop ah-cha-koo-suk*]
Seven Stars

KOKOMINOW
KOHKOMINAW
ᑯᐦᑯᒥᓇᐤ
[*coo-coo-min-ow*]
First Grandmother

PAKWON KISIK
PAKONÎ KÎSIK
ᐸᑯᓃ ᑮᓯᐠ
[*pah-gwun-gii-sg*]
Hole-in-the-sky—better known as the Pleiades

MIKINAK MINISTIK
MIHKINÂHK MINISTIK
ᒥᐦᑭᓈᕽ ᒥᓂᐢᑎᐠ
[*mick-in-ack minonis-tick*]
Turtle Island

NINANASKOMITINAN
NINANÂSKOMITINÂN
ᓂᓇᓈᐢᑯᒥᑎᓈᐣ
*Also known as ninanâskomon
ᓂᓇᓈᐢᑯᒧᐣ
[*ni-nah-nask-oh-mit-tin-nan*]
I am humbly grateful

PAWAMI NIKITITICIKIW
PAWÂMI NIKITITICIKIW
ᐸᐚᒥ ᓂᑭᑎᑎᒋᑭᐤ
[*pah-wah-mi Nih-kih-tee-tee-chi-ghew*]
The Dream Keeper

BY CHELSEA KOWALSKI

Hack the Valley IV

Battle of the Coding Clashers

Technology inspires innovation, and in recent years, hackathons have become increasingly popular as a way to explore innovative solutions to complex challenges. In just a matter of hours, teams of students can consider creative solutions that otherwise may have seemed overwhelming. Hackathons are a great way to test knowledge and build communication skills in a short time.

A hackathon is a competition that involves collaboration and requires both technical and non-technical skills to apply creative problem-solving to a challenge. Typically over two or three days, participants team up and work quickly to create a product/solution

Hackathons could be a part of innovative changes that fill needs identified by a community.

and present it to the other participants and representatives from technology companies.

In October 2021, Pinnguaq co-sponsored a University of Toronto hackathon called Hack the Valley IV: Battle of the Coding Clashers, which challenged students to come up with original and educational games, either in concept or design. Glenn Ye and Leo Wang, both in the third year of a computer science program, won the Best Game award. Both students had little to no experience with hackathons but a vested interest in gameplay and found the hackathon to be good motivation to try something new.

Ye and Wang created an educational, quiz-style battle game that covered a variety of STEM topics and concepts. However, the pathway to success was not easy. The first hurdle came before the hackathon even started. Originally, they were part of a team of four, but their colleagues had to drop out due to school demands. Ye and Wang persisted, despite the disadvantage, relying on each other and their limited background in coding. Wang says he was glad the hackathon encouraged him to work collaboratively. “As a computer science student, I’m used to working on my own. But sometimes a project as big as the one we tried to take on, like most projects in the world, requires split[ting] up the effort.”

According to Ye and Wang, hackathons breed innovation and creativity. They found the experience forced ideas by making them bypass the planning phase. Wang thought he wouldn’t enjoy rushing through his work but now he sees the value in a forced creative bubble. “It will really help if you’re struggling to find some ideas.”

Part of the allure of a hackathon is the lack of industry standards, which allows creativity to flow. According to Wang, “a lot of [computer science students] have ideas, but no one really wants to start on an idea because that’s the hard part. I think hackathons put you under pressure and force you to just roll with an idea. And sometimes it works out.”

When it comes to advice for future hackathoners, Ye and Wang agree on one thing: go for it—with friends. Ye says a team of friends is key to success. “I think working with a team of people you already know is much easier and smoother, and you’re more likely to succeed because you can trust your friends to participate and help you out.” Wang also points out that hackathons are open to everyone. “There are plenty of people that spend almost the whole hackathon [on] a design of a product. It’s not always about creating the product. Sometimes a really good proposal of a product can also win prizes.”

The non-coding parts of a hackathon aren’t highlighted very often but they are just as important. The companies that sponsor hackathons host workshops on software and digital tools that are open to all participants and are a great way to learn about potential new skills. And if you want to code but have no experience, Wang says there’s no reason to worry. “I think in general, you’ll always find people that can explain stuff to you and teach you quickly because that’s what the environment of a hackathon really promotes.”

And for students with an interest in coding and computer science, hackathons can be a great way to network with other students, educators, and companies offering mentorships and programming training.

Ye suggests that because hackathon event organizers are usually looking for participants to produce creativity and functionality, hackathons could be a part of innovative changes that fill needs identified by a community. “They want to encourage original ideas. So, if there was a hackathon that was focused on creating technology that would help remote communities, I think that would spark a lot of original concepts and projects that would grow and help transform these communities.” &

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CHANDRASEKHAR'S LIMIT

Subrahmanyan Chandrasekhar (1910–1995) was born in the city of Lahore in pre-Partition India. At the time, the regions that are now India, Pakistan, and Bangladesh were part of a British colony. The young Chandrasekhar was inspired by his mother Sita, who encouraged him to study science, and his Uncle Raman, who was a noted physicist.

At school, Chandrasekhar excelled in math and physics. He taught himself about the latest developments in astronomy and the papers he wrote were too advanced for even his teachers to understand. As a young man, he travelled to England by sea to study at the University of Cambridge.

At the time, astronomers believed that as a star aged it would slowly burn out, becoming what is known as a white dwarf. On his voyage to England, Chandrasekhar tried to determine the mathematical equations that would represent this process and made an astonishing discovery. The math showed that if a star was larger than a certain size, it was impossible for it to burn out slowly and become a white dwarf.

Chandrasekhar was sure his calculations were correct. It was not that he could not solve the problem but that no solution could exist. Even a computer could never find the solution.

In England, Chandrasekhar spent years trying to understand what happened to these larger stars. Far from home, he was lonely and found his British colleagues often did not take his work seriously. Even though India was part of the British Empire, Indians were frequently treated as second-class citizens and overlooked in professional fields.

