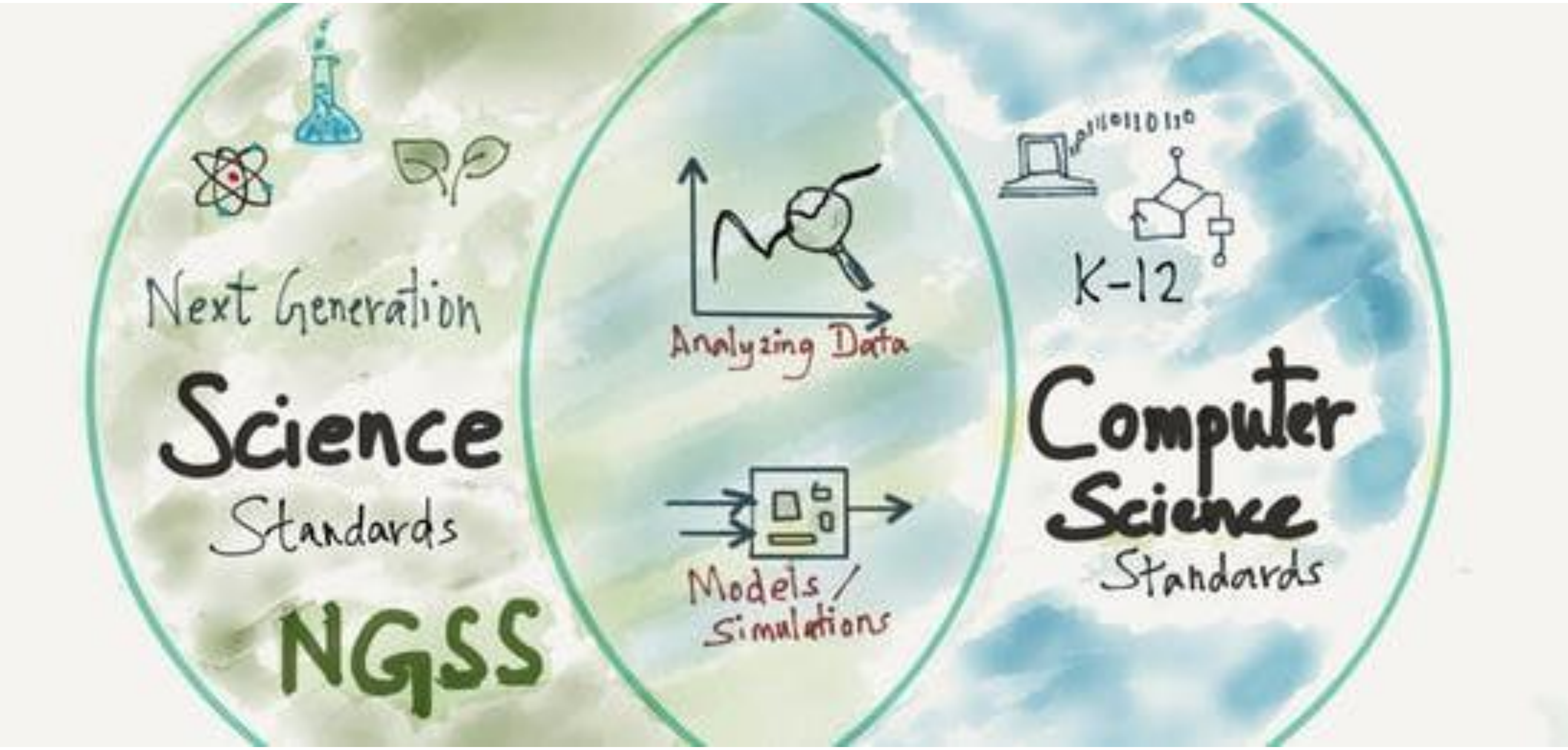
Microsoft

An Interdisciplinary Approach for Bringing AI into Existing Curriculum

Karon Weber & Ankur Anand

November 8, 2019

“STEM is a Smoothie…



“Interdisciplinary instruction encourages connections among disciplines to help learners construct stronger schema. Linking science and reading, writing, social studies, and mathematics through common themes or topics creates the potential for more effective learning.”
(Nuthall 1999)

you need all four vitamins

Dr. Ainissa Ramirez

Illustration credit: Sheena Vaidyanathan
Source: [EdSurge] and https://www.nsta.org/publications/news/story.aspx?id=53302

Hacking STEM Program

Interdisciplinary & inquiry-based STEM learning experiences aligned to the NGSS, ISTE and Common Core Math standards with an emphasis on **design and computational thinking**

Phenomena

The Hook

Phenomena should drive units and keep students working to "figure out" rather than "learning about."

