A STEAM Resource for Educators in a Digital World | FALL 2024 • ISSUE 10

ROOT & STEM

Tech Horizons: Innovating for Tomorrow

THE IMPACT BEHIND "INDIGENUITY"

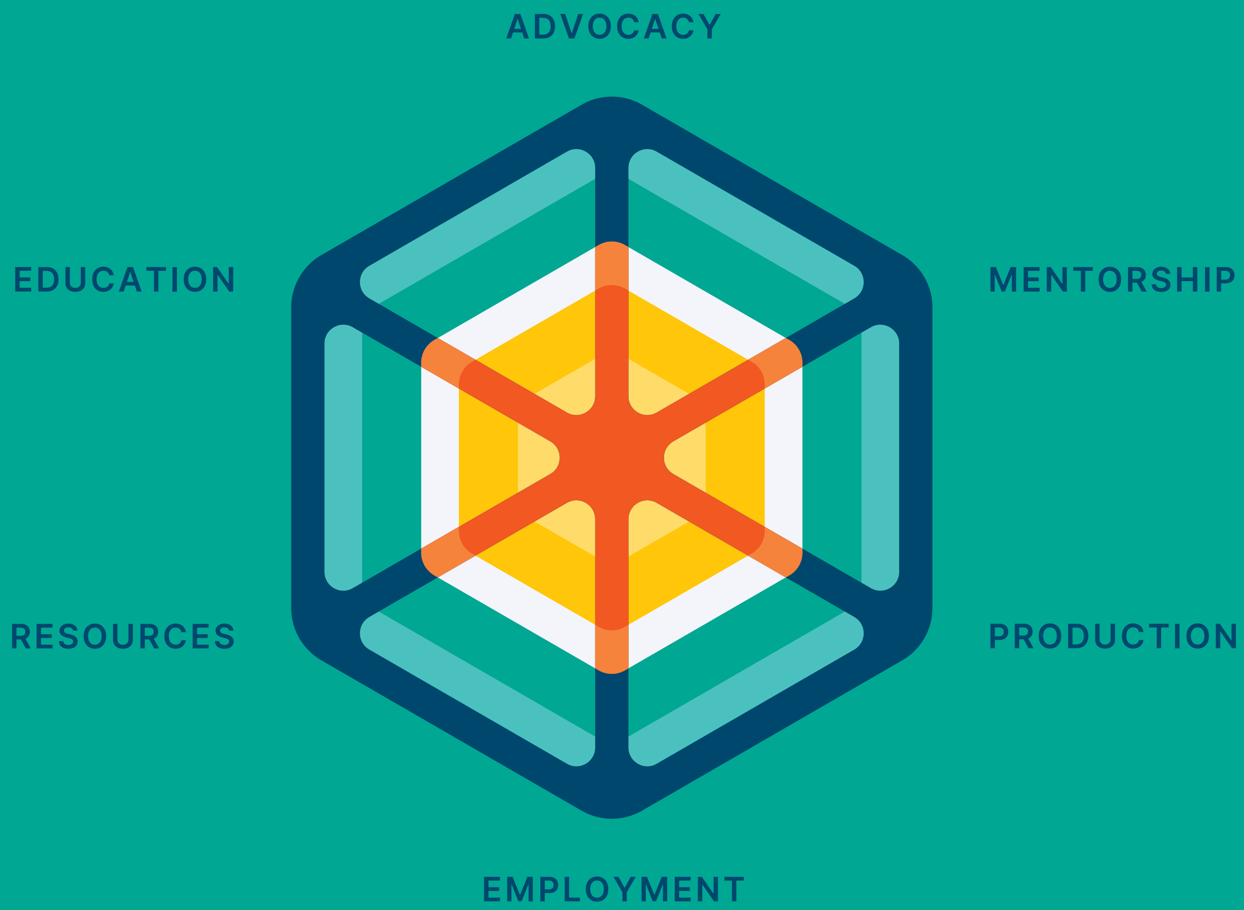
How Dawn Pratt makes science come alive

THE TECH BEHIND FEAR

Decoding fright in horror gaming

CHARTING NEW WATERS

Students setting robots off to sea



AMPERE LIFE CYCLE

Ampere 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

amp.ca

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ROOT & STEM

ABOUT AMPERE

Ampere, 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, Ampere 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

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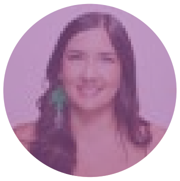

TAYLOR MCARTHUR

Cover Illustration

Taylor McArthur (Niná wašte šiyo poğa hąska wíya/hummingbird woman) Nakoda of Pheasant Rump Nakota First Nation was raised in Southwestern Manitoba and currently resides in Montreal. She is an undergraduate in Concordia University's Faculty of Fine Arts, where she is specializing in computation arts. An award-winning digital artist, McArthur works in 3D animation, video game design, and video. Her practice is informed by Indigenous Futurisms, and she seeks to situate her Indigenous culture within both the modern and potential future visions.

JON CORBETT

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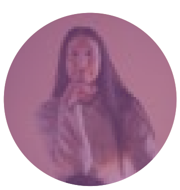
Jon Corbett is an assistant professor with Lived Indigenous Experience in the School of Interactive Arts and Technology at Simon Fraser University. His research focuses on Indigenous forms of expression through "Indigitalization," which he describes as a computational creative practice that braids together Indigenous and decolonial computing practices facilitated through traditional and computer-based expressive media art forms.

SALMA ABDI

Deciphering Deepfakes • Page 7

Salma Abdi is a Grade 11 student currently attending the Virtual Learning Centre. In her free time, she likes to read, knit, and code.



CHRISTINE M'LOT

Your Voice Is Power • Page 10

Christine M'Lot is an Anishinaabe educator, curriculum developer, and consultant from Winnipeg. She has over 12 years of experience working with children and youth in various roles, such as teaching, facilitating, family programming, and children's disability services. Additionally, M'Lot co-edited the Indigenous education textbook *Resurgence: Engaging with Indigenous Narratives and Cultural Expressions in and beyond the Classroom*.

SHARON ASCHAIEK

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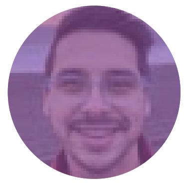
Sharon Aschaiek, the principal of Higher Ed Communications, writes about the education space, producing articles about research breakthroughs, successful alumni, and innovative practices.



BRIAN POTTLE

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Brian Pottle, a Nunatsiavut Inuk who grew up in Postville and Rigolet, graduated with a degree in electrical engineering from Memorial University of Newfoundland in 2015. With a vested interest in empowering Indigenous youth to actualize their potential, Pottle is helping to enrich the lives of Nunavummiut youth in his role as Executive Director of the Katinnganiq Makerspace Network.

BONNIE SCHIEDEL

The Impact Behind "Indigenuity" • Page 19

Bonnie Schiedel has been writing, editing, and producing content for print and web in northwestern Ontario for 20 years. When she's not pounding the keyboard, she enjoys exploring Thunder Bay with her family.

BRIAN MCLACHLAN

Always Inaccurate • Page 22

Brian McLachlan is the cartoonist of *Complete the Quest: The Poisonous Library*, a combination role-player game and RPG/graphic novel, and *Draw Out the Story: Ten Secrets to Creating Your Own Comics*. He makes comic tutorials on Deep Thought Balloon, his YouTube channel.

SOFIA OSBORNE

Charting New Waters • Page 30

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 a co-host and producer of *Beyond Blathers*, an Animal Crossing science podcast.

Computing for Indigenous Communities

As an artist and professor, I weave together nehiyaw (Plains Cree) cultural narratives with technology. My goal is to transform computing technologies into a medium that reflects Indigenous traditions and engages Indigenous people, particularly youth. To further this endeavour, I contribute my expertise in Indigenous-focused computing by serving as a fact-checker for the Government of Ontario's Grade 10 Computer Science curriculum.

In computer science education, fostering inclusivity and diversity is essential to create meaningful learning experiences that resonate with all students. The Government of Ontario's consultation with Indigenous and subject matter experts like myself is crucial, as it ensures the educational landscape in computer studies is equitable and inclusive and makes the world of information and communication technology more welcoming and diverse, a world where every student sees their culture and identity reflected and valued in their learning journey.

INDIGENOUS LANGUAGE INTERFACES

It is essential to acknowledge the significance of language in cultures, particularly for Indigenous communities and other colonized communities. Language carries the wisdom, traditions, and identity of a people. Thus, developing language translation software and applications that support Indigenous languages is crucial in making technology accessible and relevant.

One of the most significant obstacles that stands in the way of computer usage in Indigenous communities stems from the dominance of English-language interfaces, which can alienate individuals who communicate primarily in languages other than English. Recognizing the importance of maintaining the vitality of Indigenous languages and fostering cultural pride, initiatives focusing on Indigenous language interfaces continue to grow.

Adaptive technologies can re-imagine user interfaces by integrating Indigenous languages, orthographies, and cultural symbols and references, broadening the accessibility and cultural relevance of computing for users whose primary language is not English. For example, software applications and operating systems can offer language options tailored to specific Indigenous communities, empowering users to navigate digital platforms in their mother tongues.

By embracing Indigenous language interfaces, computing becomes a tool for communication and productivity for speakers of these languages, as well as a means of cultural preservation and revitalization. Moreover, incorporating Indigenous perspectives into software design and development nurtures a sense of ownership and belonging within Indigenous communities, challenging the notion that computers are culturally invasive.

COMMUNITY-CENTRED TECHNOLOGY

In Indigenous communities where skepticism or apprehension towards technology prevails, traditional approaches to computer education may fall short. Community-centred technology workshops can offer promising solutions to address concerns and cultivate a culture of technological empowerment.

These inclusive initiatives prioritize community engagement and participation by tailoring computer education to align with Indigenous cultural values, traditions, and learning styles. Participants gain practical skills through hands-on activities, storytelling, and collaborative problem-solving while reaffirming their cultural identities. In British Columbia, for example, Simon Fraser University's School of Interactive Art and Design hosts an annual computational arts workshop for Indigenous high school students from rural school districts. The all-day event exposes these students to the ways post-secondary educational pursuits can support cultural practices and languages that are unique to Indigenous students.

Community engagement workshops can also serve as platforms for intergenerational knowledge exchange, bridging the digital divide between Elders and youth. By encouraging dialogue and mutual respect, these workshops empower Indigenous communities to harness the benefits of technology while safeguarding their cultural heritage.

Adaptive and inclusive computing solutions hold tremendous potential in empowering Indigenous communities and bridging the digital divide. In prioritizing cultural sensitivity, linguistic diversity, and community engagement, initiatives such as Indigenous language interfaces and community-centred technology workshops pave the way for equitable access to computing technologies.

— JON CORBETT

Deciphering Deepfakes

BY SALMA ABDI

Disclaimer: This article provides information on deepfakes and the techniques used to create them, and is intended solely for educational purposes. While deepfakes can be fascinating, they also come with significant ethical and legal considerations. We do not condone or support the misuse of this technology. Please use this information responsibly, be mindful of the potential consequences, and always obtain consent from any individuals you may wish to feature in deepfake content.

Last year in Putnam County, New York, three high school students created deepfake videos of the principal of another nearby school, George Fischer Middle School. In the videos, the man appeared to be yelling racial slurs, going so far as to threaten violence against students of colour. Parents and guardians received a vaguely worded letter stating that some students had "used artificial intelligence to impersonate" the staff member in a video in which he appears to make "inappropriate comments." Despite assurances that there was no actual threat, many were deeply concerned about potential danger, and even considered withholding their children from school.

WHAT ARE DEEPFAKES?

Deepfakes are digitally altered photos, videos, or audio recordings of a person or people to make them appear as someone or something else. This technology utilizes artificial intelligence (AI) to create a convincing false identity, often for the purpose of spreading misinformation. While early attempts at deepfake content were easily recognizable, more recently the results have become so realistic that it can be very difficult to distinguish them from recordings of actual events. Deepfakes are starting to become mainstream (although such content is usually easily debunked and labelled as fake), as even beginners can make this content with access to the necessary software and a few hours of internet research.

FACE REPLACEMENT

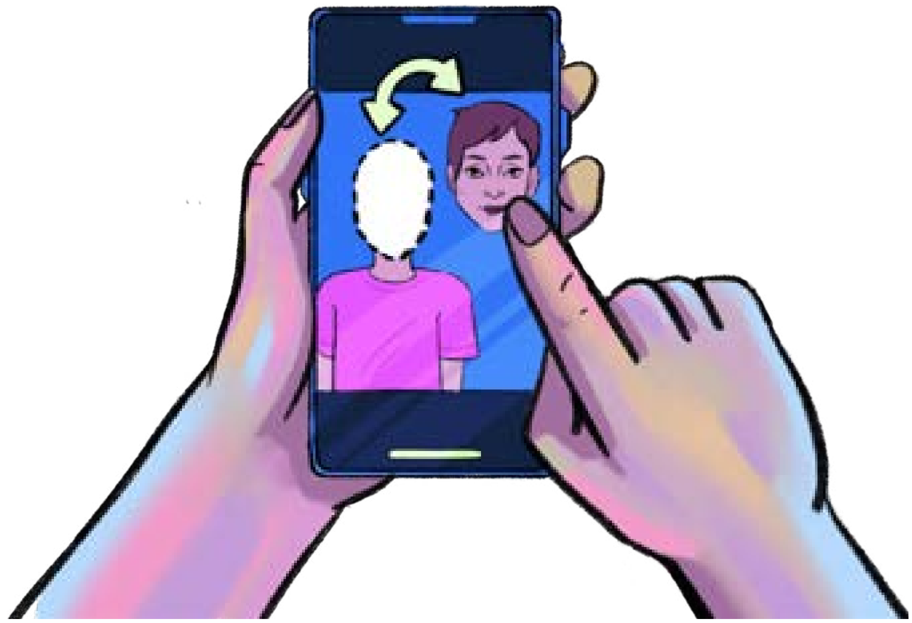
Face replacement software allows the user to manipulate images of faces. Users might alter their own facial appearance to mimic someone else's, such as that of a celebrity, or create an image in which one person's face appears on someone else's body. While this was once a complex task that had to be done manually, advanced AI technology now enables people to manipulate photos and videos easily.

Despite being simple for the user, this kind of software has to undertake several steps to generate a user's request. Let's say you want to put the face of a celebrity, like the painter Bob Ross, over your own face in a photo or video. First, the AI deepfake tool you choose needs enough content to train its face replacement model. Together with a photo or video of yourself—the source material you want Bob Ross's face to inhabit—you need to upload several photos or videos of Bob Ross in various scenarios. The algorithm will then split the files of your target (in this example, Bob Ross) into hundreds of pictures so it can analyze the face in each one. Depending on the algorithm used by the software, as many as 5,000 images of your target could be required.

The next step is where the magic, so to speak, happens. The AI uses one algorithm, called a generative model, to

PHOTOS COURTESY OF AMPERE

create the deepfake photo or video you requested, while a second algorithm (the discriminator model) detects differences between the generative model's output and the original source material. The discriminator model's feedback is then delivered to the generative model, which responds by altering the deepfake until it is practically identical in quality to the source material. This cycle is repeated until the discriminator model can no longer identify differences between the deepfake and the or genuine content. This continuous improvement of the deepfake's accuracy is referred to as a generative adversarial network (GAN).



FACE RE-ENACTMENT

Face re-enactment refers to the manipulation of the facial expressions of the target. To begin, the algorithm needs to be trained to detect faces and their individual features. Then, it will pinpoint certain places on the faces of the user and the target (Bob Ross in this case), which are called facial landmarks. This is what allows the user to control the image of the target's face. Then, the source actor (you!) uses a camera to record the facial expressions you would like to see in the manipulated video of the target. Using that video information, the algorithm alters the target's face in the video so it mimics the new facial expressions you have provided in the video of yourself. As it did in the process of face replacement, the AI tool uses a GAN to improve the quality of the deepfake. Some software even lets you see the progress in real time.