Eventually, he solved the problem. He discovered that when stars are very large (more than 1.4 times the size of the Sun), something much more remarkable happens: the star collapses in on itself, then explodes in what is called a supernova. The star then becomes either a black hole or a neutron star.

His discovery, which is known as Chandrasekhar's Limit, changed what we know about the life cycle of stars.

Chandrasekhar used math to learn about parts of the universe that are so enormous they are difficult for us to imagine. Use the space above to draw what you think the collapse of a giant star looks like.

Iqalliarkluk—ᐃᖃᓪᓕᐊᕐᓗᒃ, an Inuktitut typing game created with Illitaqsiniq. Access it here:
↳ **typing-game.pinnguaq.com**

LET'S MAKE COOL THINGS

Pinnguaq has proudly partnered with organizations from coast to coast to coast on exciting learning projects, like our newest collaboration, **Iqalliarluk—ᐃᖃᓪᓕᐊᕐᓗᒃ**, an Inuktitut typing game created with Ilitaqsiniq—the Nunavut Literacy Council. Find this game, along with other great resources at **ilitaqsiniq.ca**.

If you want to collaborate with us on projects that improve digital skills and STEAM learning for residents of the Yukon, Northwest Territories or Nunavut, we're excited to work with you!

Let's chat! Send us a message at steam@pinnguaq.com

PINNGUAQ

A screenshot from Star Scribe, an online game which promotes stellar knowledge and lunar exploration

Digital Kit

PAST ISSUES

If you missed the past issues of *Root & STEM*, you can find them online at
pinnguaq.com/root-stem

RESOURCES

We have developed additional digital resources for educators to use in their classrooms—including lesson plans, video tutorials, and activity handouts. They can all be accessed online via the links that follow.

Root & STEM Podcast

The podcast expands on our publication, *Root & STEM*, and invites subject experts from the issue to share knowledge. The episodes are approximately 15 minutes long and are available on the Pinnguaq website, and through popular podcast platforms, such as Apple and Spotify.
pinnguaq.com/learn/the-root-stem-podcast

What's Above Us Video Series

The What's Above Us video series is an engaging resource for learning about the Earth's atmosphere and the space beyond. Each video explores a different feature of the sky and provides examples of the interconnected systems that exist above us. Most videos also include a visual representation of the topic, like the water cycle, to show how each aspect of the sky above us is formed.
pinnguaq.com/learn/whats-above-us-video-series

Star Scribe Game

Star Scribe allows users to explore the surface of the Earth's Moon and the surrounding stars. They can also listen to spoken star knowledge connected to those constellations as shared by Ininiw/Cree astronomer Wilfred Buck. Additionally, there is a Roblox edition of Star Scribe where users can learn about Cree star knowledge by scanning a map of different constellations as they find them in the sky.

Star Scribe:
pinnguaq.com/learn/canadian-space-agency-game

Star Scribe Roblox Edition:
roblox.com/games/7776768070

Message to Educators

The following lessons centre our learners on planet Earth, our home, and encourage the curiosity of what lies outside our atmosphere. These lessons provide learners the opportunity to explore beyond our planet with learning concepts such as cycles and phases, habitable planets, and gravitational forces. We hope learners will be inspired to begin looking at our night sky to make sense of the stars we see with the perspective from their own culture and other cultures. Each lesson provides hands-on learning opportunities to reinforce the concepts through tactile, STEAM (Science, Technology, Engineering, Art, Math), age-appropriate activities. These lessons are a taste of how learners can develop a curiosity and love for space science.

— **UJARAK APPADOO**
Pinnguaq Curriculum Developer

LESSON 1

Exploring the Moon

Author: Ujarak Appadoo

Level: Kindergarten to Grade 3

Learning Objectives

- Students will learn about Earth's moon
- Students will be able to describe the moon's characteristics
- Students will be able to describe the phases of the moon

Vocabulary

- **Waxing Crescent**—In the Northern Hemisphere, we see the waxing crescent phase as a thin crescent of light on the right.
- **First Quarter**—We see the first quarter phase as a half moon.
- **Waxing Gibbous**—*Waxing* means the portion of the moon we see is getting bigger. This phase is between a half moon and full moon.
- **Full Moon**—A fully illuminated moon.
- **Waning Gibbous**—*Waning* means the portion of moon we see is getting smaller. The waning gibbous phase is between a half moon and full moon.
- **Last/Third Quarter**—We see the third quarter as a half moon, too—but it is the half opposite to the one illuminated in the first quarter.
- **Waning Crescent**—In the Northern Hemisphere, we see the waning crescent phase as a thin crescent of light on the left.
- **Taqqiq**—The Inuktitut word for "moon" and for "month."

In this lesson, students explore the cycles and phases of the moon. Students will be "over the moon" for this lesson, as they will be asked to observe the moon over a period of two months, document their observations, and learn the phases of the moon together as a class. The students begin to describe patterns and the moon's phases throughout the month.

Reading Activity

Prior to the lesson, students will listen to a story about the moon called "Little Moar and the Moon" by Roselynn Akulukjuk.

"Moar has always loved autumn—playing outside with his friends, feeling the weather get colder—but there is one thing about autumn that really worries Moar. The moon. The days become shorter and the moon, with its creepy face and eerie smile, seems to be looking down on him before he can even get home from school! So, one day, Moar is determined to get home before the moon appears in the sky. But there are so many fun things to do on the way home, he may just run out of time!"

inhabitbooks.com/products/little-moar-and-the-moon

Art Activity

Does the moon really have a face? Have you seen a face on the moon before? In your observation of the moon, check to see if there is a face, then draw the face on your own moon.

Material:

- Paper
- Crayons
- Circular object to trace for shape of the Moon

Bonus: Name your moon

Introduction to Earth's Moon

To activate prior knowledge, ask students: What planet do we live on? When we look outside, what do we see? What are elements of space that we know? What do we know about the moon?