NGSS standard guidelines

Science

Telling stories and scientific method

“The goal of science is to reach toward the one most elegant and efficient explanation”

Engineering

Prototyping

“…while the goal of engineering is to negotiate trade-offs to arrive at one of the many possible solutions”

Data

Collecting and Analyzing

Collection & Analysis
Math & Statistics
Visualization & Communication

Design, Make, Play *Growing the Next Generation of STEM Innovators* | Margaret Honey & David Kanter

Working Hypothesis

Mastery of core skills lead students to **care** which leads to **care-ers**

A framework for inquiry-based learning

Be curious

Ask good questions

Develop frustration resistance

Exercise patient problem solving

Work in a real-world context

Craft conceptual armatures

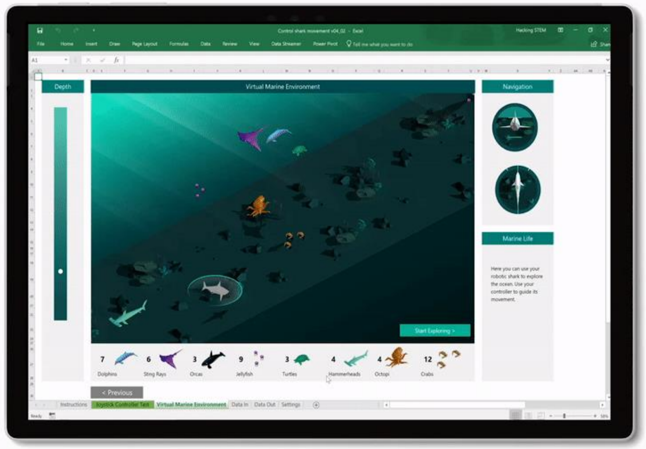
Articulate what you think is truth

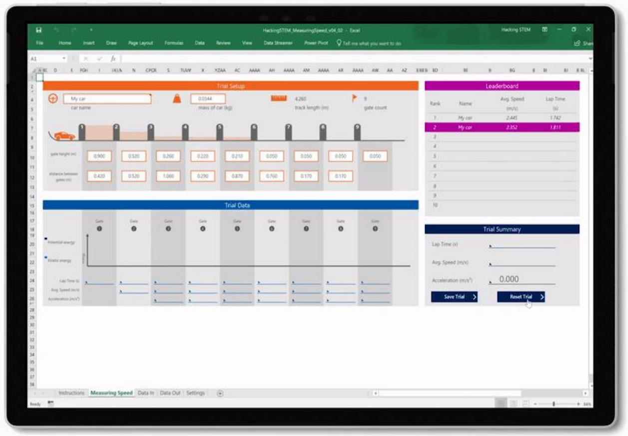
Relate your understanding to something else

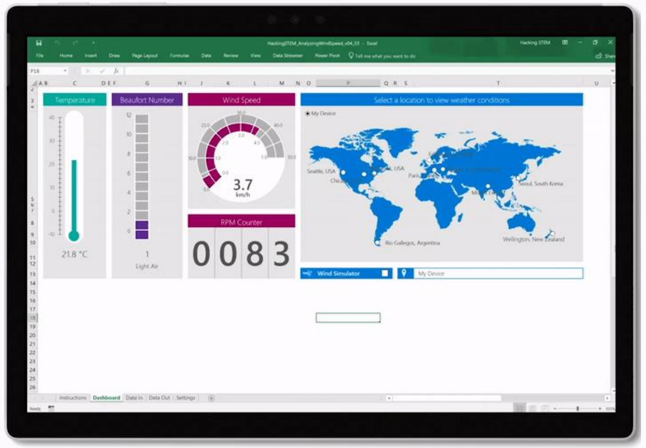
Focused on data collection and analysis experiences

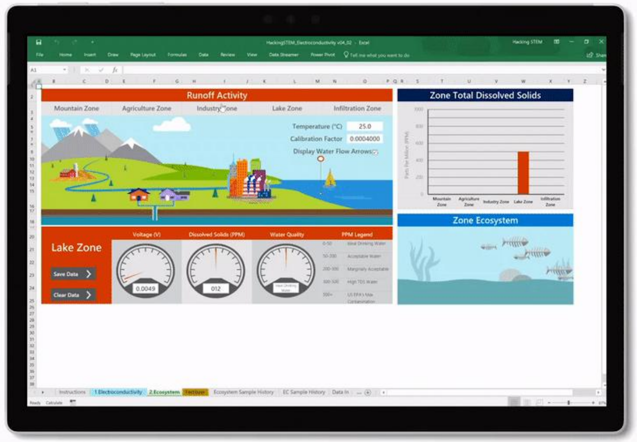
Hacked Excel to stream **real-time data**

Tailored worksheets stream data from serial port of microcontrollers. Code is in service of inquiry.