VOICE CLONING

Now you know it's possible to change an existing video file to place Bob Ross's face on an image of your body and even make the new image of him smile or frown. But you might have realized that any deepfake video you make will either be silent or feature the sound from the original video. To make a video of Bob Ross in which he appears to say whatever you want him to, you need to make some audio to go along with the image frames. As it happens, adding audio is much easier than the two processes we have already outlined. To start, the AI you select needs at least one audio sample to train its voice cloning model, so you would need to add audio from an interview with Bob Ross, or an episode, into the system. The model analyzes the audio sample for distinctive speech patterns, a particular accent, and other individual characteristics, so that the words you want the target to appear to say take on their specific manner of speaking and any of their verbal tics. Once the AI has done this modelling, input your script and wait until audio that closely resembles the sound of the target talking is produced. This process can take from a few minutes to a few days, depending on the AI model being used and the complexity and quality of the recording it will deliver.

THE FUTURE

Deepfakes are increasingly a widely used form of technology, which will affect our lives in the near future. A few years ago in a Florida museum, an AI rendition of Salvador Dalí brought several of the artist's quotes alive, to the amazement of the audience. Someday, students will be able to listen to the life stories of historical figures coming from their "own mouths," which could potentially increase the entertainment value and the interest of viewers.

Some companies, including Google, TikTok, and Meta, have recently vowed to combat deepfakes on their platforms by utilizing technology to detect and prevent the spread of this kind of content. This decision came in light of the risk of election interference, as a recent voice call deepfake of President Joe Biden began making the rounds, discouraging "individuals from voting in the New Hampshire primary," according to ABC News. Despite these tech giants beginning to put countermeasures in place, it is clear that deepfakes aren't leaving the internet. As important as it is to learn the how and why behind deepfake technology, it's just as important to learn the how and why behind responsible use and creation. The more we know, the more we can protect ourselves and others. &

COMPUTING AND NETWORKS

TECHNOLOGY AND SOCIETY

Your Voice Is Power

Landback Records team with facilitator Christine M'Lot (fourth from left) and hip-hop consultant Chad Allsopp (third from left) at a Winnipeg Hackathon

BY CHRISTINE M'LOT

I grew up listening to hip-hop.

I developed a deep appreciation for the artform, so, as a teacher, I've integrated hip-hop music in every poetry unit I've ever taught. Prior to the COVID-19, my passion for hip-hop transcended into a comprehensive, four-month-long explorative journey for my Grade 11 English class. During this unit, students delved into the rich history of hip-hop, collaborated in groups to craft original songs, worked alongside a producer to compose beats, recorded their tracks, and even filmed a music video. This project was always a highlight of the academic year for me, fostering creativity and engagement among my students. However, the onset of the pandemic forced an abrupt change to teaching and learning.

Once the pandemic hit, bringing guests into the classroom was no longer an option. It was around this time I started creating educational resources for TakingItGlobal, a Canadian charity that focuses on promoting collaboration among youth to tackle global issues by promoting awareness and engagement. Shortly thereafter, I was asked if I would be interested in helping to create a new curriculum for the Your Voice Is Power program, a hip-hop coding initiative aimed at inspiring African-American youth in the United States to enter STEM fields, where they are under-represented in the workforce. Amazon sought to extend this program into Canada, tailoring it to Indigenous students who similarly face under-representation in computer science careers. Of course, I said yes.

Over the course of a year, I collaborated with diverse educational stakeholders, including Indigenous community members, Indigenous student-teachers from the University of British Columbia, and another Indigenous educator to shape the curriculum. It was imperative to me that the Canadian iteration of the program pay homage to the roots of hip-hop, which originated in African-American and Latinx communities. To ensure cultural authenticity, I enlisted the expertise of Chad Allsopp, a Bajan-Canadian hip-hop historian, in integrating activities that educate Canadian youth about the origins of hip-hop music, including its roots in social justice. These activities now constitute Module 2 of an extensive eight-module curriculum. Additional modules were developed to spotlight Canadian hip-hop history, featuring analyses of song lyrics by Indigenous artists such as Dakota Bear, Samian, and Fire and Flame. Furthermore, lessons were tailored to explore the Truth and Reconciliation Commission of Canada, wherein students dissect the 94 Calls to Action and select one that resonates with them.

Throughout the program, students are introduced to coding in Python, enabling them to manipulate sound clips to compose original beats. Students can expand their creative skills by incorporating recordings of themselves playing instruments or rapping over their beats, seamlessly integrating these elements into their compositions. At the program's conclusion, students emerge with remixed beats that advocate for social justice causes close to their hearts. More than 15,000 students nationwide have participated in the program in the last year. Teachers can seamlessly incorporate this curriculum into their classrooms at no cost by accessing the modules freely online at yourvoiceispower.ca. The only prerequisites for students are access to a laptop and an internet connection. Moreover, students have the opportunity to showcase their work in a national competition, with winners receiving grand prizes of $5,000, Amazon gift cards, and tokens from our Indigenous artist partners. As the program continues to thrive, my hope is that it empowers today's youth to harness the power of their voices, just as the pioneers of hip-hop did, catalyzing positive change and igniting a legacy of creativity, advocacy, and social justice for generations to come. &

CODING AND PROGRAMMING

TECHNOLOGY AND SOCIETY

PHOTOS COURTESY OF CHRISTINE M'LOT

Top: Students in Calgary work with Allsopp (right)
Bottom: The Your Voice is Power presentation kicks off with presenters

Helpful and Humanoid:

Social Robots in the Classroom

BY SHARON ASCHAIEK

Top Right: The Learning Disabilities Society showcases the QTrobot at the Vancouver International Children's Festival.
Other Photos: Early RISErs, an early childhood education initiative, utilizes the QTrobot to support child development

"Humanoid robots—assistive technology with human-like characteristics and functions—were found to be a powerful teaching tool."

As educators in science, technology, engineering, art, and math (STEAM) prepare their students for modern life, research developments in the STEAM domain may impact not only *what* they teach, but *how* they teach.

Humanoid robots—assistive technology with human-like characteristics and functions—were found to be a powerful teaching tool in "User Evaluation of Social Robots as a Tool in One-to-One Instructional Settings for Students with Learning Disabilities," a study conducted at the Learning Disabilities Society (LDS) in Vancouver.

"Overall, we found very encouraging results that [indicate] a robot can make a significant contribution ... to the instruction experience, both for students and the instructor," says Kerstin Dautenhahn, the university's Canada 150 Research Chair in Intelligent Robotics.

Dautenhahn and her team designed and conducted the field study together with the LDS. Five staff instructors were recruited for the study, as well as 16 children, ages seven through twelve, who receive reading instruction at the society and have been diagnosed with or are suspected of having a learning disability. Half of the youngsters were a control group and participated in standard one-to-one sessions with their instructor. The other half, the intervention group, attended lessons in which the instructor was supported by a social robot.

Made by LuxAI, a Luxembourg-based company that specializes in digital therapeutic products that support neurodevelopmental disorders, the l QTrobot RD-V2 i5, which stands just over half a metre in height, can speak, perform facial expressions, and gesture with its head and hands. The researchers developed a web application that the instructors use to operate the robot, which performs pre-programmed functions in the instructional sessions over three phases.




PHOTOS COURTESY OF LEARNING DISABILITIES SOCIETY

In the first phase, the robot introduces itself and the session, engages the student in warm-up activities such as breathing exercises and stretching, and asks them to set a learning goal. In the second, the student works on their goal and, if they stay on task, the robot delivers praise as a form of positive reinforcement. If they become distracted, the robot redirects them to stay on task. In the final phase, the robot and the student play a simple game like tic-tac-toe, ending the session with a fun activity.

The researchers found that the students in the intervention group completed their learning goals at a higher rate, were more engaged, and displayed fewer off-task behaviours than those in the control group. When the students were asked to reflect on their perception of the robot, they gave generally high marks for friendliness, intelligence, and helpfulness.

As a non-human entity, the social robot "provided an opportunity for the students to express themselves and try new things," says Dautenhahn in reflecting on its efficacy as a teaching aid.

Meanwhile, instructors' survey feedback generally conveyed that the robot increased students' enjoyment, motivation, and engagement, calling it a "fun addition to the classroom" and "effective as a reward system," as well as "helpful for getting the students to stay on track/focus."

"In BC, the education system is chronically under-sourced, especially for children who have learning disabilities and who need different supports," says Rachel Forbes, the executive director of the LDS. "Anything we can do to provide additional support, ideas, and tools to help children who have learning differences is important."

Dautenhahn says whether public schools adopt social robots as teaching aids for educators depends largely on government investment, and the technology is not cheap: the robot model used in the study costs around $14,000, and there are additional expenses associated with training and maintenance. But she is certain social robots can help alleviate pressures on teachers and support their efficacy in the classroom.

"Teachers know [better than robots] what children's interests are, what their capabilities are, their strengths and weaknesses. So this is not about replacing professionals, it's about providing options," says Dautenhahn. "If you have 30 children in a class, and maybe three or four of them have disabilities, a social robot could help provide those students with some personalized support."

For those children (and their educators), this kind of personalized support can make a huge difference. &

DATA

DESIGN

TECHNOLOGY AND SOCIETY

Ripples in (Space)Time

Information in Waves

NB: This article is for readers with prior knowledge of physics

Waves occur all around us in nature. The light we see is made up of electromagnetic waves. These waves can be reflected off smooth surfaces, like mirrors, just like sound waves (although their ability to reflect depends greatly on the quality of the surface). Earthquakes are caused by seismic waves travelling through the Earth's crust. Gravitational waves, which ripple outwards from moving objects within the universe, such as black holes, move at the same speed as electromagnetic waves—the speed of light.

Today, we use electromagnetic waves to send and receive information through cables and wirelessly through the air.

Wireless communication is the only option for internet connectivity for devices like tablets and smartphones. Thankfully, to use wireless communication, we just need to know how to add a wi-fi network to our device, which network to pick, and its password.

However, you may have also found yourself wondering, "What is wi-fi?" The simple answer is that it is a wireless networking technology and an example of wireless communication.

But to dive deeper, let's consider a scenario. Imagine there are two people, Korra and Tenzin. Korra visits Tenzin's house, and asks Tenzin, "What's your wi-fi password?"

What's a wave?

A wave is an oscillation that transfers energy

Fun Fact

There is a common misconception that "wi-fi" is short for "wireless fidelity" but it is not. It was created by the Institute of Electrical and Electronics Engineers but the trademark is now owned by the Wi-Fi Alliance, and the term "wi-fi" was created by a marketing firm and doesn't have any significant meaning.

How is information sent in this case?

A request for information, in the form of Korra's question, is being sent from Korra (wirelessly!) through the air and is received by Tenzin in the form of sound waves. These sound waves, which store information in the form of air pressure, are created by Korra's vibrating vocal cords and travel through the air. The sound waves from Korra that make it to Tenzin's ears cause little hairs (called cilia) in Tenzin's ear canals to vibrate. His brain then deciphers the changing air pressure into words, thus allowing wireless communication between Korra and Tenzin.

A similar process is employed for wireless communication in smartphones and tablets. Korra's and Tenzin's vocal cords and ears are replaced by antennas, and the sound waves are replaced by electromagnetic waves. For the purpose of wireless communication, the message is sent as electromagnetic waves that are created and transmitted by supplying electrical signals to transmitting antennas. The message is then received by a receiving antenna, in which electrical signals are created (or induced) when it receives electromagnetic waves.

Electromagnetic waves can be transmitted in particular patterns (like Morse code) to encode information, which is similar to the way sound waves encode our words when we speak. For electromagnetic waves, this pattern is called *modulation*, because we modify (or modulate) the signal.

A Nod to Avatar

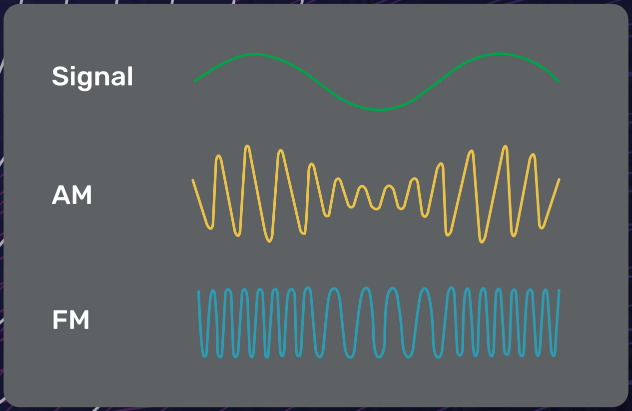
The names Korra and Tenzin come from the animated show *Avatar*.

Consider a car radio: there are both AM and FM radio stations.

AM stands for *amplitude modulation.* Amplitude refers to the size of the wave. For sound waves, a larger amplitude means a louder sound, while for electromagnetic waves, a larger amplitude means a stronger signal. So, with amplitude modulation, information is encoded in a carrier electromagnetic wave by modifying how large the signal is. (The carrier electromagnetic wave carries the information from a transmitting antenna to a receiving antenna.)

FM stands for *frequency modulation.* Frequency is how quickly a wave completes a cycle. For sound waves, an example of a high-frequency wave would be the sound waves created by someone whistling, and a lower frequency wave would be their regular speaking voice. For electromagnetic waves, we only need to look at a rainbow: the red end of the rainbow is made of lower frequency electromagnetic waves, and the blue/violet end of the rainbow is made of higher frequency electromagnetic waves.

It sounds like nature intended life to be full of ups and downs.



Fun Fact

The electromagnetic spectrum contains a range of frequencies and wavelengths, most of which are not visible to the human eye. Colour is the only sliver of the spectrum that is visible.

Infographics by Kelly Eng and Stephanie Amell
Text by Brian Pottle

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STEAM Is for Everyone

Ampere educators share success stories from a community engagement experience

BY AMPERE

Last April, in partnership with Ampere, Whitby's Colonel J.E. Farewell Public School hosted a family engagement night. The event delivered a variety of engaging activities focused around the STEAM disciplines—Science, Technology, Engineering, Art, and Mathematics. Ampere staff, including Digital Skills Educator Sherisse Richards and Social Media Coordinator Kyle Gordon, attended the event to promote the use of technology as a tool for learning. They brought along some robotics innovations that captured the attention of parents and students alike.

This is what they had to say about the experience, the impact of their work in delivering information on tech innovation in the classroom, and the future of STEAM education in Canada.

WHAT IS A FAMILY ENGAGEMENT NIGHT?

Sherisse Richards: It's an opportunity for schools and parents to create an event where STEAM is brought to the forefront for the community. With some support, technology, and facilitators from our Ampere team, we were able to make it a chance for everyone to have fun while learning.

Kyle Gordon: It was an interactive chance for the whole family to get hands-on experience, especially younger children and parents.

WHAT KINDS OF ACTIVITIES WERE OFFERED?

SR: We had simple robotics stations alongside more intricate activities, including art stations where kids could draw and Lego stations where they could copy a prototype robot or build a structure. Then, for the little, teeny-tiny tots, we had B-Bots, so they could learn about simple programming and sequences. Older children had the opportunity to learn about Dash and Dots—moveable, programmable robots—and block-based coding.

We also had Binary Beading, an activity where you spell out your name with beads, and our first ever mbot soccer tournament. mBots are little robots that are controlled with apps that let you code games and increase your knowledge of programming skills. In a tournament, each robot is a goalie and you try to get the ball past your opponent. They're a great way for children to learn about coding while having fun.

WHICH ACTIVITY HAD THE BIGGEST REACTION?