Watching Activity: youtube.com/watch?v=6x_ZVRPqAnQ

Introduce the concept of "phases" by explaining how the moon doesn't always look the same every night! That means the moon looks different to us each night during its one-month orbit. Use descriptive words to describe how the moon looks with terms such as, "full moon," "first quarter," and "new moon". Do we know which phase our moon is in right now?

The Moon in Culture

Learning about space from different cultural perspectives builds and reinforces concepts with children. Once children have heard a story about the moon and share their prior knowledge, share with the students the fact that there are many different stories from different cultures about the moon because the moon is one of the objects almost everyone in the world can see.

The traditional story told by Inuit, "Origin of the Sun and Moon," is an example of how people around the world thought about elements in space, specifically the moon. This story has been edited to accommodate the age group of this lesson, but you can find the original at **inhabitmedia.com/wp-content/uploads/2014/01/Unikkaaqtuat Adult1.pdf**

Gather the students in a circle or in the storytelling area of the classroom and read out the story, asking the children to use their imaginations to envision the story as there are no images associated.

In a village, an Inuk girl lived in an igloo all by herself. One evening, while the people were assembled in their dancing igloo, a boy went to the girl and blew out her lamp! He was teasing her. After this night. he came to the girl's igloo every night while the people were in the dancing igloo. He continued to tease her. The girl wanted to know who this boy who kept blowing out her light was. She often asked him "who are you?" but he did not tell his name or utter a sound. Since she was unable to convince him to tell her his name, she resorted to a ruse. One day, after he arrived, she rubbed her fingers across the bottom of one of her pots, and then across the left side of his face. After a while he left her. She followed him to the dancing igloo and heard much laughter coming from inside. She went in, and there she saw that the people were laughing at her own brother, who bore the marks of her fingers on the left side of his face. She was quite upset that her brother was bothering her so much, so she ran away. She took up a piece of wood, such as is used for trimming lamps, and lit it. He ran after her, taking a trimming-stick in his left hand and lighting it. She went out of the dancing igloo and ran around it, chased by her brother. Finally her brother fell down. She looked back and the flame on his stick went out, while hers continued to burn brightly. A gust of wind suddenly came and the sister and brother were wafted up into the sky. As his light had been dimmed, he became the moon, only being lit sometimes, while she became the sun, shedding light and warmth. The brother had been reduced to becoming the moon as a lesson to his teasing and mistreatment of his sister. ["Origin of the Sun and Moon," *in Unikkaaqtuat: Exploring Inuit Folktales, Legends, and Myths (Inhabit Media, 2012) p. 85.]*

What are the moral lessons in this traditional Inuit story?

- Was the brother showing kindness to his sister?
- Is there a reason the sister became the sun and the brother became the moon? Does it have anything to do with how brightly each of them shone?
- Would you rather be bright and warm like the sun or dimly lit and cold like the moon?

Observation Activity

To understand the phases of the moon better, students will fill out a moon tracking board, individually at home as well as collectively at school.

PDF template of the moon cycle (see the following page).

In this activity they will need:

- The PDF chart
- An adult to observe the night sky and the moon with the child
- Crayons

Prior to tracking the moon phases, students will be asked to predict how long it will take for the moon to go from a full moon to a half moon and from a full moon to a new moon. As students track the phases of the moon at home, they will also track collectively at school, filling the chart one day at a time. As the moon enters a new phase, a new term will be introduced. For example, if the moon is already a **full moon**, the students will learn this phrase, but through observation as the moon shifts phases, students will be asked to describe the moon with guiding questions such as, "does the moon still look full or does it look different?" Based on the students' responses, the teacher will then introduce a new phrase such as **waning gibbous**. Continue observation for a period of two months.

Conclusion

Going back to the predictions they made about how long it would take to go from full moon to half moon, or from full moon to new moon, students will see if their predictions were close or off target based on their individual and collective tracking of the moon phases over the period of two months.

Additional Resources

- **asc-csa.gc.ca/eng/youth-educators/objective-moon/**
- **asc-csa.gc.ca/eng/youth-educators/activities/fun-experiments/creating-moon-craters.asp**
- **youtube.com/watch?v=WLhlRUnzbTM**

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To view a digital version of this lesson plan, visit **pinnguaq.com/learn/exploring-the-moon**.

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Moon Observation Board

Name ____________________

Month ____________________

Directions: Observe the moon in the night sky and its phase over a period of two months (you will need two of these charts). Ask an adult to help observe the moon at night or look online to see the current moon phase. Draw the shape of the moon in the circle template and mark down which date and time this shape was seen. As the moon changes shape, your teacher will provide a new vocabulary word to describe that phase of the moon.

Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______
Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______
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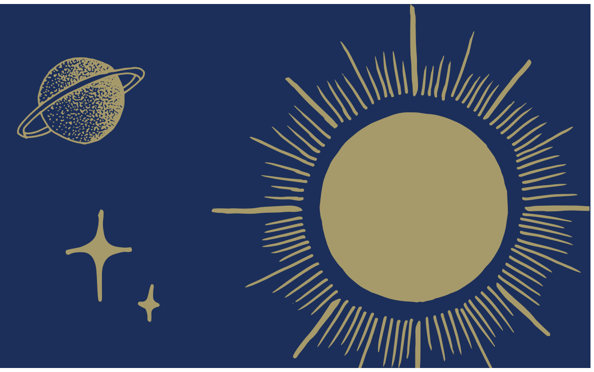
Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______

LESSON 2

Understanding Our Solar System



Author: Ujarak Appadoo

Level: Grades 4 to 6

Learning Objectives

- Students will know the eight planets—their names, order, and sizes
- Students will be able to describe different characteristics of planets in the solar system
- Students will be able to explain why Earth is the only habitable planet in our solar system

Vocabulary

- **Habitable**—Suitable to live in
- **Atmosphere**—The gases surrounding the Earth or another planet

In this lesson, students come to understand the solar system in which they live. They will learn what makes a planet habitable and why most planets are inhabitable. The guiding question for this lesson is: Is there another planet that can sustain life?