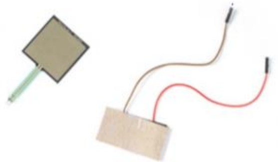




Unboxed how sensors work and connected Excel to existing classroom data tools

Designed low-cost **sensor library** for students to make their own or use commercial offerings

Example of build your own sensors



Flex/Pressure Sensor

A pressure sensor can be used to measure flexion and extension or applied force.

Electromagnetic Sensor

An electromagnetic sensor can be used to generate an electrical current induced by a magnetic field.

Electrical Conductivity Sensor

An electrical conductivity sensor can be used to detect the flow of charge within a liquid.

Electrical Switch

An electrical switch is used to turn ON and OFF the flow of electricity in a circuit.

Example Data Streamer Partners

Vernier sphero PLAY IMPOSSIBLE databot™

Partnered with Educators to hack curriculum

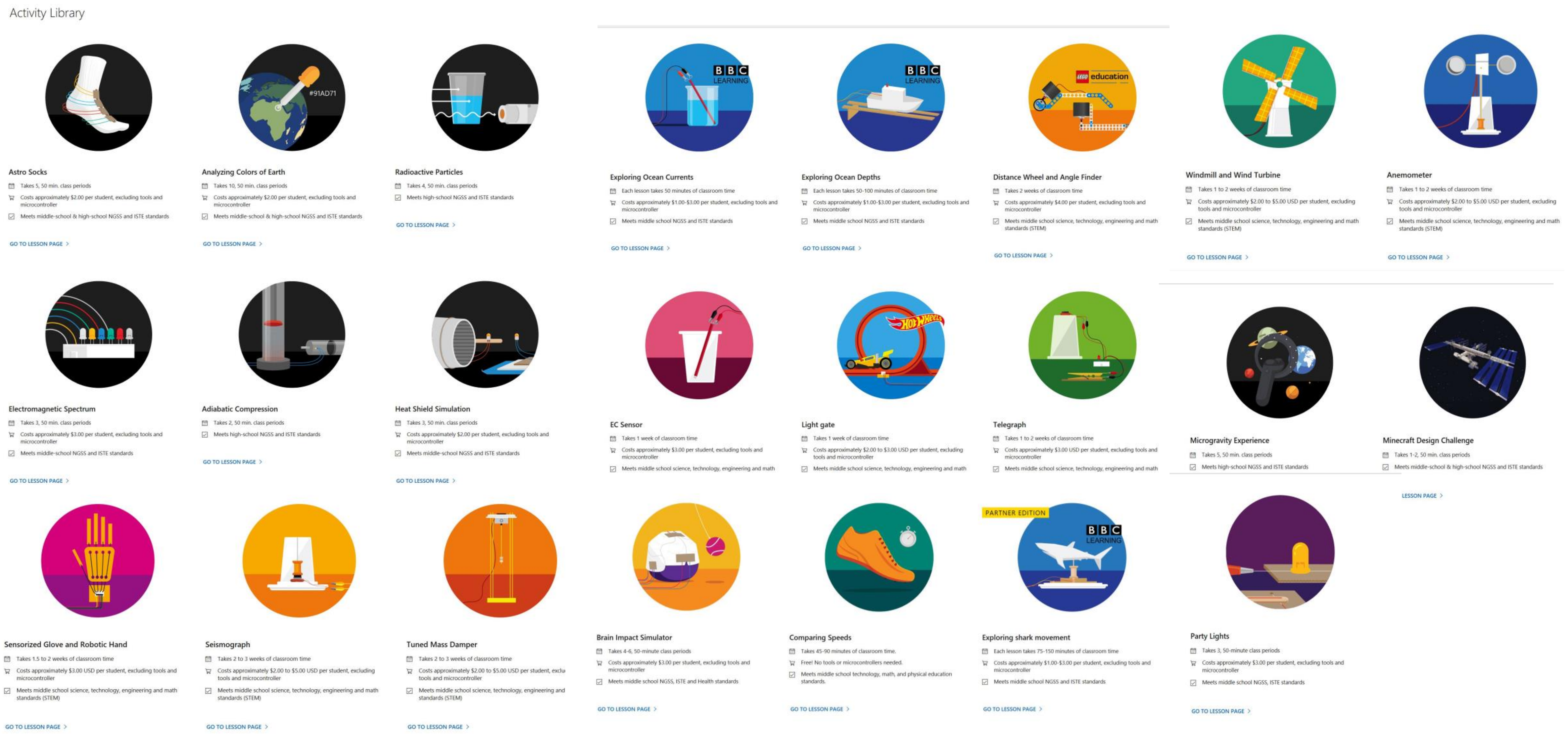
Developed content, activities and PD to support adoption