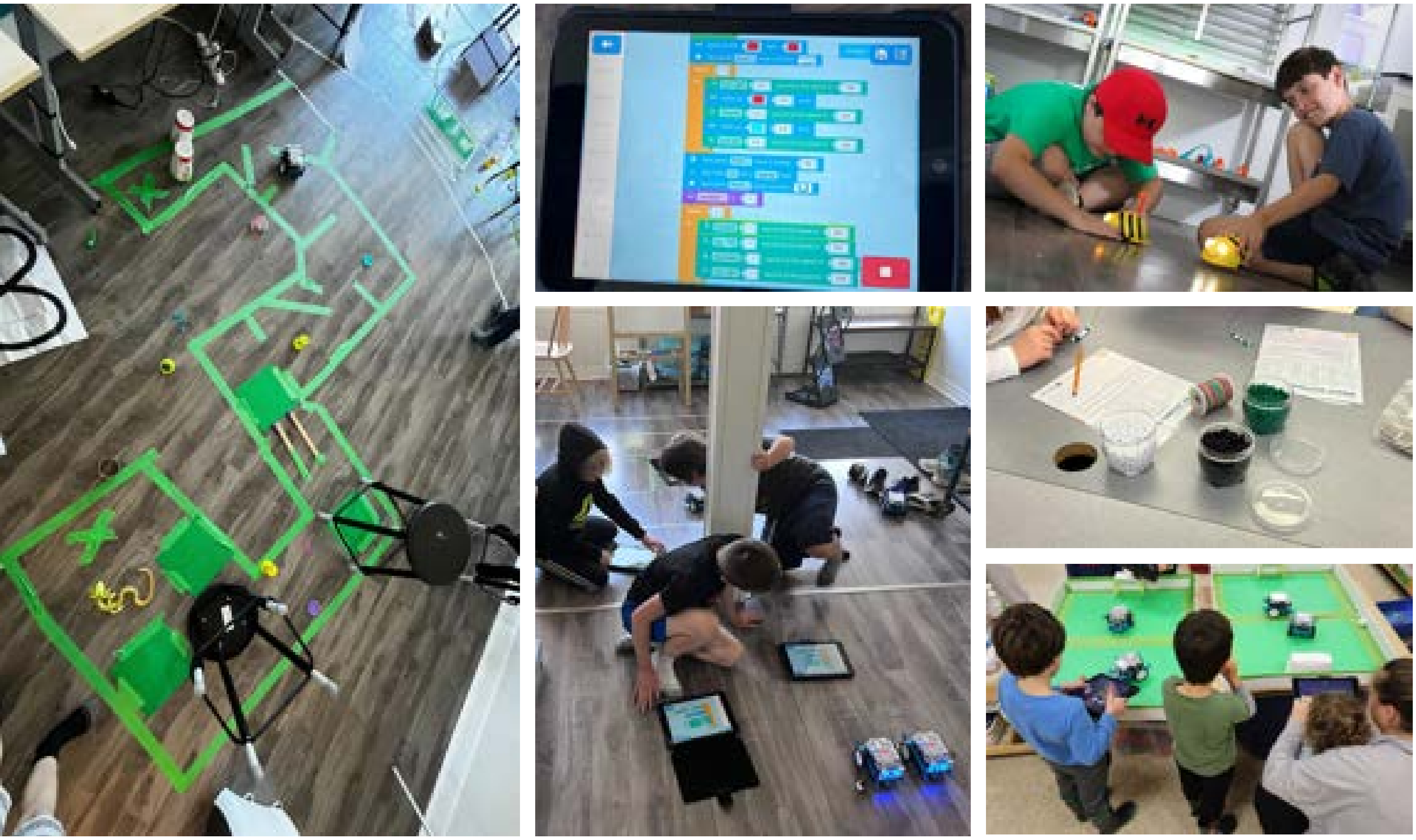
KG: The mBots are essentially the eye-catcher—it's the activity that every youth there wanted to go and do, as well as the parents. They're paired using Bluetooth to an iPad or iPhone, and the kids can control them through the device. The kids would have a go and then instantly get back in the line and try and get another turn.

HOW DO YOU THINK STUDENTS AND PARENTS FEEL ABOUT IMPLEMENTING ROBOTICS INTO EDUCATION?

SR: I've seen many parents who are excited, but there's a flip side. Sometimes, people are averse to new things. We have to remind them that there's nothing to fear but fear itself. If you learn how to utilize technology, then you become more comfortable with it. We're here to support children as young as two or three, as well as seniors and everyone in between, to embrace that scary feeling and overcome it. That's what's so wonderful about hands-on learning—you really get a chance to feel the equipment and utilize it yourself, and I think that makes a difference. Learning while having fun is a transformational experience.

KG: The parents were very open-minded and excited about adding robotics into the curriculum and education, but they were also uncertain about how that could be achieved, wondering how to get the robots

Top: Ampere Digital Skills Educator Sherisse Richards and her son Christian deliver a demonstration on Dash and Dots robots at Colonel J.E. Farewell Public School's family STEAM engagement night in Whitby.
Bottom: Children at the after-school drop-in STEAM technology skill building program at the Ampere Lindsay Makerspace practise controlling a Dash and Dots robot with a tablet



All Photos: Participants playing with different learning tools, like Bee-bot robots and mBots, through different interactive activities, like an mBot soccer tournament, coding workshops, and binary beading, that merge coding skills with art and movement

and how they can help teach something they don't fully understand themselves. That's a gap that we can bridge with educators in the field.

WHY IS IT IMPORTANT FOR PARENTS OR GUARDIANS TO ENGAGE THE SAME WAY EDUCATORS DO?

SR: Oftentimes, we want to look to educators and ask, "What can they do for our children?" but truly, parents or guardians are the first educators in a child's life—learning really starts at home. So it's very important for them to be engaged because children learn not only from what we say, but what they see modelled in front of them. It's a great opportunity not only for children to learn but also for bonding to take place. It's amazing to see what some of these little ones, teens, and parents create.

WHAT DO YOU THINK THE FUTURE HOLDS FOR ROBOTICS OR MORE TECH IN CLASSROOM SETTINGS? WHAT DO YOU HOPE TO SEE?

SR: I often think about this as a parent and an educator. The environment of learning has changed with virtual and hybrid learning opportunities and robotics and tech integration has become so much more prevalent since the pandemic. Now we're seeing smart classrooms, where virtual reality headsets or augmented reality are embedded within the learning experiences. I think technology is only going to become more and more prevalent, especially in rural or remote areas. I think we just have to embrace technology.

KG: I love seeing the light bulbs go off when one of the learners or parents has discovered something new. When I was small, I didn't have access to STEAM education the way youth nowadays do, so I want to try and provide that, whether it's through robotics, music, or art. What I'd hope to see is more coding in the classrooms and a little more engineering, just to get that hands-on experience. &

If you are interested in bringing a Family Engagement Night to your community, visit **amp.ca** to learn more, or reach out to us via root_stem@@amp.ca

This conversation has been edited and condensed for space and clarity.

CODING AND PROGRAMMING

COMPUTING AND NETWORKS

TECHNOLOGY AND SOCIETY

The Impact behind "Indigenuity"

BY BONNIE SCHIEDEL

PHOTOS COURTESY OF DAWN PRATT

When Dawn Pratt sees a tipi, she also sees a spaceship.

"It's the most aerodynamic shape," says Pratt, a member of Muscowpetung Anihšināpē Nation and a STEM educator who lives in Saskatoon. "I was just blown away by thinking about the tipi and how it's designed perfectly, so much so that the shape is employed in spaceships."

Pratt has always been fascinated by math and science, especially chemistry (she vividly remembers getting a chemistry set as a gift from her parents when she was a kid). After earning her master's degree in chemistry—with a focus on the use of organic absorbent materials to remove arsenic from contaminated water—she worked in several teaching roles before launching her own education company, which develops and teaches Indigenous STEM lesson activities, in 2020.

"I kept seeing big gaps in our education system, or going to a science centre and not seeing Indigenous [technology]," says Pratt. "I like to Indigenize my content." She named her business askenootow STEM Enterprise in honour of her great-great-great-grandfather, a translator who spoke Cree, English, and French. The Cree term *askenootow* means "Earth workers" in English.

It's important to Pratt to integrate Indigenous, Elder, and Knowledge Keeper teachings into her work. "I started working alongside a Knowledge Keeper [...] and I realized that he was very observant, something we use in science." She also discovered how often traditional expert knowledge and cultural teachings fit in with current scientific research. For example, she says the star people teachings found in many First Nations creation stories align with recent analyses of ancient meteorites, which have revealed that the chemical components needed to form DNA—and life—may have arrived on Earth with them.

Pratt's Indigenized science content teaches about everything from using coding in beadwork to the natural chemical processes at work in tanning hides, and even what a robot chicken pow wow dancer looks like.

Previous Page: Dawn Pratt (middle) attends a Tipis and Telescopes event, held at the Biogeoscience Institute in Kananaskis, Alberta, in September 2022.
Bottom: Pratt attends a science fair in Red Earth First Nation

Left: Pratt and her daughter Cianna building an igloo at the Saskatchewan Science Fair Indigenous Indigenuity Exhibit.
Right: Pratt delivers a canoe presentation at Starblanket First Nation for SIIT and L3 Harris Indigenous Dreamers Doers Innovation Camp

Land-based and hands-on learning is a definite focus of Pratt's work. For example, in learning about the technology of tipis, she says: "We build miniature tipis and talk about the math. We talk about what tools Indigenous people had available to measure the base of a tipi so they could figure out how far apart their poles need to be, how many poles they need, how they go on the tipi, the importance of triangles, and just how aerodynamic it is."

Hands-on learning offers a tactile approach that isn't always available in the classroom. And it's not just for tipis. As an engineering activity, students were tasked with figuring out which shape of canoe offers the best combination of stability, strength, and speed. They made miniature versions with simple materials and then attempted to float them with rock weights to see which shape and material performed best. In another lesson, the jawbone of a buffalo, its teeth intact, was passed around the group to facilitate a discussion about herbivores, carnivores, and omnivores.

Ultimately, says Pratt, Indigenous knowledge and worldviews, including spirituality, can bring balance to Western STEM, which, Pratt notes, "tries to be objective—but it's not as objective as it likes you to believe it is."

For Pratt, learning is lifelong. "When I go places, I'm learning. I just learned that the Inuit created their own wetsuits from whale intestines!" she says, proposing that we coin a word to describe Indigenous ingenuity: "Indigenuity!"

TECHNOLOGY AND SOCIETY

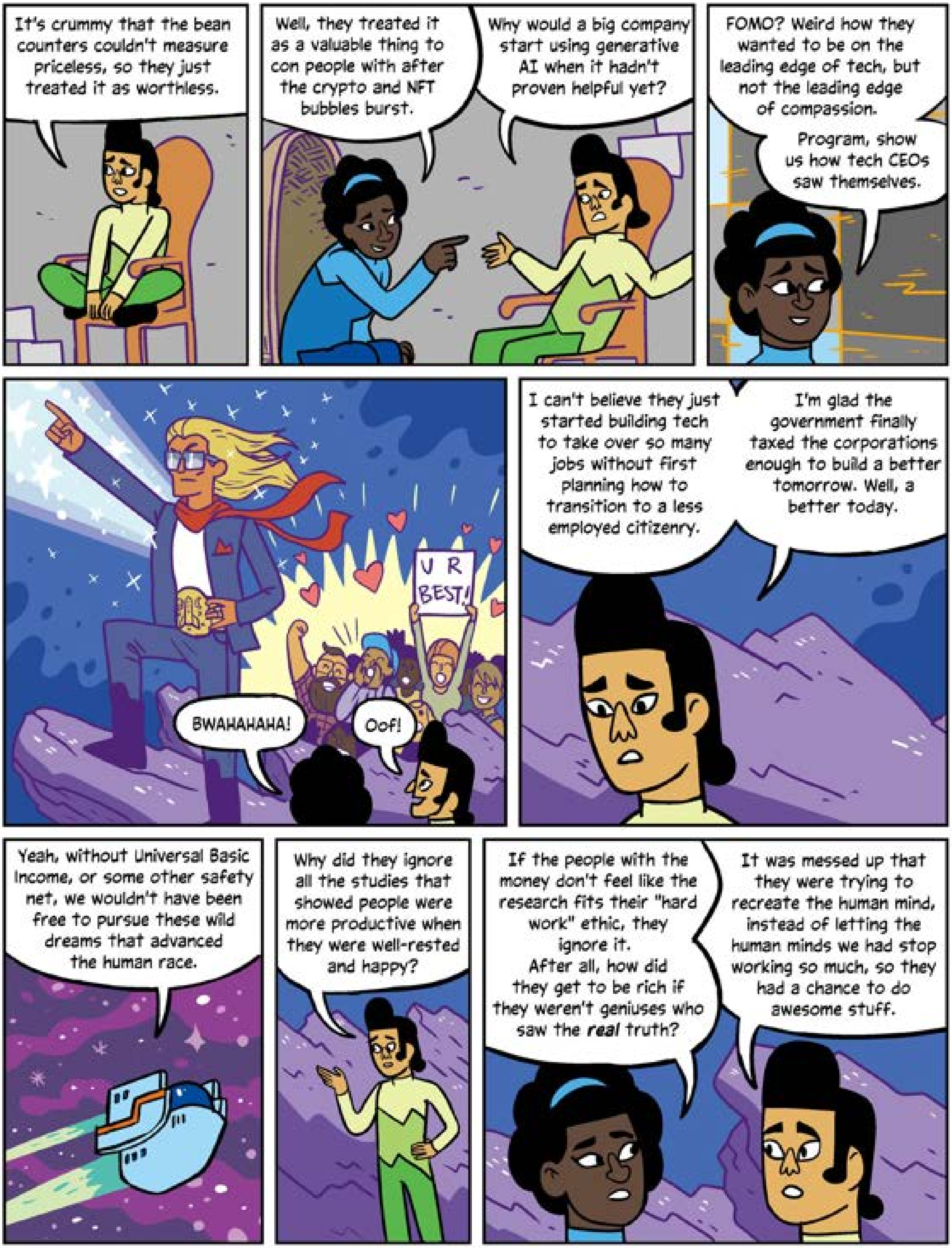
DESIGN

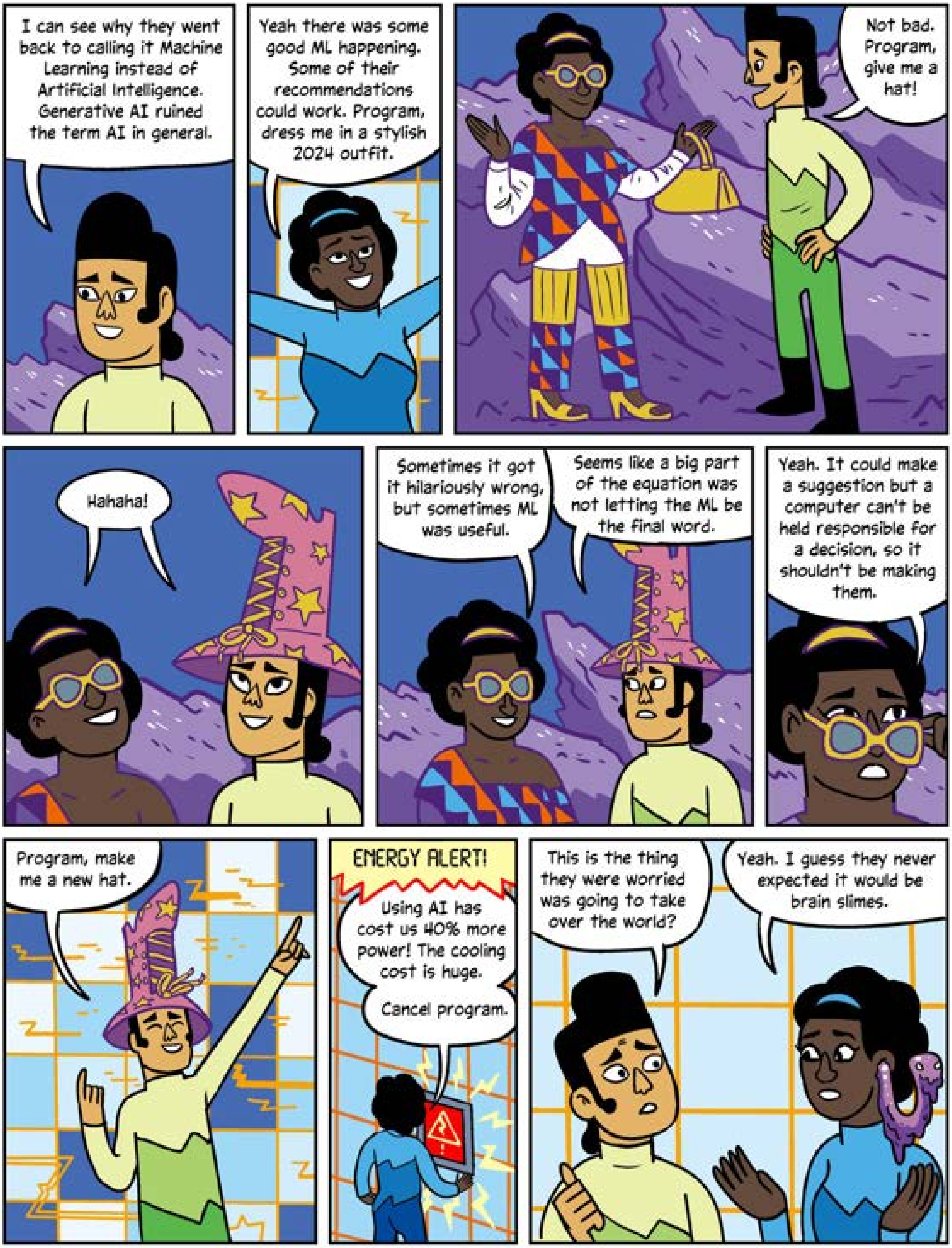
"Ultimately, Indigenous knowledge and worldviews, including spirituality, can bring balance to Western STEM."