Introduction to the Solar System

To start the lesson off, the teacher will engage the students in a discussion around what the students already know about the solar system and the planets in the solar system. Activating prior knowledge, students will be asked what planet we live on. Students will be asked to name what they already know about space, such as our own planet, the moon, the sun, etc.

Reading Activity

Read the story *There's No Place Like Space!* by Tish Rabe.

"Au revoir, Pluto! In this newly revised, bestselling backlist title, beginning readers and budding astronomers are launched on a wild trip to visit the now eight planets in our solar system (per the International Astronomical Union's 2006 decision to downgrade Pluto from a planet to a dwarf planet), along with the Cat in the Hat, Thing One, Thing Two, Dick, and Sally. It's a reading adventure that's out of this world!"

[Rabe, Tish. *There's No Place Like Space: All About Our Solar System* (New York: Random House, 1999).]

Engage in discussion after reading the story. Ask students to share anything that stood out to them and to name the planets. Ask if they know why Earth seems to be the only planet that can sustain life.

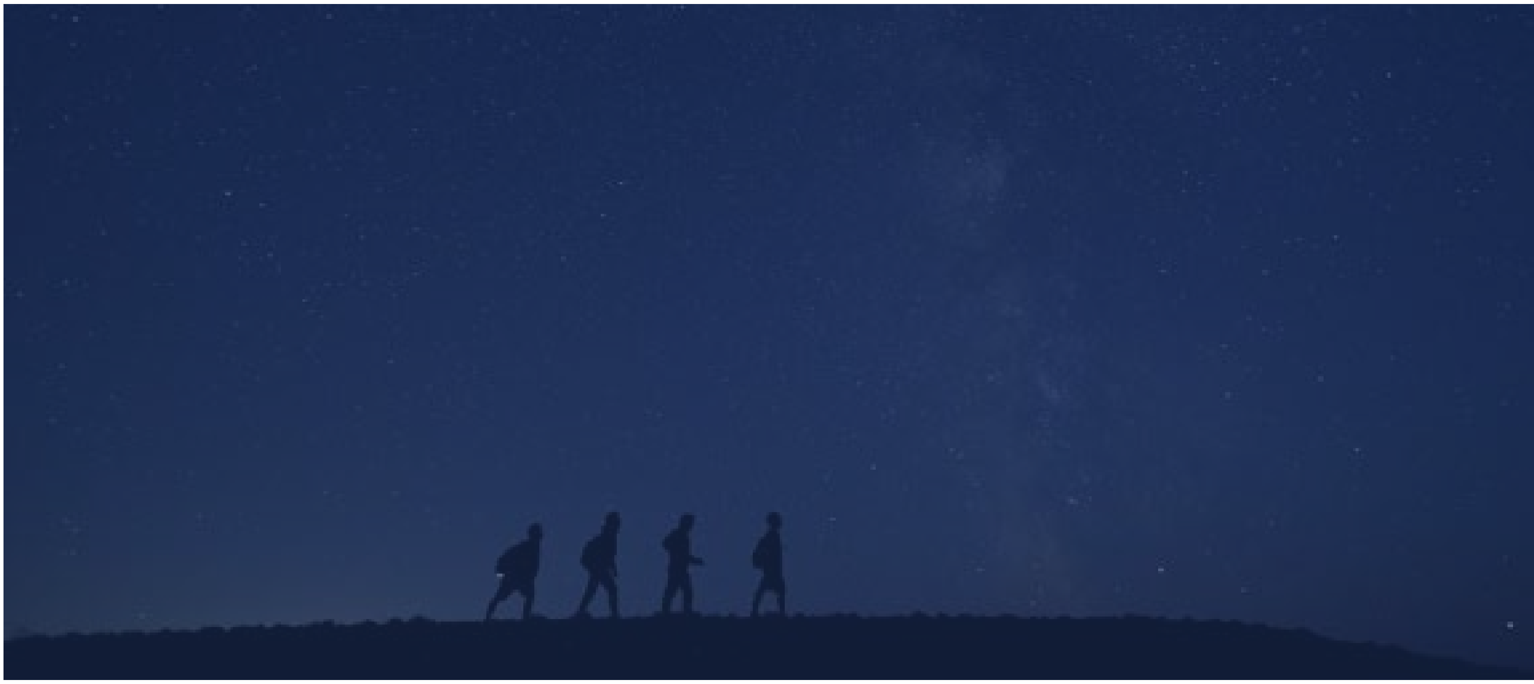
Modelling the Solar System

Materials:

- 30 cm square of yellow construction paper to act as the sun
- Nine images of the planets on index cards or drawn by the students
- Ruler
- Large space for students to demonstrate the solar system (classroom)

What To Do:

Have one student hold the image of the sun in the centre of the classroom. Ask a few other students to hold the planets. One by one, ask the students to place themselves around the sun based on the measurements given by the teacher.



Use the following measurements:

- Mercury: 2.5 cm
- Venus: 3 cm
- Mars: 5 cm
- Earth: 7 cm
- Jupiter: 29 cm
- Saturn: 48 cm
- Uranus: 96 cm
- Neptune: 152 cm

Ask students what they notice about the distance of the planets from the sun. Where would the hottest planet be? Where would the coldest planet be? Where is Earth in relation to these points?

A Habitable Planet

Ask the students what they think makes Earth habitable. They saw from the demonstration that Earth is not too far from the sun but not too close either. The sun is a very important element in our solar system. It is what the planets in our solar system rotate around. The sun provides heat and light which helps plants on Earth grow. But what else helps make Earth habitable? What about our atmosphere?