Build competence and confidence by learning to work by asking big questions

Model future job skills in context of real-world problem solving

Hands-on experiences to support design and engineering thinking

Website: aka.ms/HackingSTEM



Example Hacking STEM Lesson Plan

Building machines that emulate humans

Real-time data and hands-on engineering tucked into existing middle school curriculum

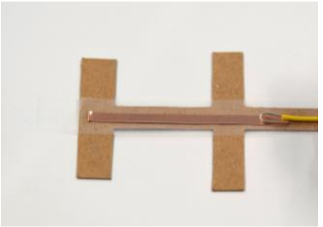
Use everyday materials to remove economic barriers

Scaffold from analog to digital

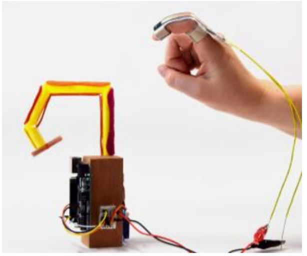
Skill development encourages “do it twice” methodology”

Learn about the anatomy of the human hand.

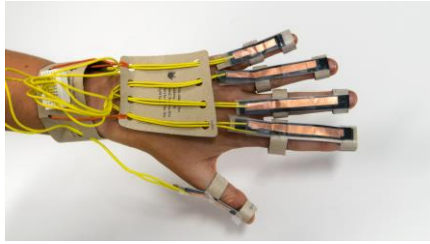
Construct a model finger from a milkshake straw and a string.



Build a flex sensor from inexpensive materials like cardboard and copper tape.

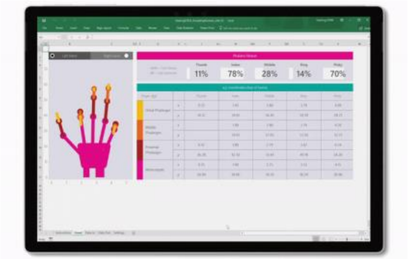


Connect the sensor to a microcontroller to control the movement of the model finger



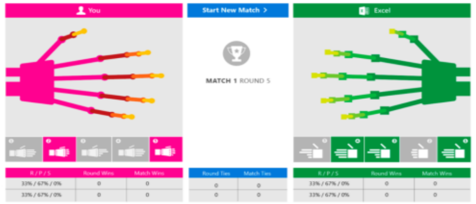
Construct five sensors and connect them to build a sensorized glove

Construct five model fingers and connect them to servos to build a robotic hand.



Measure and visualize flexion and extension data in Excel.

Use the design loop to improve the design of the robotic hand or build a prosthetic hand