COMIC


Always Inaccurate
by Brian McLachlan
Whoa. Someone's hooked this hologram room up to AI from the year 2024.
Program, make a throne room!
Huh? How does it get it so wrong?
Low-paid workers fed it texts, chats, and images but the algorithm can't understand if material contains an error, a joke, a bias, or if it's missing context, etc.
Just like how a chair can be a beanbag, one piece of sculpted metal, a plush recliner. Things you sit on can look very different.
Imagine you're tired in a forest. You might see a fallen log as a chair. Can an algorithm see it that way?
And if it's raining and I put a chair over my head, does it stop being a chair and become an umbrella?
I guess I know it when I see it, but thinking about it hurts my head.
A computer has to guess the answer without having a body to inspect things. Just trusting what's it's been told.
And it's easy to have bias in the data. Notice how it chose a European throne room?
Yeah. This isn't what I was picturing.
Let's switch it up, a bit.
Program, make a throne room with a painting of Denise as queen.


That's not cool. Making pictures of me without my permission.
Hey, we've drawn each other before. For fun.
Yeah, but using a photorealistic generator to make me fit your imagination is creepy.
It does hit different. Sorry.
I feel like a dupe in a genie story who makes wishes without thinking things through first.
Ha. You're not the only one who used generative AI for wish fulfillment. A lot of people believe art owes them endless entertainment catering to their whims. Nothing challenging.
Can you believe they didn't have Arts Officers in their sci-fi stories? It was mostly science and war. Maybe comms.
Oof. I don't know what I would have done without art therapy.
How else am I supposed to cope with being cloned in a transporter accident and a week later watch my duplicate die from Cardovian snake jazz poison?
Or being stuck in a time loop where I was repeatedly pushed out an airlock by a living pizza monster?
Prompting an AI to make a sad sculpture would not have been the same.
Program, make some sad art.
Yeah. Totally feeling the transformative power of art now.
It's priceless.


It's crummy that the bean counters couldn't measure priceless, so they just treated it as worthless.
Well, they treated it as a valuable thing to con people with after the crypto and NFT bubbles burst.
Why would a big company start using generative AI when it hadn't proven helpful yet?
FOMO? Weird how they wanted to be on the leading edge of tech, but not the leading edge of compassion.
Program, show us how tech CEOs saw themselves.
U R BEST!
BWAHAHAHA!
Oof!
I can't believe they just started building tech to take over so many jobs without first planning how to transition to a less employed citizenry.
I'm glad the government finally taxed the corporations enough to build a better tomorrow. Well, a better today.
Yeah, without Universal Basic Income, or some other safety net, we wouldn't have been free to pursue these wild dreams that advanced the human race.
Why did they ignore all the studies that showed people were more productive when they were well-rested and happy?
If the people with the money don't feel like the research fits their "hard work" ethic, they ignore it.
After all, how did they get to be rich if they weren't geniuses who saw the *real* truth?
It was messed up that they were trying to recreate the human mind, instead of letting the human minds we had stop working so much, so they had a chance to do awesome stuff.


I can see why they went back to calling it Machine Learning instead of Artificial Intelligence. Generative AI ruined the term AI in general.
Yeah there was some good ML happening. Some of their recommendations could work. Program, dress me in a stylish 2024 outfit.
Not bad. Program, give me a hat!
Hahaha!
Sometimes it got it hilariously wrong, but sometimes ML was useful.
Seems like a big part of the equation was not letting the ML be the final word.
Yeah. It could make a suggestion but a computer can't be held responsible for a decision, so it shouldn't be making them.
Program, make me a new hat.
ENERGY ALERT!
Using AI has cost us 40% more power! The cooling cost is huge.
Cancel program.
This is the thing they were worried was going to take over the world?
Yeah. I guess they never expected it would be brain slimes.

The Tech behind Fear

Decoding Fright in Horror Gaming

BY NADIA SCOTT

In the realm of gaming, horror stands out as a genre that evokes deep emotions in the minds of players, tugging on fears and capitalizing on shock value with a myriad of jump-scares, gory imagery, and spine-chilling audio effects.

It's easy to chalk up a good horror game to its ability to grasp the player visually, immersing them as it does in twisted environments marked by blood-smeared walls, haunted corridors, and decayed faces. But where the genre truly excels is in its beckoning of players to explore the psyches of characters as well as spaces riddled with intensity.

ICONIC HORROR GAME FRANCHISES AND THEIR SCARE TACTICS

- *Resident Evil:* A survival horror game franchise known for increasing the interest in zombies in popular culture, as well as its grotesque monster designs, blend of horror and sci-fi, and puzzle-solving elements. The game series spawned a string of blockbuster movies that helped bring the zombie genre back into the mainstream and inspired a variety of other titles blending action and horror.
- *Silent Hill:* This anthology series is known for its psychological horror style, with gripping narratives that delve into themes of religion, grief, and the corruption of humanity, as well as its immersive lighting and sound design. The series is also regarded as a pioneer in third-person 3D gameplay, setting the stage for other horror games that utilize this style.
- *Amnesia:* Known for its critically acclaimed storytelling and its terrifying monsters, the *Amnesia* franchise features four titles that explore landscapes taken over by dark forces. The franchise is known for its use of a sanity meter in some of its games, which monitors how long a character has been stuck in the dark or exposed to horrifying events, situations that result in a decline in their mental condition. As sanity lowers, the game environment becomes more dangerous, requiring players to find items that can build their sanity back up, as well as avoid situations that will lower it further. A variety of other games in the genre have since utilized this engaging feature.

MORBID CURIOSITY AND THE THRILL OF FEAR

What exactly makes these horror games so iconic, impactful, and interesting? The answer is that they satisfy the parts of our psychological make-up that desire to feel the thrill and rush of adrenaline this genre delivers. Humans possess an innate need to feel and experience the release of strong emotions, whether through screaming, crying, laughing, or another booming action. Horror games have the ability to pull these emotions out of us through their use of common human fears, intense storytelling, and shocking audio and visual stimulation that catches us off-guard.

While the games and their mechanics are a huge part of why the genre is so beloved, its popularity also says a lot about its fans. Morbid curiosity is one significant reason players immerse themselves in these terrifying gaming experiences, perhaps due to inner conflict about death, fears, or the supernatural. When we take a front-seat position in these games, we are set up for a potential exploration of self that runs bone deep, helping us to better understand how we feel about these large, sometimes intimidating concepts that rule the human experience.

HORROR GAMES IN THE CLASSROOM

While the horror genre might not appear to be the most traditional subject to explore in an educational setting, some

"Imagine a game where a player inputs specific fears and AI steps in to create their perfect monster, which changes to become less terrifying throughout the game as the player works to overcome those fears, and mutates back when they fail to do so."

schools have chosen to dive right in. The University of Victoria's department of Art History and Visual Studies offers a course titled Horror Video Games, described by the school as "an inquiry into the nature of fear and the grotesque in digital games as an interactive visual medium." The course promises exploration into the horror tropes used in both mainstream and independent games by way of a variety of theoretical perspectives.

The Game Center at New York University's Tisch School of the Arts has a Horror Games course that explores iconic titles including *Resident Evil, Silent Hill,* and *Amnesia*. These games are used as educational tools for the purpose of "tracing how their design aesthetics were formed via their relationship with horror fiction in the wider media landscape," according to the university. Students deliver historical and critical analyses of games within the genre, reflecting on their use of specific audio-visual aspects and themes that create emotion-driven narratives and gameplay.

GAME DESIGN, MECHANICS, AND IMMERSION

Horror games employ various mechanics that play into morbid curiosity and the thrill of fear in order to immerse players in their worlds. The popular paranormal investigation simulator *Phasmophobia* uses voice recognition technology to allow players to interact with the game's ghosts, which hear and respond to players' voice commands like asking ghosts to speak through a spirit box or show a sign by throwing an item or knocking a painting off a wall. Crude or aggressive language can anger the ghosts, often prompting them to hunt the player. When a player is being hunted, the game employs ghoulish whispers, pounding heartbeats, and flickering lights to create the tense atmosphere of being followed by a supernatural force.

Five Nights at Freddy's, another immersive title, positions the player as a security guard in charge of monitoring Freddy Fazbear's Pizza, an entertainment and event business. But there's a terrifying catch—Freddy's is ruled by animatronic mascots that are possessed by the dead and become active and hostile at night. The goal of the game is to survive a timed shift from midnight to 6 a.m. without encountering the wrath of the animatronics. The animatronics are slowly approaching the player at all times, requiring the player to be on constant watch, observing them through security cameras and controlling steel doors to lock them into rooms as they attempt to get closer. However, there is a game mechanic that makes this whole process quite precarious. There is limited power available to keep the cameras and doors up and running, and the game keeps track of the player's usage. If these tools are used in excess, the power shuts down, resulting in the player's untimely death.

Prey (2006) is an excellent blend of survival horror and sci-fi, following Cherokee mechanic Domasi "Tommy" Tawodi, who gets wrapped up in an intense abduction by an extraterrestrial force known as the Sphere. This first-person shooter game delves into Tommy's Indigenous heritage when he is transported to the Land of the Ancients, a place where he is given spiritual powers by his grandfather. These powers include revival after death, separation from the body to pass through objects, and help from his childhood pet, a hawk that becomes his spirit guide. Tommy's spirit powers are a compelling feature that not only makes for interesting gameplay and design but also celebrates representation of heritage and the importance of spiritual guidance in Indigenous cultures. *Prey* employed Indigenous voice actors Michael Greyeyes, who takes on

PHOTOS COURTESY OF AMPERE

the pivotal role of Tommy, and Crystle Lightning, both of Cree descent.

VIRTUAL REALITY AND THE FUTURE OF HORROR GAMING

Along with several other horror titles, among them *The Walking Dead: Saints and Sinners*, *Alien: Isolation*, and *Paranormal Activity: The Lost Soul*, *Phasmophobia,* and *Five Nights at Freddy's* can be played with virtual reality (VR) technology, in which players wear a headset that displays a three-dimensional version of the game. The use of VR in horror gaming is widely praised for its immersive capabilities and its ability to scare players as the room-scale, first-person position takes over their entire scope of vision. Providing an experience that can conjure the feeling of walking through a haunted house, VR brings players deeper into the game's landscape, forcing them into face-to-face encounters with antagonists that seek to haunt, attack, or otherwise terrify them.

VR, and the game mechanics discussed above, have made waves in the growth and development of the horror game genre. But where can it go from here? It's difficult to hypothesize how horror games will get deeper under the skin of players in the future, but with the emergence of artificial intelligence (AI) and its impact in gaming, the possibilities are seemingly endless. Imagine a game where a player inputs specific fears and AI steps in to create their perfect monster, which changes to become less terrifying throughout the game as the player works to overcome those fears, and mutates back when they fail to do so. Or, imagine a game in which augmented reality—an interactive technology combining computer-generated content with the real-world—uses the walls and characteristics of your home to create a gruesome landscape that makes you doubt what is real and what is not.

Wherever horror gaming goes from here, new technology seems to promise an ever-evolving landscape ripe for increasingly immersive and shocking experiences. &

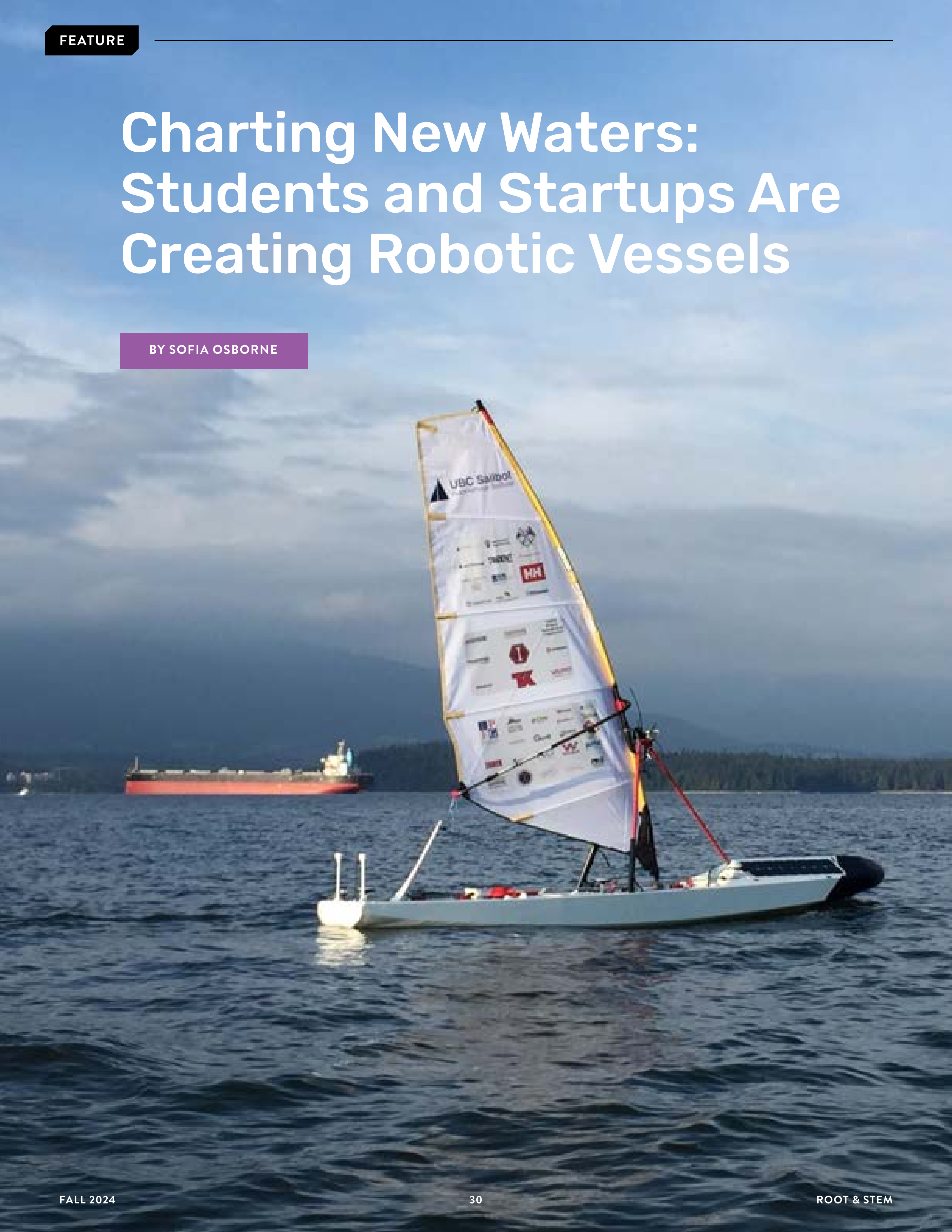
CODING AND PROGRAMMING

DATA

DESIGN

Charting New Waters: Students and Startups Are Creating Robotic Vessels

BY SOFIA OSBORNE



UBC Sailbot testing their boat *Ada*'s ability to sail on its own in the water on English Bay in 2016

PHOTO COURTESY OF UBC SAILBOT

Ella Knowles started working on boats when she was a kid, helping her father—an aircraft maintenance engineering instructor—with his San Juan 23 keelboat.