Watching Activity:

- Layers of the Atmosphere
  youtube.com/watch?v=ZXGUCY_xByU
- What Causes the Seasons
  youtube.com/watch?v=mEx3YTLu59I&t=2s

Research Project

In this research project, students explore whether we could live on another planet in our solar system. Ask the students: What if we lived on another planet? What would we need to survive on a really hot planet like Mercury? What would we need to be able to survive on a really cold planet like Neptune? In groups of two, choose a planet of your choice and research the elements of that planet. Is the planet hot or cold? Is it solid or gaseous? Thinking about the elements that make Earth habitable, come up with ways one can survive and make a different planet in our solar system habitable. Create a poster with your research findings and drawings of how you would survive on another planet.

Conclusion

Showcase group research projects around the classroom, asking students to circulate the room and comment on their peers' projects.

Additional Resources

- **nineplanets.org**
- **akjeducation.com/there-s-no-place-like-space-9780679891154**
- **youtube.com/watch?v=w36yxLgwUOc**

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To view a digital version of this lesson plan, visit **pinnguaq.com/learn/understanding-our-solar-system**.

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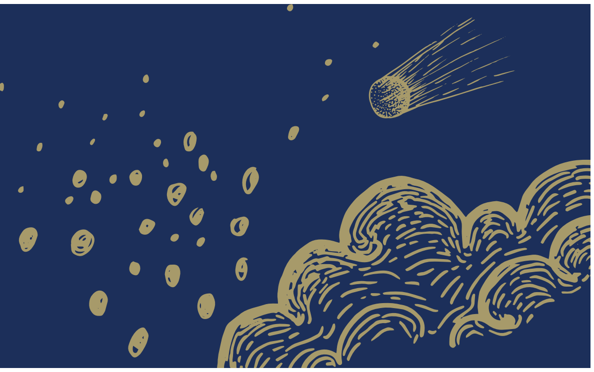
LESSON 3

Gravitational Forces and Their Impact



Author: Ujarak Appadoo

Level: Grades 7 to 8

Learning Objectives

- Students will be able to define "force"
- Students will be able to demonstrate an understanding of force and motion in the activity
- Students will be able to understand the concept of force and how it feels on Earth vs. in space

Vocabulary

- **Force**—A push or pull upon an object
- **Gravity**—The force that attracts a body toward the centre of Earth, or toward any other physical body having mass
- **Inertia**—The tendency to do nothing or to remain unchanged
- **Friction**—the resistance that one surface or object encounters when moving over another

In this lesson, students explore the concept of what a force is and how forces affect our lives. The force of gravity is continually playing a role in our lives. In this lesson, students are asked to think of other forms of forces shaping their lives.

What Is Force?

Guiding Question:
What is a force? How do forces act on humans on Earth and in space?

The gravitational pull is constantly acting and interacting with our lives. Forces and motion are part of everything we do. How do we know what forces are acting on us or on an object? Can we predict how the laws of motion will affect an object?

Newton's Law

There are three laws of motion discovered by Isaac Newton:

Law 1: An object that isn't being pushed or pulled by a force either stays still or keeps moving in a straight line at a constant speed. Inertia is an object's tendency to resist any change in its motion. A body in motion stays in motion.

Law 2: Forces make things move. The bigger the force and the lighter the object, the greater the motion.

Law 3: Every action has an equal and opposite reaction.

Watching Activity: **pbslearningmedia.org/resource/idptv11.sci.phys.maf.d4kfom/force-and-motion**

Gravity on Earth vs. in Space

To understanding the force of gravity, ask the students a few guiding questions:

- What is gravity?
- Where is gravity?
- What does gravity do?

After a discussion around these questions, students will have a basic understanding of what a force is. Does the force of gravity change based on where you are in the universe? On Earth, it acts in a particular way, so would it change if you are in space? Ask the students to ponder this question: Is there gravity in space? And then watch this video.

Watching Activity: **youtube.com/watch?v=qnzquEOMLGU**

Activity

Students conduct an experiment in landing an object onto a target. In this activity, the students hypothesize how best to land the object onto a target depending on the weight and size of the object. As they observe a variety of approaches, the students will see how to approach a particular landing based on the object's size and weight and how gravity plays a part in the outcome.

LANDING A SPACESHIP TARGET

Materials

- 3m of smooth line (e.g., fishing line, kite string, or dental floss)
- 1 index card
- Different balls or objects (e.g., a tennis ball, marble, rubber ball)
- 1 paper clip
- 1 medium-size paper cup
- Target drawn on a piece of paper OR printed PDF
- Masking tape
- Scissors

** Don't worry if you don't have all of the materials. Be creative and substitute materials with what you have! It's part of the design process.*

Step 1: Set up

Tie the smooth line between two desks to create a zipline. Place a paper target on the floor in the middle of the line.

Step 2: Brainstorm

Have the students choose their object, some may choose the marble, some may choose the tennis ball and so on. Ask the students to hypothesize how their object will fall onto the target. Students should come up with a plan of action while considering the following:

- How will they drop the object onto the target?
- What will need to happen to hit the target?
- Will the object travel inside or how is the cup used?
- What if it is underneath it? How will your spacecraft release the marble lander while zipping down the line?

Consider whether you will use an automatic release system or a remotely activated release system.

Step 3: Build it

Based on the brainstorming, the students now create their spacecraft.

Step 4: Test and Evaluate

Try it out! Have the students execute their experiment. Taking turns to demonstrate their contraption, ask the students to watch their peers experiment. Observing how the target fell, ask the students: how did your spacecraft work? Did you achieve your desired goal? Was there one in particular that worked the best and why?

Step 5: Redesign

Now the students have seen how their plans have worked or not worked and how their classmates' plans have worked. Based on their observations, they redesign their spacecraft to accommodate their observations.

Once students have completed the activity, ask them to describe what happened in their experiment using some of the vocabulary words of the lesson. Ask them to explain the force of gravity using different sizes and weights of the objects and which was the most successful experiment.

Conclusion

To conclude this lesson, students engage in a discussion around forces in everyday lives. Have the students write in their journals a list of examples of forces and motion we see everyday. How are they acting on us and why? As they are writing out their list, ask them to use 3–5 forces and motion vocabulary words.