Learn about statistics and probability by playing RPS vs. Excel

Interdisciplinary alignment

Building machines that emulate humans

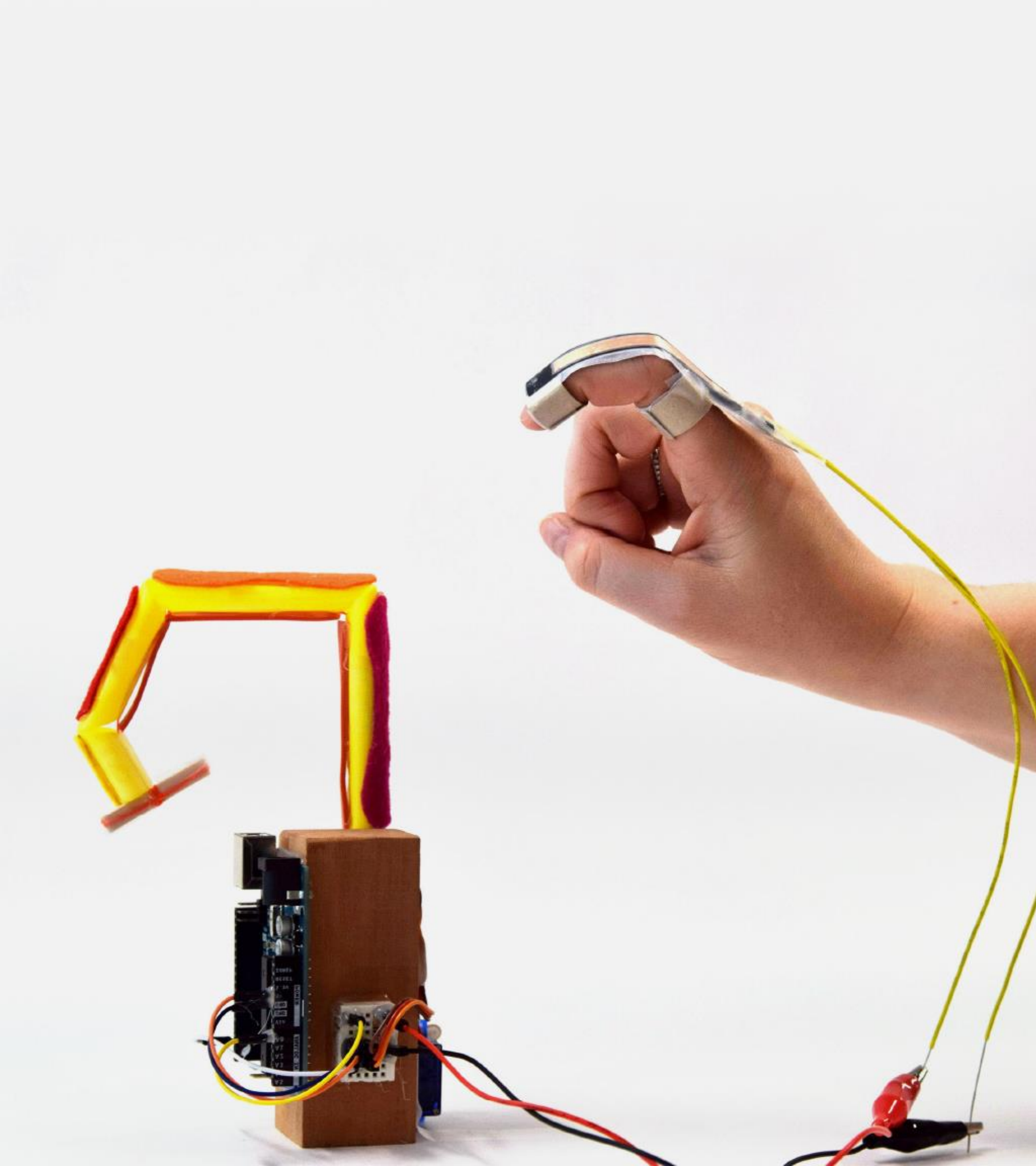
SCIENCE
- Anatomy
- Using Models
- Structure & Function

ENGINEERING
- Biomechanics
- Robotics
- Sensor design
- Testing & Modification

TECHNOLOGY
- Sensors & IoT
- Code in service of inquiry
- Microcontroller-based projects

MATH
- Real-time Data
- Scale & Proportion
- Statistics
- Probability

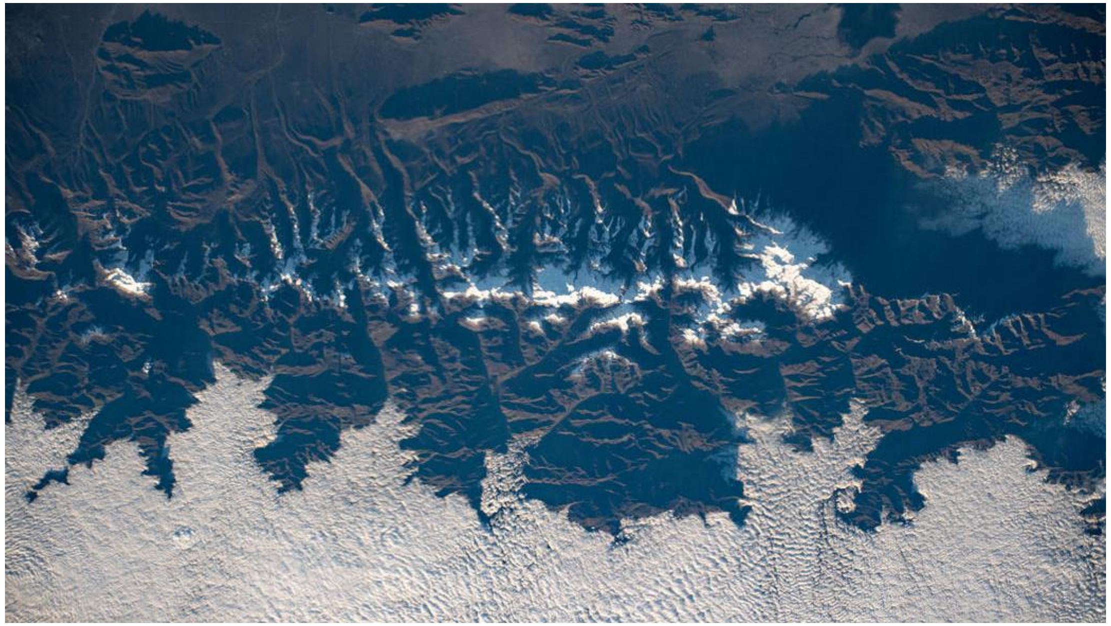
APPLIED ARTS*
- Sketching
- Industrial Design
- Pattern Making