"Although sailing is very much a sport, there's a lot of technical aspects: using your sail to catch the wind and aerodynamics," she says. "That sparked my scientific, engineering interest."

Now, as a third-year mechanical engineering student, Knowles serves as the mechanical lead on UBC Sailbot, an engineering club at the University of British Columbia. The club designs, builds, and launches autonomous sailboats, which are unmanned vessels that can be operated by a variety of systems including robotics, artificial intelligence, and solar panels.

The club started in 2005 as an engineering capstone project, says Asvin Sankaran, a fourth-year engineering physics student and UBC Sailbot co-captain. Now, the undergraduate club has developed three vessels, creating and exploring new challenges with each sailboat. Their 5.5-metre vessel, *Ada*, which was launched in 2016, was created to attempt a trans-Atlantic voyage from Newfoundland to Ireland with no human assistance or feedback.

"All was going well for around the first third of the trip until she hit hurricanes, which we definitely didn't plan for," says Sankaran. "The rudder completely broke and the windsurfing sail was ripped out of the hull."

Ada kept up communication with the team back in Vancouver for a few months before going completely off the grid. A year later, she was picked up off the coast of Florida by a shipping vessel and sent back to UBC, where the Sailbot team analyzed what went wrong.

"It constituted a really unique opportunity to see a project from start to finish to failure, and then get to [try again] with the next boat," says Sankaran.

That next boat was *Raye*, another 5.5-metre sailboat, which was set to sail the Pacific Ocean in the summer of 2022. The team didn't get to send her off to Hawaii—their ultimate goal for the vessel—and she was retired in 2023, but Sankaran says they are happy to have proved that undergraduates are capable of devising such an ambitious project.

Now, the team is working on their next vessel, *Polaris*, a three-metre, fully autonomous sailboat they intend to be capable of collecting oceanic and atmospheric data in the Pacific.

"We as a team, and as students, felt that we could do so much more with the technology that we were pursuing," says Sankaran. "Because we have the support of the university, we are able to pursue such ambitious projects without having to face as many adverse risks as if you were, say, a startup company dealing with money, dealing with legalities; that's something that the university helps us with tremendously."

The team has been working on *Polaris* for about a year now, and Knowles says they are wrapping up the design stage.

"We spent the last year testing in the wind tunnel and using simulation software to optimize our design," she says. "Now we're ordering materials and prototyping and getting ready to start building our main final products."

With construction starting, *Polaris* is set to make her maiden voyage in the summer of 2025. Unlike the team's previous vessels, she will have a hard wingsail, a rigid type of sail similar to an airplane wing turned vertically, which will provide lift and propel *Polaris* forward. The sides of the wingsail will be covered in solar panels, which will power the boat. Solar panels will also be mounted on the deck, and additional space for sensors and batteries.

On a non-autonomous sailboat, the crew is able to look at the sail and see how full it is, monitor wind direction and speed, and consider everything else that must be taken into account when plotting a course. In the case of an autonomous sailboat, it's the algorithms developed by the software team that make these calculations.

"As you can imagine, it's an incredibly complex system and an incredibly complex project," says Sankaran. "Trying to merge classical naval architecture and marine engineering on the left with software and robotic systems on the right, and electrical systems being the middle person talking between the two, is really challenging."

Because *Polaris* will be collecting ocean data, which the UBC Sailbot's research team will work to give context to and interpret accurately, the hope is to use what they find to support efforts of ocean conservation, according to Sankaran. How they do that will depend on the data they find.

There are very few autonomous sailboats in existence, so the UBC Sailbot team is voyaging into mostly uncharted waters with little prior research to guide them.

"I think that gives [the team] a lot of room for research, but it also gives us a lot of room for innovation. There's no way that we can copy somebody else's design. We have to propose our own designs from scratch. That gives us a lot of freedom in how we pursue our projects."

As undergraduate students, being involved with such a hands-on project has allowed Knowles and Sankaran to learn new skills

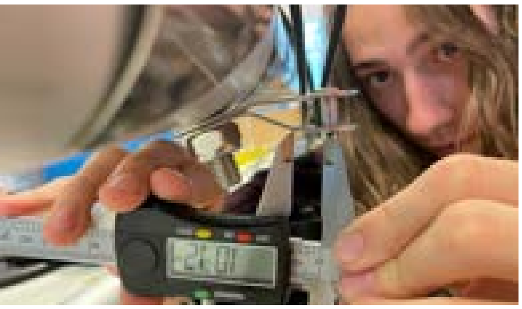
Testing *Raye* on land to check if the sensors, motors, and computer are correctly communicating

Smoothing out *Raye*'s carbon fibre hull with sandpaper to get it ready for painting

A team member drawing ideas on a chalkboard to determine design considerations for a rigid wing sail

To build *Raye*'s hull, layers of carbon fibre are placed on top of a foam and wood mold called a "wet layup," which is then covered with a layer of expoxy-infused carbon fibre

PHOTOS COURTESY OF UBC SAILBOT



Top: Testing *Raye* on land to check if the sensors, motors, and computer are communicating correctly. Bottom: A team member uses calipers to measure the mast hardware

PHOTOS COURTESY OF UBC SAILBOT

A DataXplorer collecting data off the coast of British Columbia

PHOTO COURTESY OF MADELEINE BOUVIER-BROWN

and go far beyond what they would be taught in the classroom—at UBC, naval architecture is only offered at the master's level.

"I joined the team as a first-year student with only my sailing experience behind me and not a lot of engineering analysis skills," says Knowles. "Joining the team and being connected with upper years ... had me learning content way before I was learning it in class. And having the ability to take what you're learning in class and apply it to a project is something that is very valuable."

• • •

Outside the world of the university, startups are developing their own robotic vessels for data collection. One such company is Victoria-based Open Ocean Robotics, which created the DataXplorer, an uncrewed surface vehicle (USV) about the size of a paddleboard. Powered by solar panels, the DataXplorer is designed for ocean monitoring and data collection in a way that is more affordable and less risky than traditional crewed vessels.

While the DataXplorer is not yet fully autonomous, Open Ocean Robotics Lead Data Scientist Oliver Kirsebom says the organization is working towards the vessels being able to navigate the water safely on their own. At the moment, DataXplorers are monitored by human operators who can control the vessels remotely, although the USVs follow their planned routes mostly autonomously.

DataXplorers are equipped with both visual and thermal cameras, whose feeds they can stream to human operators in near-real time, that can collect data on conditions like wind speed and air temperature. Madeleine Bouvier-Brown, the company's Marine Operations Lead, works on launching and recovering the USVs, creating mission plans, working with clients, and monitoring the vessels when they're out on the water.

"As the operator, you're often just sitting there being like, 'Everything OK? Are you still on your mission? OK, great, I'll just let you do your thing.'" says Bouvier-Brown. "And that does require you to pay attention. But it doesn't necessarily mean that you're intervening."

When the vessels are farther offshore and out of range of cellular service, they are no longer able to stream camera footage to operators. For situations like this, Kirsebom has been training artificial intelligence algorithms for the USVs to detect other vessels and avoid collisions on their own. This kind of autonomous detection is also important for monitoring purposes, like the collaboration Open Ocean Robotics is working on with the coast guard in the Bahamas.

"We will have three boats on the water down there very soon, keeping an eye out for illegal fishing—and not only an eye, but an ear as well," says Kirsebom. "In addition to the cameras, we'll also have a hydrophone deployed from each of these boats, and so we'll be able to listen for the noise that the vessels make."

Hydrophones, or underwater microphones, can be towed by the USVs to collect sound data for many potential applications. Bouvier-Brown—who has a background in whale research and bio-acoustics—was initially hired by Open Ocean Robotics to collaborate on a project with the Department of Fisheries and Oceans Canada. The idea was to assess the critical habitat of the endangered southern resident killer whales using hydrophones attached to USVs.

"I had only ever worked with seafloor-mounted hydrophones that were digital and did near-real time streaming, so this was quite different, because now we could move the hydrophones to wherever we wanted," says Bouvier-Brown. "If you thought 'Oh, maybe [the whales] will be over here today,' you could just drive the USV there, and then let it sit and listen. If you wanted to do multiple passes, you could just keep moving the USV back and forth."

Unlike larger, crewed vessels, the DataXplorer is small and unobtrusive, moves slowly, and produces almost no noise, meaning it causes minimal disturbance to marine mammals.

"This is a way to have a positive impact on the oceans and to learn more about what it means and what it's going to take for us to conserve them without actually impeding these animals or habitats," says Bouvier-Brown. "It's the best of both worlds of getting that research, getting that data, helping them, but then also not hindering them by trying to help them."

In the future, the USVs could be used to listen for marine mammals in real time, for example to alert ships when whales are nearby to prevent collisions.

Outside of supporting marine mammal conservation, the USVs can also be used for patrolling borders, mapping the seafloor, and monitoring the impacts of projects such as offshore wind farms and ocean-based carbon capture and storage, among many other applications.

Like Knowles and Sankaran say about working on their autonomous sailboat, Kirsebom says it's an exciting challenge to work on the DataXplorer. For example, since they are powered exclusively by solar energy, these vessels have a tight power limit. While the batteries are able to recharge while the boats are out on the water, he says caution must be taken for how much power they use.

"We want to be able to do all of these things with our little computer on the boat, but at the same time, we don't have infinite power to do it," says Kirsebom. "It's a fun challenge for me as a data scientist to develop these AI algorithms while making sure that they're not too big, and not too power hungry."

In working on such new technology, another puzzle Kirsebom faces is to figure out which data the vessel should transmit to operators on the shore, as sending data is expensive. When the algorithm has made a potential detection of a vessel or marine mammal, Kirsebom must figure out what evidence it should send to operators so they can decide if it's a real detection.

"As one of several companies worldwide that are developing these types of ocean drones," says Kirsebom, "we're breaking new ground here. It's really a growing market at the moment."

For Bouvier-Brown, the future of ocean science—and many other fields—is autonomous but that doesn't mean robot boats will be taking people's jobs.

"The beauty of working with USVs, and with all these different advancing technologies, is that the jobs are just going to become different, but we're still going to be lowering our impact on the environment, and really lowering our risks to human life," she says. "The ocean is one of the most dangerous places in the world, especially the open ocean. Being able to send a vessel out there that can still collect all this data and do all these things that a crewed vessel can do, but do it more affordably, safely, and with multiple vehicles at once, is really a game changer."

In the future, Bouvier-Brown says, maybe we'll see a new generation of smarter, safer marine technologies—from ocean drones to sailbots—all working together to collect and share data to help conserve our oceans. &

CODING AND PROGRAMMING

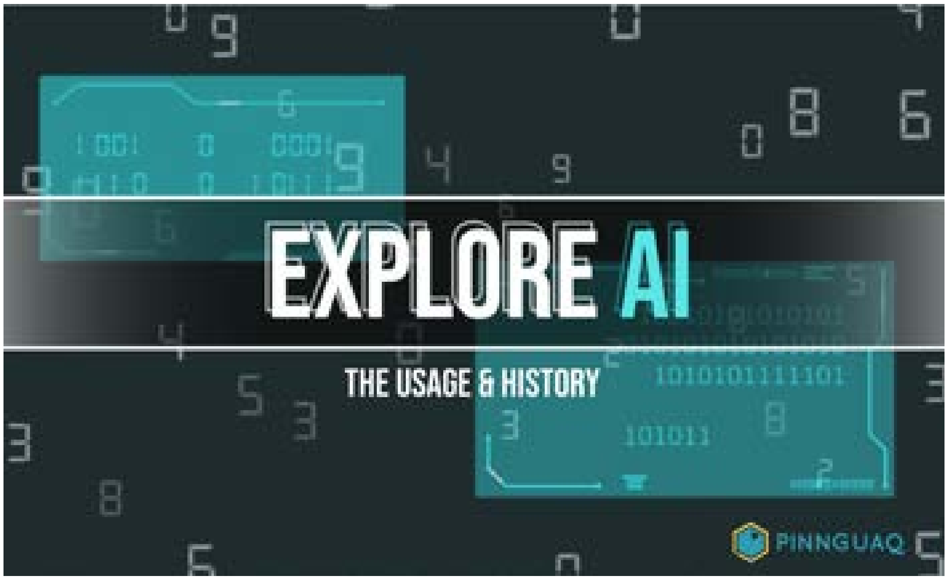
COMPUTING AND NETWORKS

TECHNOLOGY AND SOCIETY

DATA

DESIGN

PHOTO COURTESY OF CHARMAINE SUVEGES



The *All About AI* educational video explains the basics and history of artificial intelligence

Digital Kit

PAST ISSUES

If you missed past issues of *Root & STEM*, you can find them online at
rootandstem.ca

RESOURCES

We have developed additional digital resources for educators to use in the classroom that connect to the concepts of computer science studies—including podcasts and interactives. They can be accessed online via the links that follow.

Root & STEM Podcast

This podcast expands on *Root & STEM* content and invites subject experts from each issue of the magazine to share their knowledge. The current series explores the theme of computer studies in relation to STEAM education. Episodes are approximately 15–30 minutes long and are available on the Ampere website or your streaming platform of choice.
rootandstem.ca/learn/the-root-stem-podcast

Harnessing the Benefits: The Digital World Podcast

This three-episode series designed for Grade 9–12 students highlights the advantages of technology while introducing some potential dangers of the online world and how to avoid them. Each episode focuses on a popular aspect of the digital world: artificial intelligence, social media, and online learning. Each episode explains how these relatively new technologies can benefit students in and out of the classroom, how others are using the technology, and how to implement digital safety to harness the benefits of the digital world.
rootandstem.ca/learn/harnessing-the-benefits/

Root & STEM App

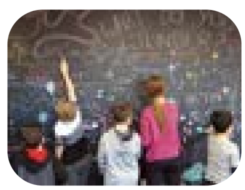
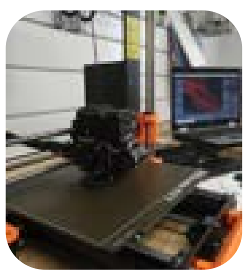
Filled with the same informative articles, podcasts, and lesson plans as its printed counterpart, the Root & STEM educational app is a free digital resource for K–12 educators and learners of all ages. The app puts the magazine's STEAM content and curriculum in the palm of your hand. Interactive elements are added regularly. Available for download on the App Store and the Google Play Store.