Additional Resources

- *Gravity Compilation: Crash Course Kids* addresses several commonly-asked questions about gravity, including "does gravity really pull you down?" and "how does gravity work in space?" This video can be found at **youtube.com/watch?v=EwY6p-r_hyU**

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To view a digital version of this lesson plan, visit **pinnguaq.com/learn/gravitational-forces-and-their-impact**.

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LESSON 4

Constellation and Stellar Knowledge

Author: Ujarak Appadoo

Level: Grades 9 to 12

Learning Objectives

- Students will learn about constellations
- Students will learn how different cultures have created stories around constellations
- Students will learn to recognize commonly known constellations
- Students will learn to look for constellations in the night sky

Vocabulary

- **Constellation**—A cluster of stars in which humans see a particular pattern

Students look to the sky and find stars that make up a constellation. Students will learn about constellations and to describe the role of celestial objects in the traditions and beliefs of selected cultures and civilizations.

Introduction to Constellations

What is a constellation?
A constellation is a recognizable pattern of stars that can help people orient themselves by looking at the night sky.

Are the stars in a constellation close together?
The stars might not actually be close together but because of the distance from the stars to Earth, it appears that they are.

Constellations in Culture

There are constellation stories and folktales stemming from many different cultures in society, from the ancient Greek and Roman cultures to many Indigenous cultures, such as Maya, Dakota, Inuit, and Cree.

Inuit have used the night sky as navigation during the long winter months for thousands of years. Though many cultures used the star Polaris, part of the constellation Ursa Minor, as a navigation point due to the latitude in the Arctic, many Inuit used the constellation of Ursa Major (the Big Dipper), known to Inuit as Tukturjuit, for orienting and navigation. Tukturjuit translates to "the caribou," as the seven stars that make up the constellation resemble a number of caribou.

Reading Activity

Have students read the article found on page 28: *Ininiw Acakosuk, The Cree Stars* by Wilfred Buck.

Research Project

Students will research one constellation. They are asked to learn about the constellation, its name and origin, and a cultural story around it.

Research Questions:

1. Find a constellation. What is its name? Does it have other names in other cultures? Where is it located?
2. What are some stars or other constellations close to your chosen constellation?
3. Find a story about the constellation from another culture and share the cultural significance of the constellation.

Video Activity

Once students have finished the research component of their project, they will be asked to create a small video (2 to 3 minutes in length) to share their findings. Follow this tutorial on how to make and put together a short YouTube video.

pinnguaq.com/learn/courses/video-production-for-social-media

Game: Exploring Constellations

The following game, Star Scribe, allows users to explore the Earth's lunar surface and the surrounding stars. During their expedition, users will also discover constellations discovered by Indigenous cultures. They can also listen to spoken star knowledge connected to those constellations as shared by Ininiw (Cree) astronomer Wilfred Buck. Additionally, there is a Roblox edition of Star Scribe where users can learn about Inuit star knowledge by scanning a map of different constellations as they find them in the sky.

Star Finder

As students learn more about constellations in the night sky, encourage them to look for different constellations using the star finder. Ask questions like: Can you view all of the constellations in a single night? Is visibility of certain constellations determined by the time of the year or the hemisphere we live in?

Using the provided PDF, students will make a star finder of their own to examine and find constellations in the night sky.

Example of star finder: **in-the-sky.org/planisphere**

Conclusion

Have students share the videos they created with the rest of the class.

Additional Resources

- **lpi.usra.edu/education/skytellers/constellations/**
- **nativeskywatchers.com/resources.html**

To view a digital version of this lesson plan, visit **pinnguaq.com/learn/constellation-and-stellar-knowledge**.

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Cover

Star Finder

0 1 2 3 4 5 6 — 23 22 21 20 19 18

1 2 3 4 5 6 7 DST — 0 23 22 21 20 19 DST

NORTH

EAST

WEST

How to assemble your

Star Finder

1. Cut out the Star Wheel and Cover along the solid lines.
2. Cut out this shaded oval on the outer solid line.
3. Fold the back and tabs backwards on the dotted lines.
4. Tape the tabs to the back of the cover.
5. Slip the Star Wheel into the folded cover.

South-East

South-West

SOUTH

TAPE THIS TAB TO THE BACK

TAPE THIS TAB TO THE BACK

CANADA SCIENCE AND TECHNOLOGY MUSEUM

Canada

How to use your

Star Finder

1. Rotate the star wheel so the date aligns with the time.

   Use the "DST" scale if you are currently on Daylight Savings Time.

2. Hold the Star Wheel in the cover so it doesn't move. Turn the entire Star Finder so the direction you're facing is at the bottom.