First Hacking STEM Lesson Plan to Explore Using AI

Analyzing the Astronauts’ photos to predict climate change

developed in partnership with the NASA STEM On Station team



Microsoft Hacking STEM

Introduces the **7 biomes** and their seasons using temperature and precipitation data.

Learn the **hexadecimal numbering system** to develop an understanding of how computers represent color.

Work with photographs taken from the ISS and satellites to **model seasonal color changes** in a biome.

Engage with **machine learning and artificial intelligence modules** to detect the season in the image.

Compare **how humans verses computers see color** before they manually predict climate change over time.

Commit to **taking social, political, environmental, or economic action** in their own communities to protect our planet.

Delivered as three interdisciplinary lesson plans to fit current learning pathways

Published Standards Alignment:

- Next Generation Science Standards
- National Geography Standards
- Common Core State Standards: Mathematics
- K-12 Computer Science Standards
- International Society for Technology in Education
- English Language Arts Standards

Academic Scaffolding

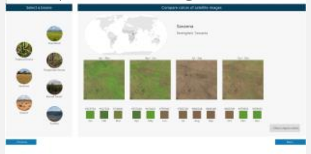
Biomes

Which factors influence the color of biomes?

Work with Biome model for location and data patterns

Learn to make a chart with seasonal biome data

Learn to analyze and interpret data signatures



Visualize the same data based on seasonal color averages

Data as Color

How are computers used to describe color data?

Read the study and visit NASA.gov

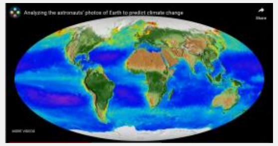
Introduction to Color Data With Crayons

Teaching hexadecimal math to explain how computers describe color

Color By Hex

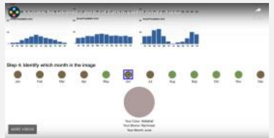
Climate Change

How can changes in Earth's colors be used to predict climate change and inspire action?



Watch NASA time lapse of climate change

Use knowledge of biome data signatures and seasonal color to inform model



Compare how student's prediction compares with computer's answer

Go do something about climate change locally

Biomes Standards Alignment

Next Generation Science Standards

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

LS2.A: Interdependent Relationships in Ecosystems
•Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
•In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
•Growth of organisms and population increases are limited by access to resources.

International Society for Technology in Education
5b: Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

National Geography Standards

Geography Standard 8: **The characteristics and spatial distribution of ecosystems and biomes on Earth's Surface**
The geographically informed person must understand that Earth's surface is home to multiple biophysical communities. All elements of the environment, including the human, are part of many different but nested ecosystems that comprise different biomes. Ecosystems and biomes, defined by specific plant and animal communities interacting with the physical environment, are unevenly distributed on Earth's surface.

K-12 Computer Science Standards
3B-DA-05**: Use data analysis tools and techniques to identify patterns in data representing complex systems.**
For example, identify trends in a dataset representing social media interactions, movie reviews, or shopping patterns.