All About AI

This video takes students on a journey through time to learn about the history of artificial intelligence (AI). It explores how AI came to be and profiles key scientists who first thought of creating intelligent computers, which are capable of using logic and mimicking thought processes to solve problems. Students learn what early models of AI looked like, what the intelligent machines of the past were, how far technology and AI have come in the last two decades, and what the future holds for humanity and AI.
www.youtube.com/watch?v=iencUcExpRo






LESSON 1

Happy or Sad?

Author: Nia Emmanuel-Briggs

Level: Grade 1 to 4

Curriculum Links

This module aligns with provincial and territorial language arts and computer science curricula.
Ontario (Grades 4 to 6)
Science:
A1. STEM Investigation and Communication Skills
use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures
A2. Coding and Emerging Technologies
use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields
Language:
A1. Transferable Skills
demonstrate an understanding of how the seven transferable skills (critical thinking and problem-solving; innovation, creativity, and entrepreneurship; self-directed learning; collaboration; communication; global citizenship and sustainability; and digital literacy) are used in various language and literacy contexts
A3. Applications, Connections, and Contributions
apply language and literacy skills in cross-curricular and integrated learning, and demonstrate an understanding of, and make connections to, diverse voices, experiences, perspectives, histories, and contributions, including those of First Nations, Métis, and Inuit individuals, communities, groups, and nations
B2. Language Foundations for Reading and Writing
demonstrate an understanding of foundational language knowledge and skills, and apply this understanding when reading and writing

In this activity, students use AI to create a character that responds to input. When paid a compliment, the character will display a happy expression. When insulted, it will show a sad expression. To achieve this, students train a computer to differentiate between friendly and mean messages. This will be accomplished by training the computer using examples of both types of messages. (For this lesson, students should already be familiar the basics of Scratch.)

Learning Goals

- Execute code in investigations and when modelling concepts
- Identify and describe the impacts of coding and of emerging technologies on everyday life

Vocabulary/Definitions

- **Bug:** A mistake in instructions or code
- **Code:** Instructions that a computer program uses to perform tasks
- **Scratch:** A coding tool that allows the user to create interactive animations using code
- **Software:** A general term for a program that operates on computer hardware
- **Troubleshoot:** A testing process to identify implementation problems
- **Debugging:** The process of finding and fixing bugs

Guiding Questions

1. What are some things people say that make you feel happy?
2. What are some things people say that make you feel sad?
3. What do you do when you feel happy or sad?

Materials

- Scratch (**scratch.mit.edu**)
- Class set of laptops/chargers

Computer Activity

1. Go to https://machinelearningforkids.co.uk. Click **Get Started** then **Try it now.** From the Projects bar, click on **Add new project** and name the project **Make Me Happy**. Under Project type, select **recognize Text**.

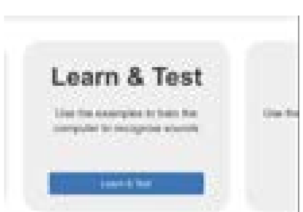
2. The new project will appear in the **Project list.** Click on the **Train** button.

3. Click on add **new label** and call it **Nice Words.** Add another label called **Mean Words.**

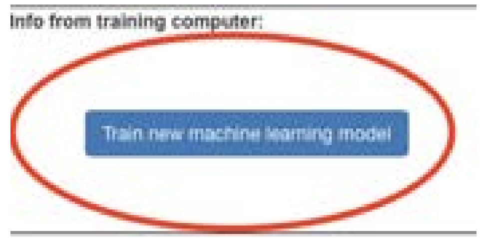
4. Click on the **Add example** button in the **Nice Words** section. Write at least six examples of nice things someone might say.

5. Now click on the **Add example** button in the **Mean Words** section. Write at least six examples of mean things someone might say.

6. Train the computer to recognize these words. In the top left corner, click **Back to project** and click **Learn & Test.**



7. Click **Train new machine learning model**. This may take a few seconds.

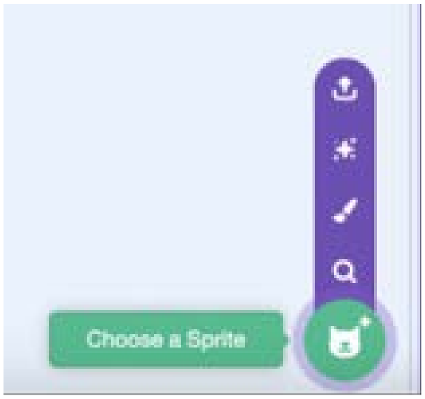


8. Once the training is completed, type something nice or mean in the text box to test the project. It will give a confidence score. If the learners are not happy with the confidence score, they can record more text in either section. (Suggested aim for a confidence score is at least 75%.)

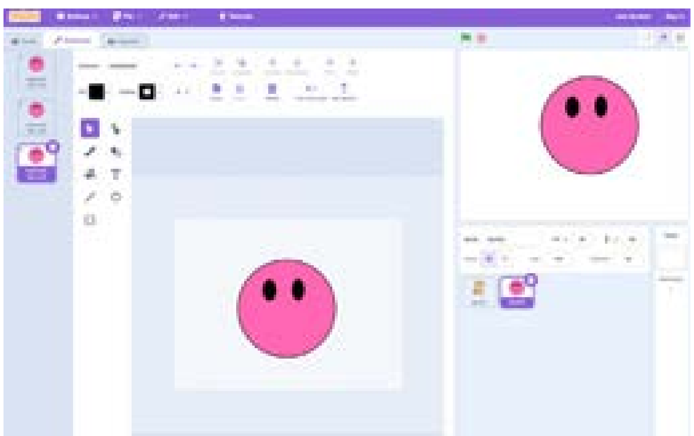
9. Click the **Back to project** link and click the **Make** button. Several program options will appear. Choose Scratch to connect to the Scratch interface.

10. When Scratch is open, the blocks for the new project appear at the bottom of the list.

11. Delete the cat sprite and create a new one by clicking on the paint icon.

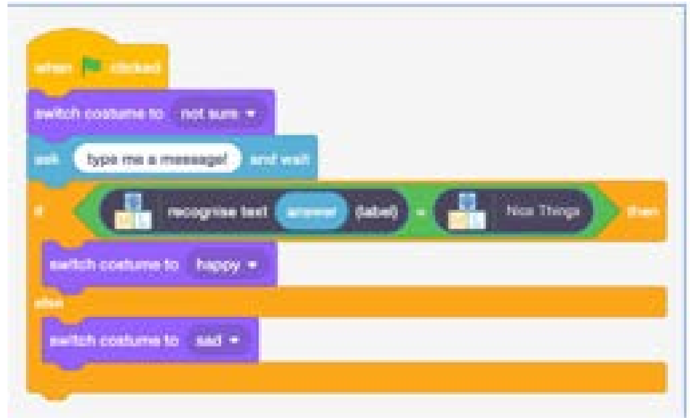


12. Click on the **Costumes** tab, then draw a face without a mouth. Right-click on the face and select **Copy**. Repeat for a total of three copies of the face costume.



13. Name the costumes **Not Sure, Happy**, and **Sad**. Now draw mouths on each face to provide their expressions. **Not sure** should have a straight line as the mouth, **Happy** should have a smile. **Sad** should have a frown.

14. In the **Code** tab, create the code pictured below.



15. Test the model to see if the computer detects nice and mean messages correctly. Click on the **green flag** on the right side of the screen and type a message. Watch the computer react. In reaction to a nice message, it should display the smiling face. If it's a mean message, it should look sad. If it's unsure whether the message is nice or mean, it should have a straight face. If the program shows a lot of **Not Sure** faces, go back to step 4 & 5 so that the program can recognize more happy and sad words/sentences.)

Conclusion

At the end of this lesson, students should be able to apply the knowledge learned to create another set of questions to correspond to other pairs of emotions. What other emotions could be recognized by this software? What are appropriate characters or sprites to respond to other emotions?

Resources

- Scratch
  scratch.mit.edu

LESSON 2

Introduction to Twine

Author: Kevin Snow

Level: Grades 4 to 6

Curriculum Links

Ontario (Grades 4 to 6)
This module aligns with provincial and territorial language arts and computer science curricula, providing an opportunity for students to share and create stories.

Science:

A1. STEM Investigation and Communication Skills
use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

A2. Coding and Emerging Technologies
use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields

Language:

A1. Transferable Skills
demonstrate an understanding of how the seven transferable skills (critical thinking and problem-solving; innovation, creativity, and entrepreneurship; self-directed learning; collaboration; communication; global citizenship and sustainability; and digital literacy) are used in various language and literacy contexts

B2. Language Foundations for Reading and Writing
demonstrate an understanding of foundational language knowledge and skills, and apply this understanding when reading and writing

D2. Creating Texts
apply knowledge and understanding of various text forms and genres to create, revise, edit, and proofread their own texts, using a variety of media, tools, and strategies, and reflect critically on created texts

In this lesson, students learn the basics of Twine, and use their knowledge about stories to create their own story using this software. The knowledge and skills gained from this activity allow students to develop the fundamental skills of creating interactive stories.

Learning Goal

- Create an interactive story using Twine

Vocabulary/Definitions

- **Twine:** A tool that allows the user to create interactive stories using code by creating branching scenarios in the stories
- **Passage:** In Twine, a passage is a narrative unit, the building block of a story
- **Narrative:** The art, technique, and process of telling and structuring a story
- **Branching scenario:** An interactive form of learning, which has students make a decision and then presents the effects of that decision
- **Interactive Fiction:** A non-linear story in which the reader has a direct influence on the narrative

Guiding Questions

1. What makes a story funny, dramatic, or exciting?
2. What kinds of stories do students want to tell?

Materials

- Twine – **Download Twine (twinery.org)**

Non-Computer Activity

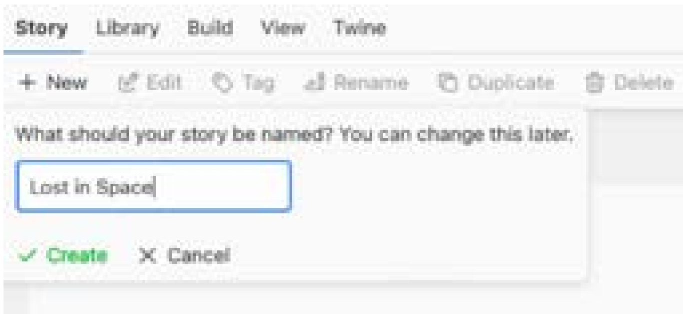
Tell the class they will be creating a story that follows an astronaut who crash lands on a planet. The first part of the story will be landing on the planet. The choice the astronaut will have to make is an “A” or “B” pattern. Will the astronaut A) stay on the ship and call Earth, or B) go and explore the planet?

Computer Activity

Creating an interactive story in Twine

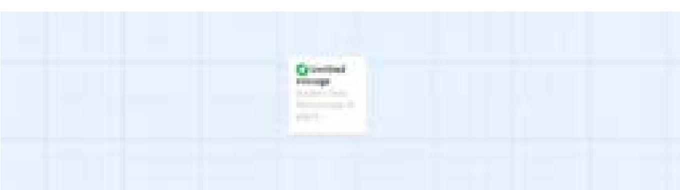
Imagine a television show suddenly pauses and offers the viewer a choice between two things. The viewer is not aware that the selection they make will have an impact on how the story ends. Twine is a tool that allows us to create interactive fiction, a kind of story in which the reader is asked to make choices about how the narrative unfolds.

Step 1: When Twine is opened for the first time, the screen will be mostly blank. To get started, select the **+Story** button and give the new story a name, which can be changed later if necessary. In this example, the new story is named “Lost in Space.”



Step 2: After the story is named, Twine immediately opens the Story Editor screen, where the main element is the box named **Untitled Passage**. In Twine, passages are basic narrative units, which are the building blocks of interactive stories. Open the passage for editing by double-clicking on the box.

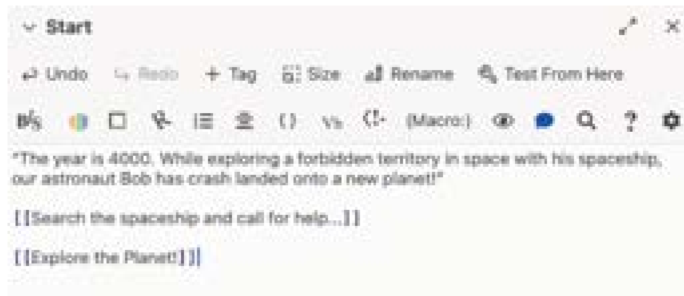
Tip: Passages in Twine can also be opened for editing by double-clicking on the box.



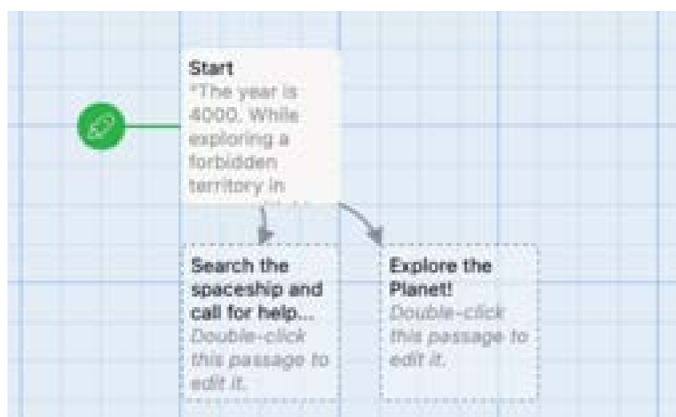
Step 3: Name the passage. These names will not be visible in the finished story, so they are just a reminder to the author of the passage’s purpose. In the example below, the passage has been named “Start” because it will be the first choice the reader encounters.

Step 4: Write that in this passage, the spaceship crash lands on the planet. For example, “The year is 4000. While exploring forbidden space territory with his spaceship, astronaut Kai has crash landed onto a new planet!”

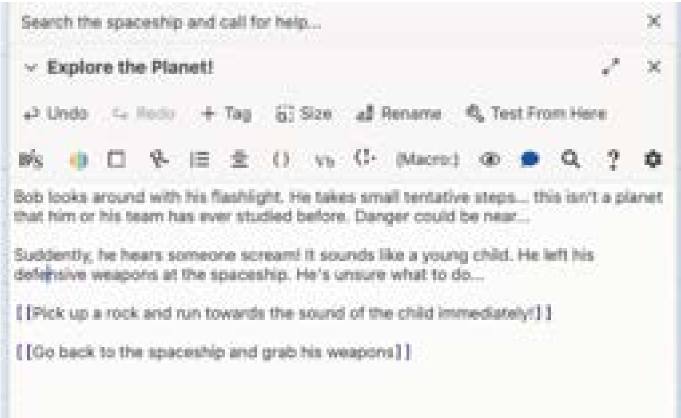
In this passage, the reader will be asked to make a choice that involves selecting either the spaceship or the planet, so links have to be created so the story continues to the appropriate next passage. In our example, the user will choose between the option to **search the spaceship and call for help** OR **explore the planet**. To tell Twine to create these links, enclose the words "spaceship" and "planet" in double sets of square brackets—[[spaceship]] and [[planet]]. These brackets always have to be put around pieces of information that are key to readers making their choices in the story.



Step 5: Close the passage by clicking on the X in the top right corner of the passage box. Twine automatically creates links to the passages. The names for the new passages will be the same as the text placed inside brackets in the previous passage. Twine automatically creates arrows between passages on the Story Editor screen to track the story flow.

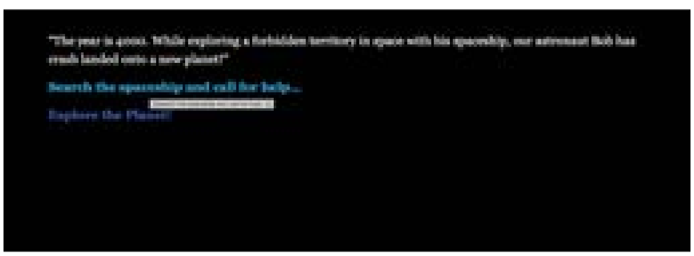


Step 6: Double click each of the newly created passages, and write what happens when the user chooses that option. Be creative! Keep creating new passages/choices for the user to go through the story, until it reaches the end.