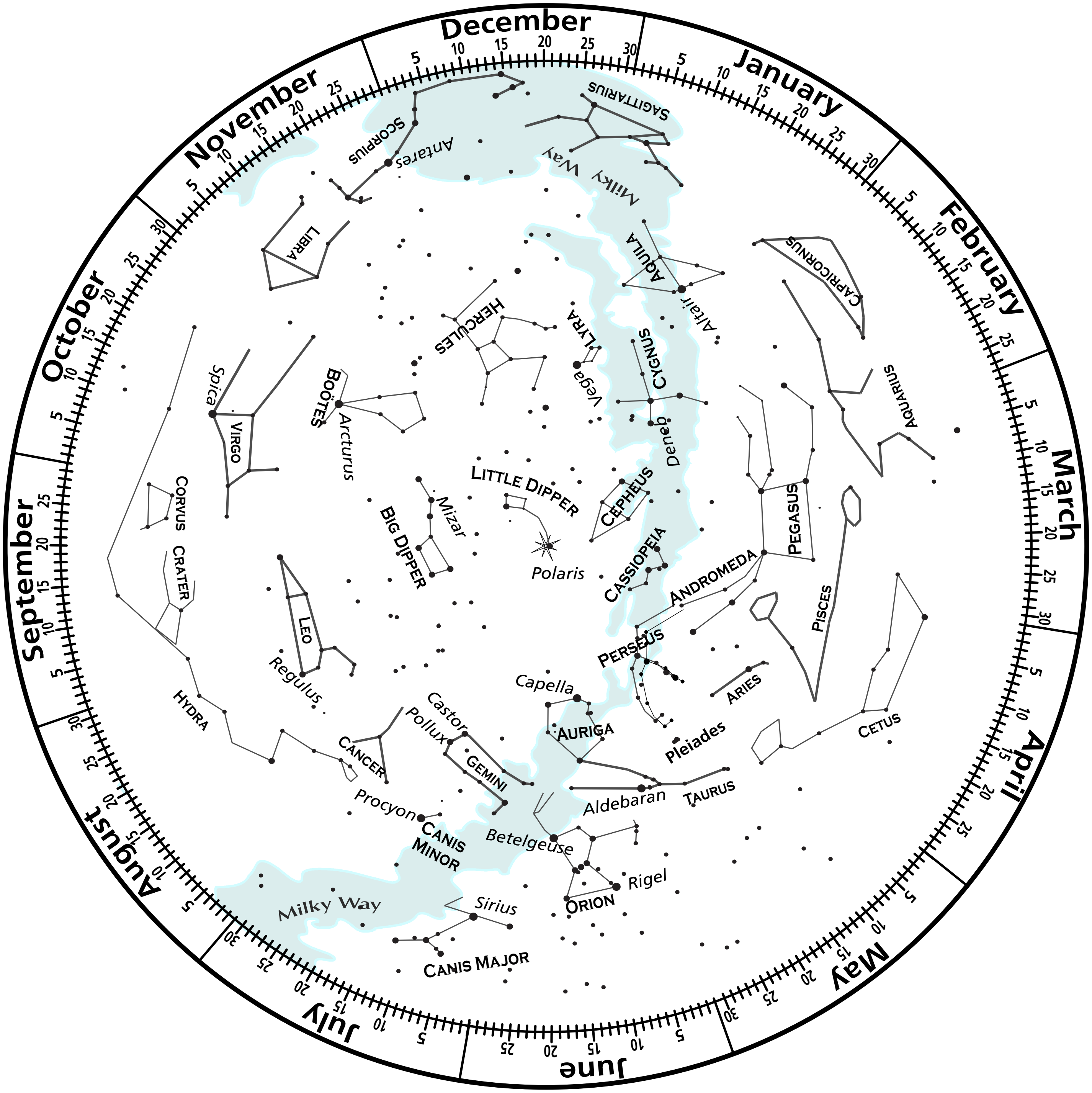
   For example, if you're facing North, rotate the Star Finder so you can read the word "North."

3. The edge of the opening shows the horizon. Stars toward the Eastern side are rising, and stars toward the Western side are setting. Stars near the center of the opening are overhead.