Color as Data Standards Alignment

K-12 Computer Science Standards

2-DA-07 **Represent data using multiple encoding schemes.**
Data representations occur at multiple levels of abstraction, from the physical storage of bits to the arrangement of information into organized formats (e.g., tables). Students should represent the same data in multiple ways. For example, students could represent the same color using binary, RGB values, hex codes (low-level representations), as well as forms understandable by people, including words, symbols, and digital displays of the color (high-level representations)

2-DA-09 **Refine computational models based on the data they have generated.**
A model may be a programmed simulation of events or a representation of how various data is related. In order to refine a model, students need to consider which data points are relevant, how data points relate to each other, and if the data is accurate. For example, students may make a prediction about how far a ball will travel based on a table of data related to the height and angle of a track. The students could then test and refine their model by comparing predicted versus actual results and considering whether other factors are relevant (e.g., size and mass of the ball). Additionally, students could refine game mechanics based on test outcomes in order to make the game more balanced or fair.

National Geography Standards

Geography Standard 1: **How to use maps an other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information**
The geographically informed person must use maps and other geographic representations, geospatial technologies, and spatial thinking to acquire, understand, and communicate information. Knowing how to identify, access, evaluate, and use appropriate geographic representations will ensure college and career readiness for students. Students will have an array of powerful problem-solving and decision-making skills for use in both their educational pursuits and their adult years.

Common Core State Standards: Mathematics

Mathematical practice 4: Model with Mathematics
Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace.

International Society for Technology in Education

5b Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

Climate Change Standards Alignment

Next Generation Science Standards

HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.

Disciplinary Core Ideas

ESS3.D: Global Climate Change: Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

National Geography Standards

Geography Standard 18: **How to apply geography to interpret the present and plan for the future**
The geographically informed person must understand that the study of geography is critical to understanding the world, now and in the future, and is not simply an exercise for its own sake. As the world becomes more complex and interconnected—as a result of globalization, improvements in transportation and communication technologies, changes in physical systems, and increased cooperation and conflict—the need for geographic knowledge, skills, and perspectives increases among the world's people. While Standard 17 focuses on the importance of geography to understanding the events of the past, Standard 18 emphasizes the value and power of geography in comprehending current events and planning for the future in geographically-appropriate and sustainable ways.

English Language Arts Standards

Text Type and Purposes
1.Write arguments to support claims with clear reasons and relevant evidence.

1. Introduce claim(s), acknowledge and address alternate or opposing claims, and organize the reasons and evidence logically.
2. Support claim(s) or counterarguments with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
3. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence.
4. Establish and maintain a formal style. e. Provide a concluding statement or section that follows from and supports the argument presented.

Research to build and present knowledge

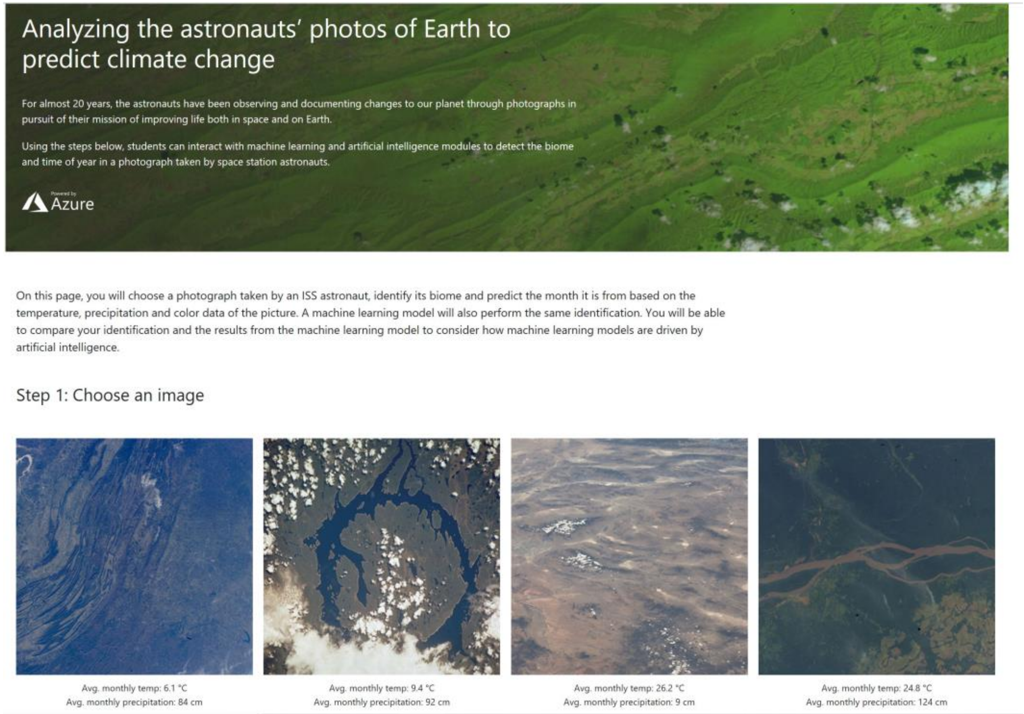
Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.