Step 7: To test the story, click the **Play** button in the bottom right-hand corner of the Twine window. If the story doesn't work through the passages properly the first time, that's OK! It can be fixed by troubleshooting, a type of problem-solving where we do tests to identify issues.

1. Are your [[brackets]] typed correctly, with opening and closing double brackets?
2. Does the choice text inside the [[brackets]] match the connecting passage's name?
3. Is the capitalization consistent between the choice text and passage names?



Conclusion

The foundation of building a story with Twine is connecting passages or scenes through choices. Students can now create full interactive stories, troubleshoot potential problems that come up, and export the story to its own .html file.

Resources

- Twine documentation **twinery.org/wiki/twine2:guide**
- TwineThreads X account **x.com/twinethreads**
- Emily Short — An interactive narrative designer's blog **emshort.blog/**
- Elizabeth LePensée — An Anishinaabe and Métis scholar and game designer **elizabethlapensee.com/about**

LESSON 3

Debugging Scratch

Author: Emily Coombes &
Caitie Blumsom

Level: Grade 3 to 4

Curriculum Links

This module aligns with provincial and territorial language arts and computer science curricula, providing an opportunity for students to share and create stories.

Ontario (Grades 4 to 6)

Science:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields

Language:

A1. Transferable Skills

demonstrate an understanding of how the seven transferable skills (critical thinking and problem-solving; innovation, creativity, and entrepreneurship; self-directed learning; collaboration; communication; global citizenship and sustainability; and digital literacy) are used in various language and literacy contexts

B2. Language Foundations for Reading and Writing

demonstrate an understanding of foundational language knowledge and skills, and apply this understanding when reading and writing

Students take on the role of "detectives" to find and fix mistakes in code created in Scratch. There might be a mistake (a "bug") in their instructions that makes the software do something unexpected or not work at all. Debugging is the process of finding and fixing these bugs.

Learning Goals

- Learners are able to execute code in investigations and when modelling concepts, with a focus on testing, debugging, and refining programs
- Learners can identify and describe the impacts of coding and of emerging technologies on everyday life

Vocabulary/Definitions

- **Bug:** A mistake in instructions or code
- **Code:** Instructions a computer program uses to perform tasks
- **Software:** A general term for a program that operates on computer hardware
- **Troubleshoot:** A testing process to identify implementation problems
- **Debugging:** The process of finding and fixing bugs

Guiding Questions

1. What is coding?
2. What is the role of a programmer?
3. What is debugging?

Materials

- Teacher's computer and projector (or Smartboard)
- Class set of laptops/chargers
- Mice

Computer Activity

Step 1: Have students log into their devices and go to the **Scratch website (scratch.mit.edu)**.

Step 2: Search "debugging" to arrive at the debugging page **(scratch.mit.edu/search/projects?q=debugging)**.

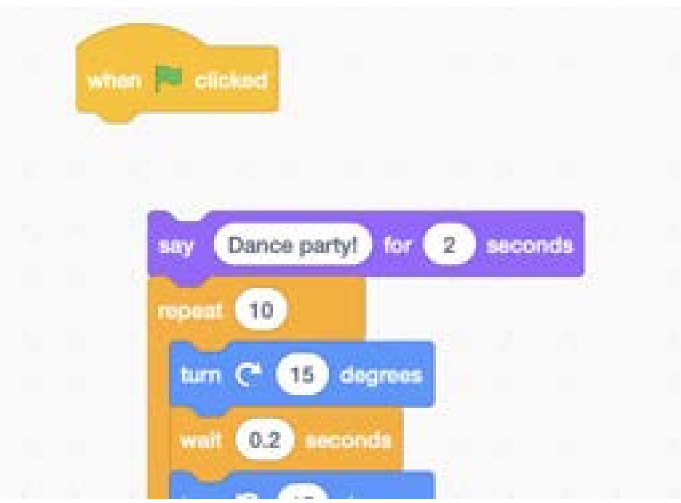
Step 3: Lead learners through debugging the following ScratchEdTeam codes:

1. **Debug-It 1.1** https://scratch.mit.edu/projects/10437040/
2. **Debug-It 1.2** https://scratch.mit.edu/projects/10437249/
3. **Debug-It 1.3** https://scratch.mit.edu/projects/10437366/
4. **Debug-It 1.4** https://scratch.mit.edu/projects/10437439/
5. **Debug-It 1.5** https://scratch.mit.edu/projects/10437476/

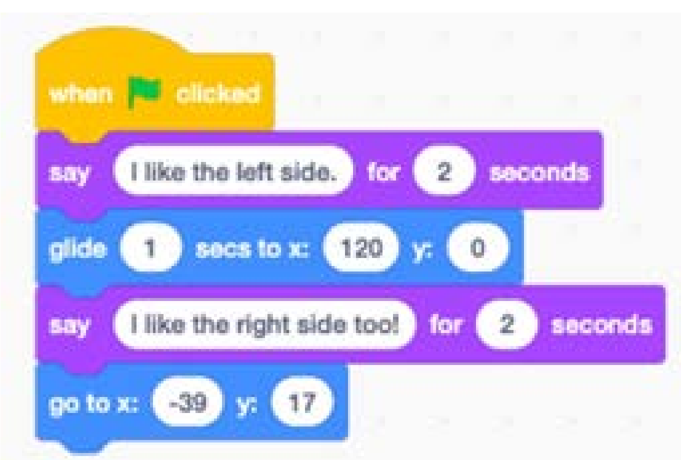
For each project, have learners begin by identifying the bug in the code. Allow 3 to 5 minutes (depending on the level of difficulty) to find a solution.

Step 4: Guide the class through correcting the code. This example will Debug the code 1.1.

1. To fix Gobo, the Sprite that is not moving, add the **when clicked** sprite.



2. Change the location of Scratch Cat so it returns to the left side of Giga. Add a **go to** block and enter coordinates. The location in the image is simply where the Cat started originally, however so long as the coordinates are to the left of Giga, the code will be debugged.

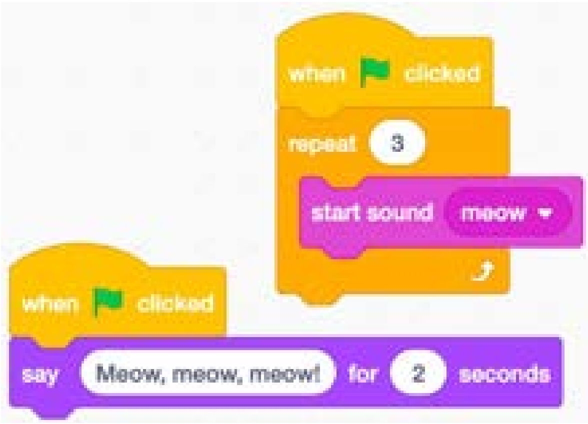


3. Scratch Cat is flipping too fast to see. Add a **wait__ seconds** block after the **turn __ degrees** block and enter a value that is less than 1. Add a **repeat block** and enter the value of 4 to condense the code.

4. Scratch Cat should pace back and forth normally, but when it returns from the right side, it appears upside down. To fix this, add a **set rotation style left-right** block from the **Motion** section.

5. Scratch Cat should say "Meow!" three times. Move the **start sound** and **say Meow** blocks into the **repeat** block.

OR



Conclusion

If time allows, wrap up the session with a group discussion. Ask learners:

- Which code was the easiest to debug? Which was the hardest?
- Why is debugging an important skill for coders to have?

Resources

- Scratch
  scratch.mit.edu

LESSON 4

Explainability

Author: Nia Emmanuel-Briggs

Level: Grade 6 to 8

Curriculum Links

This module aligns with provincial and territorial language arts and computer science curricula.

Science:

A1. STEM Investigation and Communication Skills

use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

A2. Coding and Emerging Technologies

use coding in investigations and to model concepts, and assess the impact of coding and of emerging technologies on everyday life and in STEM-related fields

Language:

A1. Transferable Skills

demonstrate an understanding of how the seven transferable skills (critical thinking and problem-solving; innovation, creativity, and entrepreneurship; self-directed learning; collaboration; communication; global citizenship and sustainability; and digital literacy) are used in various language and literacy contexts

B2. Language Foundations for Reading and Writing

demonstrate an understanding of foundational language knowledge and skills, and apply this understanding when reading and writing

In this project, students discover an easy way to figure out how an image checker works, by creating a tool using Scratch that will show which parts of a picture a smart computer recognizes. An image checker is a program that can cross reference or pull information from a photograph. (For this lesson, students should already be familiar with the basics of Scratch.)

Image checkers are used in a variety of ways. Here are some examples:

Social media platforms: Image checkers are used to flag and remove inappropriate or offensive content to ensure a safe and positive user experience.

Law enforcement and security: Image checkers are used to analyze and compare images of individuals or objects for identification, surveillance, and investigation purposes. This helps to find offenders, or find cars that have been stolen.

Healthcare and medical imaging: Image checkers are used to assist in the analysis and interpretation of medical images, such as X-rays, MRIs, and CT scans, to aid in diagnosis and treatment planning.

Brand protection: Image checkers are employed to monitor and identify the unauthorized use of copyrighted or trademarked images and logos to combat intellectual property infringement and counterfeiting.

Aviation and aerospace: Image checkers are used to inspect and analyze images of aircraft parts and components for quality control, maintenance, and safety compliance.

Learning Goals

- Provide learners with the opportunity to execute code in investigations and when modeling concepts
- Identify and describe some of the impacts of coding and of emerging technologies on everyday life

Vocabulary

- **Bug:** A mistake in instructions or code
- **Code:** Instructions that a computer program uses to perform tasks
- **Troubleshoot:** A testing process that helps identify problems
- **Debugging:** The process of finding and fixing bugs

Guiding Questions

- What skills do you think are needed to use for this lesson?
- What problem-solving skills might be needed in this project?
- Where else can image checkers be found?

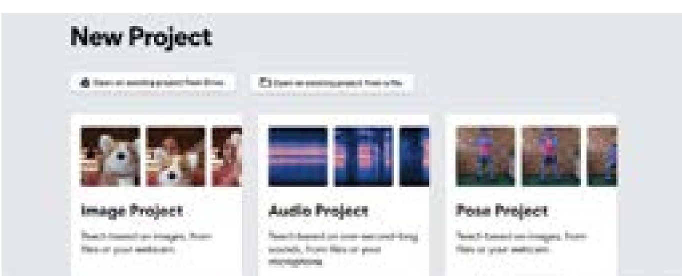
Materials

- Scratch (**scratch.mit.edu**)
- Class set of laptops/chargers
- Mice

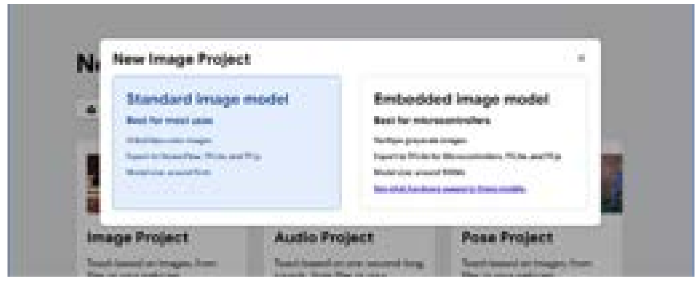
Computer Activity

1. Choose four small objects to train the computer to recognize.

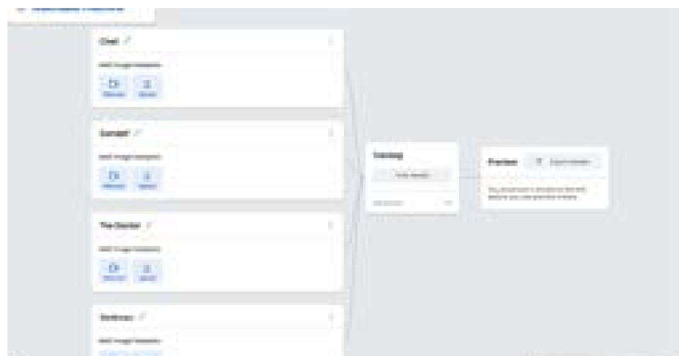
2. Go to **teachablemachine.withgoogle.com**. Click **Get Started**, then click **Image Project**



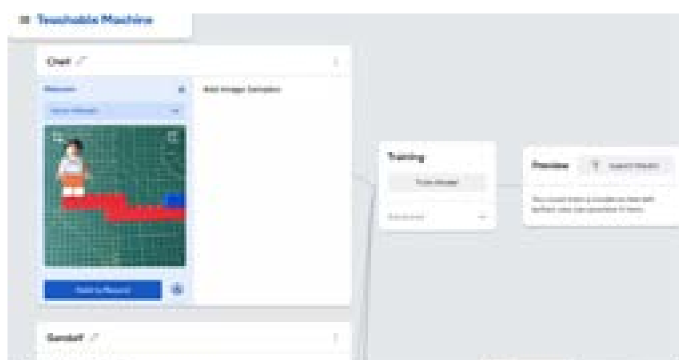
3. Click on **Standard image model**, then click the **Add a class** button twice, for a total of four classes to work with.



4. Click on the **pencil icon** beside each class heading and name the class according to the four objects selected in Step 1.

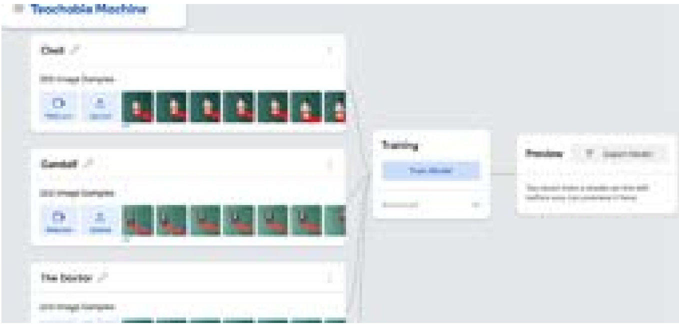


5. Use the webcam button to take photos of each object. Make sure that all the photos have the same background.

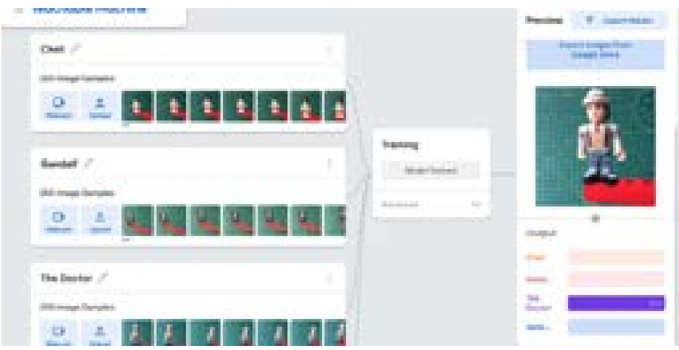


6. Take 250 photos of each object in different positions and angles. This will take some time, but the more photos the software analyzes, the more accurate the output will be.

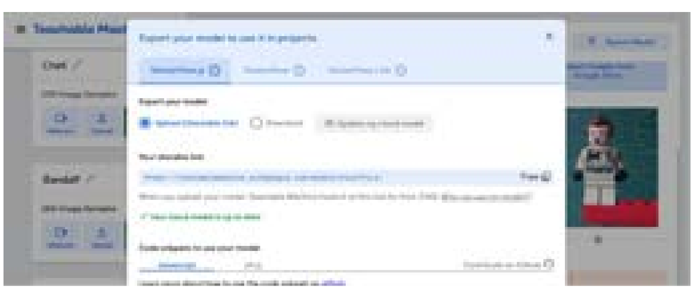
7. When all the photos have been taken, click on **Train Model**.