FOR LATITUDES BETWEEN 40°N AND 50°N

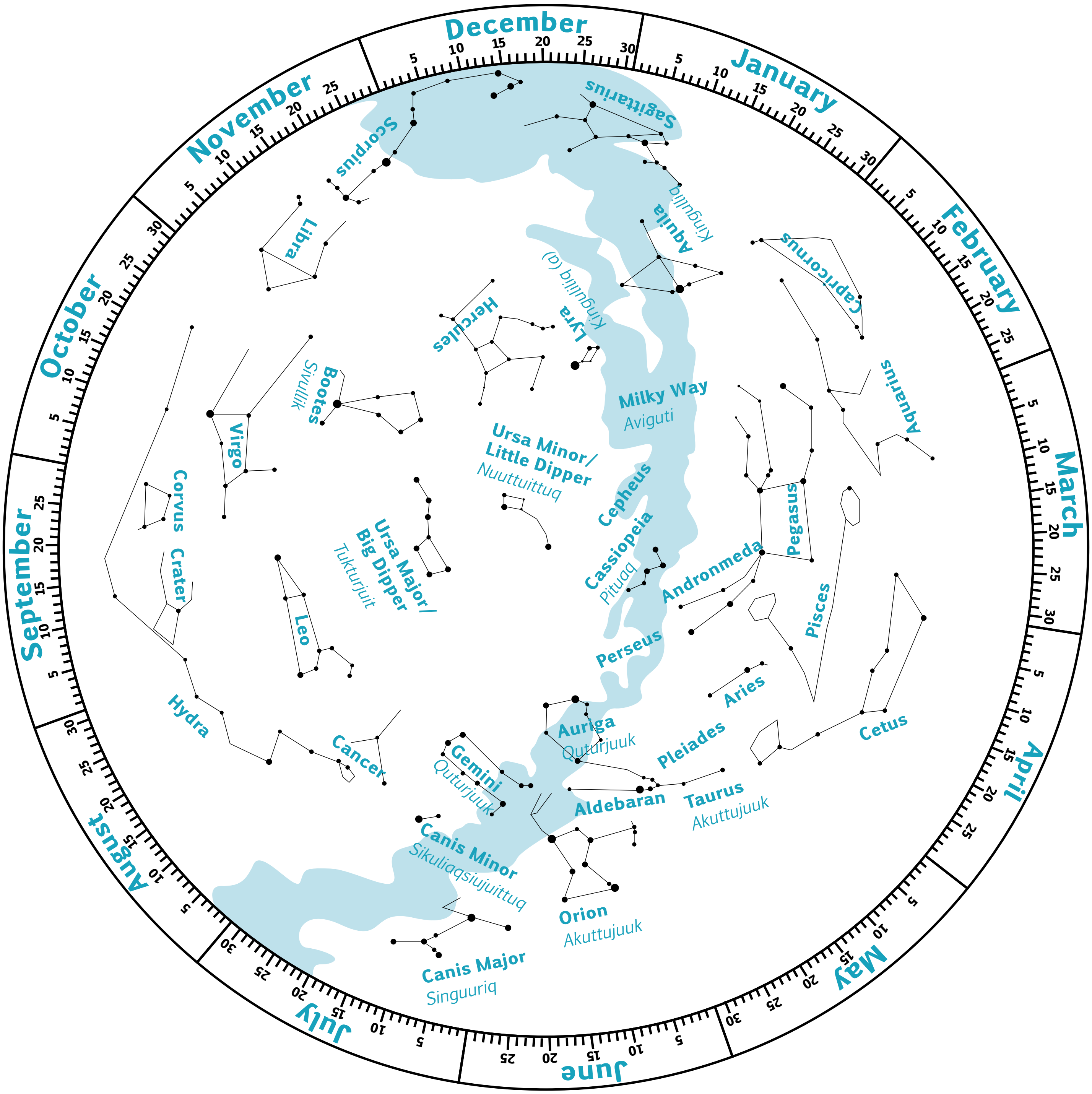
Star Wheel

Carefully cut around the outer solid line

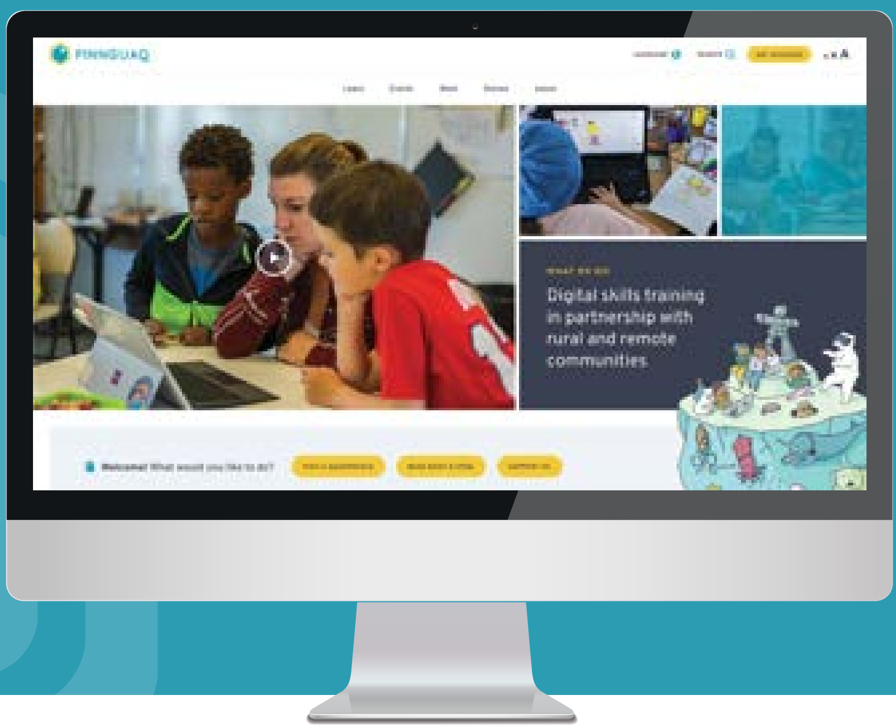


Star Wheel

An additional version of the star wheel with the Inuit names of the constellations



LEARNING RESOURCES



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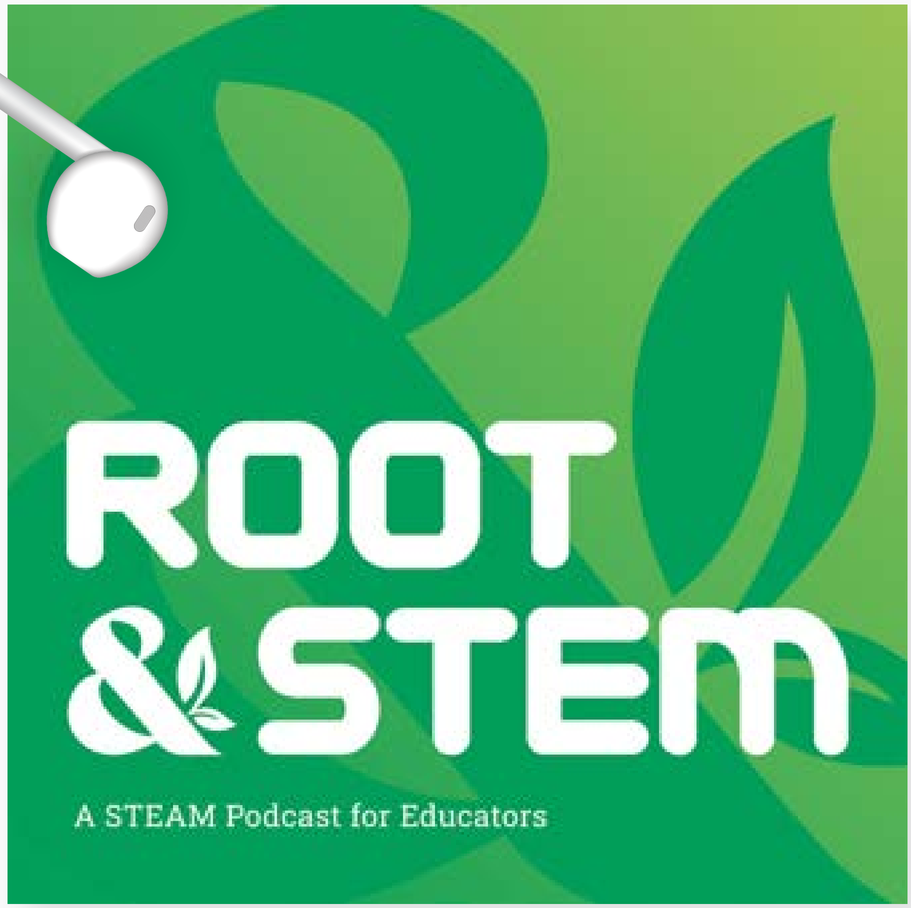

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