8. In the preview, check to see if the model is identifying the object correctly. Do this by taking and uploading a new picture of the object and see if it is correctly identified. If the object is repeatedly misidentified, or if the confidence level is consistently below 70%, take more photos of the object and train the model again. Once the model is working well, click **Export Model** beside the preview tab.



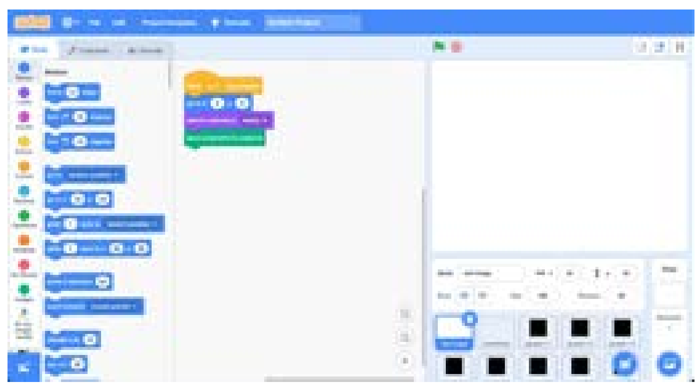
9. Click **Upload my model** when the pop-up window appears. Copy the shareable link.

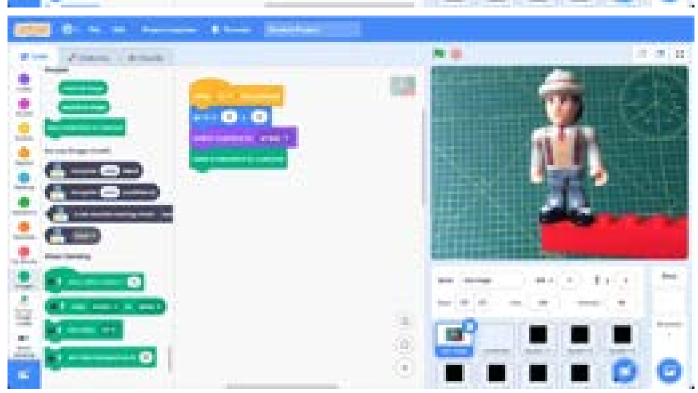


10. Go to **https://machinelearningforkids.co.uk/pretrained**. Scroll to the bottom of the page and click **Open a TensorFlow Model**. Under **Where is the TensorFlow model**?, paste the link copied in step 9.

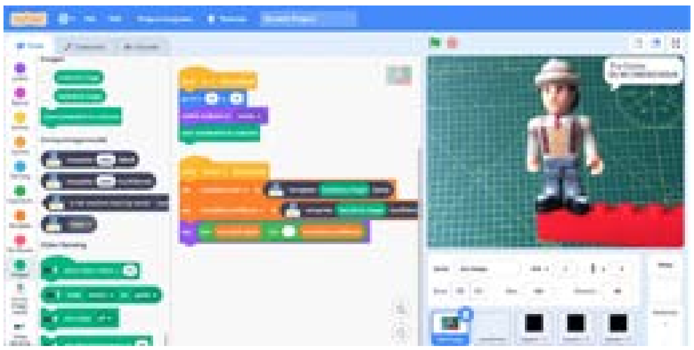
11. Click **Open Scratch, then** click the **Project Templates** button. Find the **Explainability** project template.

12. Once the template is open, click on the **Test Image** sprite and click the **green flag** button. Against the same background used for the training photos, use the webcam to take a picture by pressing the **W** key. To take a new photo, press **W** again.





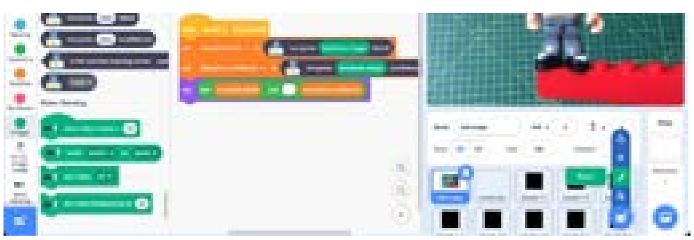
13. Create the script pictured below, then press the spacebar. Make a note of the confidence score that shows up on the screen, as it will be needed later.

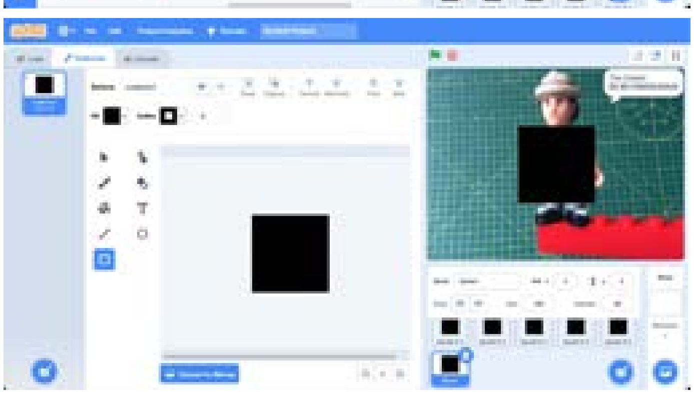


Great job! So far, we have trained a machine learning model to recognize images of objects. Now we are going to figure out which parts of the image were the most important for the model's prediction for recognizing an image, and which were irrelevant.

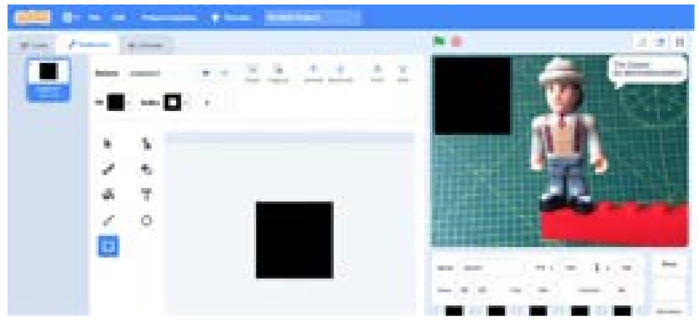
Part 2

14. Create a new sprite by clicking the **Paint** option and drawing a solid coloured square. Use a colour that is uncommon on the four objects. (In the example below, black was chosen because none of the toy characters is black.)





15. Drag the square to a position that is as far away as possible from the object on the stage and press the spacebar. *Compare the new confidence level to the level noted in step 13. They should be similar because the area that is covered is not significant for making a prediction.*

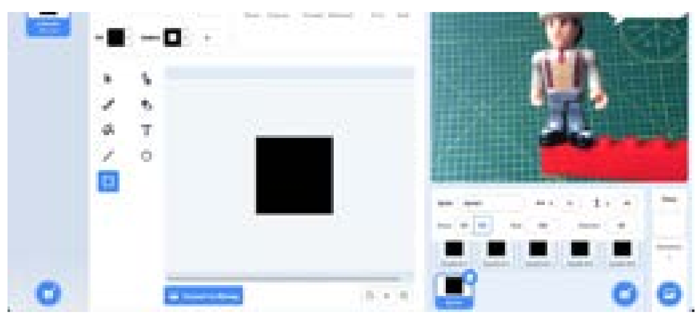


16. Now, move the square to cover a section of the object. *Compare the new confidence score to the one from step 13. This new confidence score should be significantly lower, and the model might even misidentify the object.*

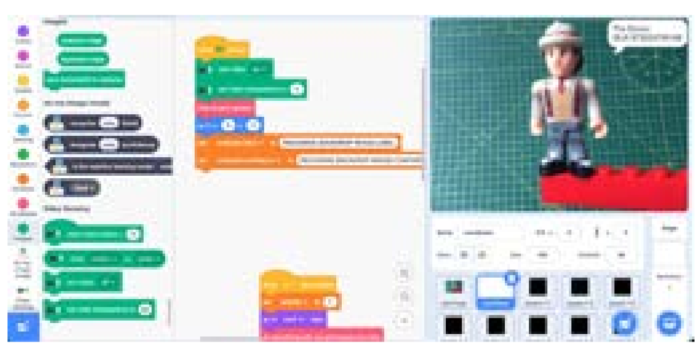
Part 3

As a more organized way to use this technique, create code to place the square in every possible location and see the difference it makes.

17. First, hide the black square sprite.

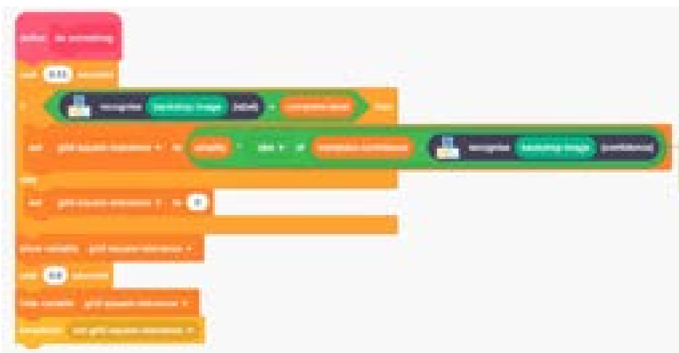


18. Click on the coordinator sprite, and locate the code with the green flag.

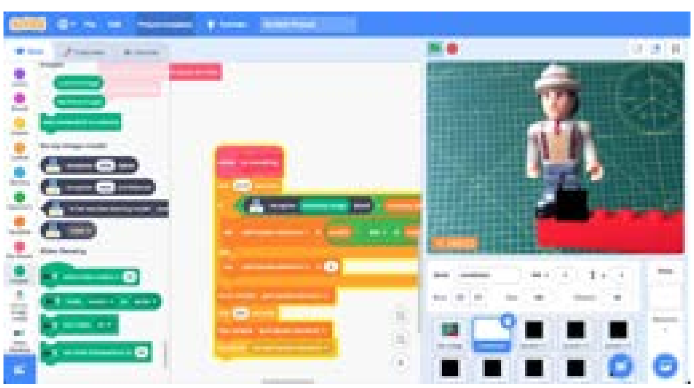


Update the code to look like this:

19. Find the **Do Something** block, then update the code to look like this:

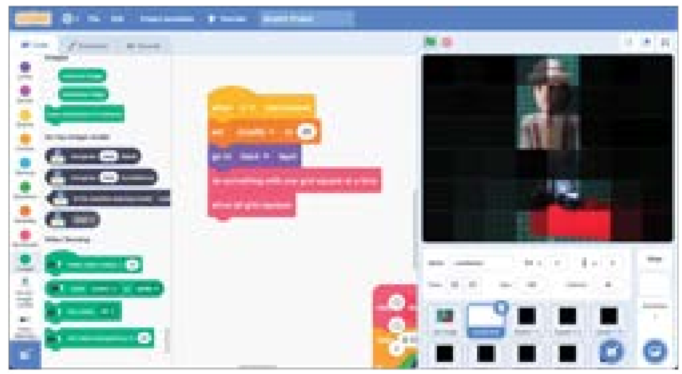


20. Click on the **green flag** and press **Z** on the keyboard. This will place the square in every possible location on the stage and will the difference in the confidence score each time.



21. Now let's do a little tweaking! Find the code where the amplify variable is. T*his controls how much of a difference that the confidence score has when the squares are covered.* We have to find the right amplify value. To do this, change the number in code and run the code again by clicking on the green flag, and then pressing **Z** on the keyboard.

22. If the result shows minimal or no transparent sections, increase the amplify value. If there are too many transparent sections, decrease the amplify value. The right visualization should be a mix of transparent and opaque sections, like this:



This simple picture shows how important different parts of the image are for the computer's guess. The parts that don't matter much to the computer's decision are black, while the important parts are transparent. This picture helps identify the parts of the image that the computer paid attention to. If a section is covered a lot, it means it doesn't matter much for the guess.

Conclusion

- How could using image checkers in Scratch software could be helpful in the future?
- What other types of projects could benefit from using image checkers in Scratch software?
- How does using image checkers in Scratch software enhances creativity and problem-solving skills?

Resources

- Scratch
  scratch.mit.edu

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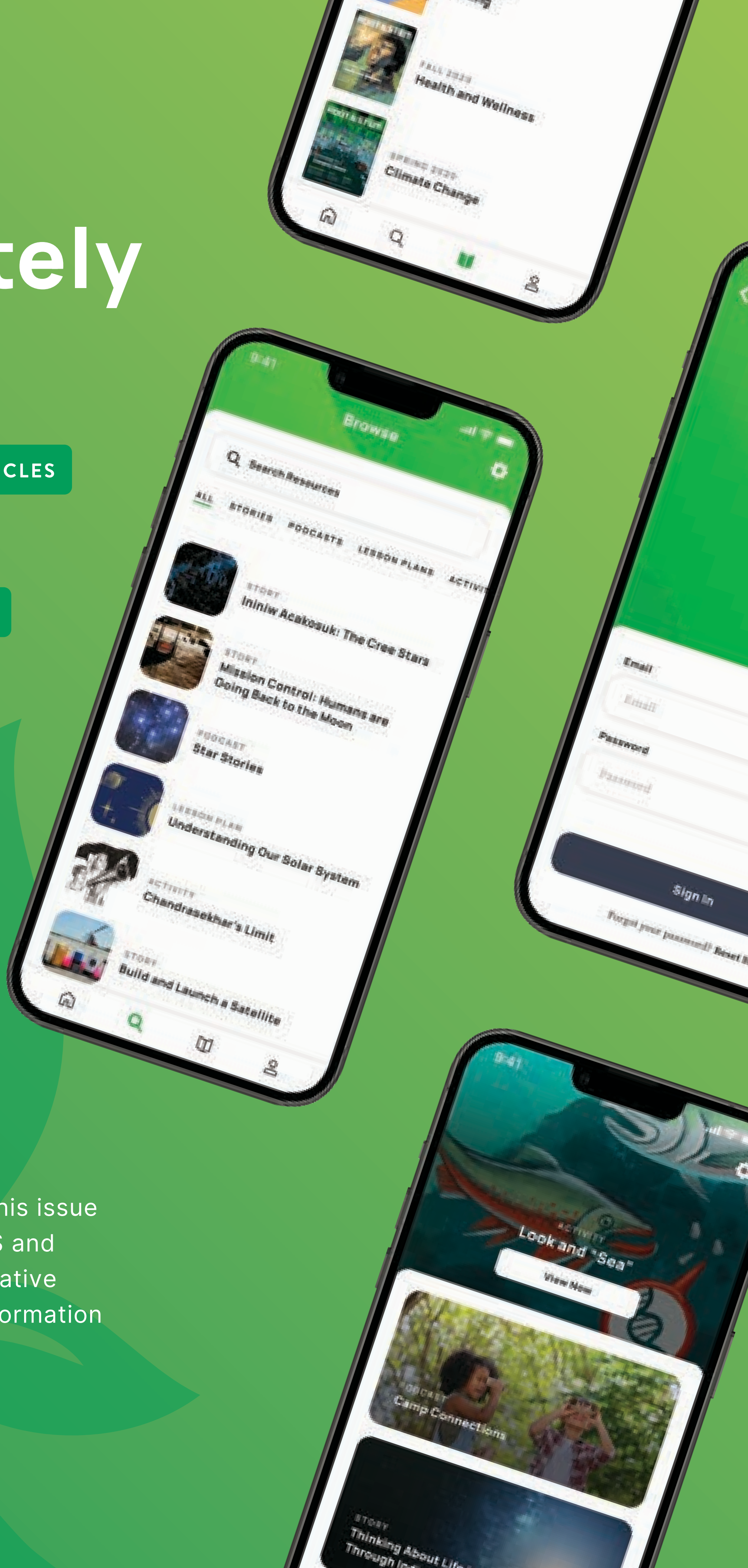

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