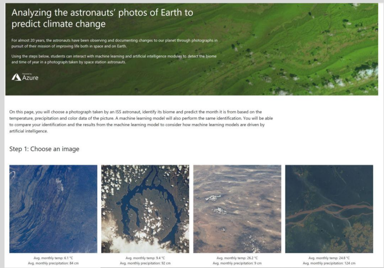
Where AI and machine learning show up in the lesson plan

Single web page experience

Students work with fixed set of data

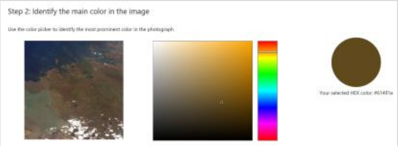
Black box hides complexity of tools, but prevents students from understanding what is really happening





Choose image of earth taken from space

+



Choose the color you think is the most dominant in the image

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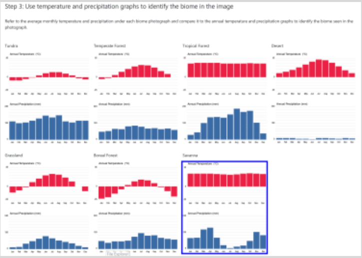

Choose the biome data signature that you think matches the photo

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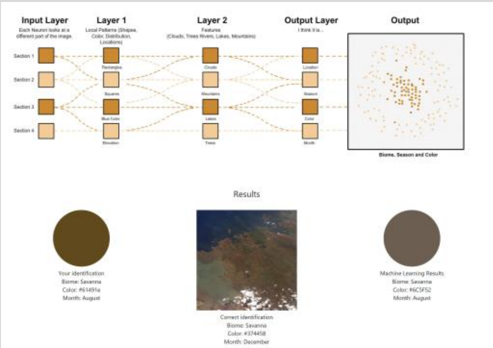
Select the season and month

Run the model and see how your choices of color, biome data signature and season/month compare with the computer's analysis



Extending the color lesson to align to the 5 Big Ideas

1. Perception

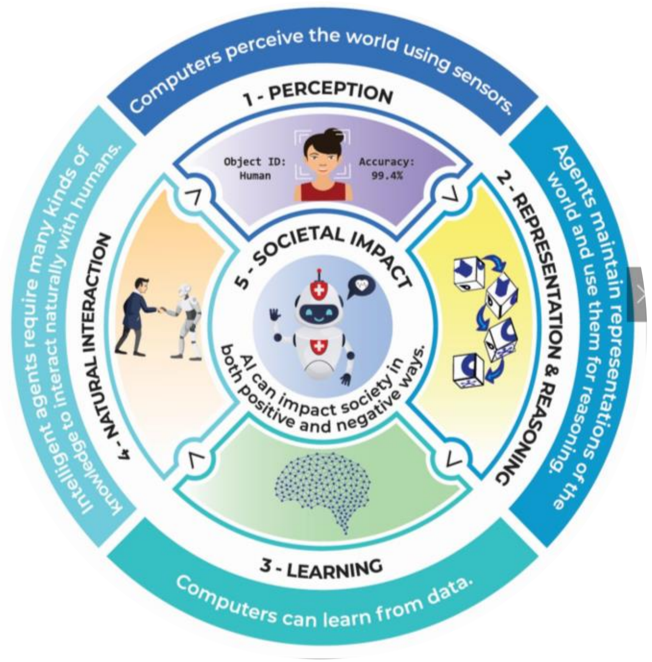
- **Human senses vs. computer sensors**
- Going from sensing to perception
- Types of perception: vision.
- How perception works: algorithms
- Limitations of computer perception
- Intelligent vs. non-intelligent machines

2. Representation & Reasoning

- **Types of representations**
- Types of reasoning algorithms
- Representation supports reasoning: algorithms operate on representations
- Families of algorithms and the work they do
- Limitations of common reasoning algorithms

3. What is learning?

- Approaches to machine learning
- Types of learning algorithms
- Fundamentals of neural networks
- Types of neural network architecture
- How training data influences learning
- Limitations of machine learning



4. Natural Interaction

- Natural language understanding
- Affective computing
- Common sense reasoning
- Consciousness and philosophy of mind
- Natural interaction applications
- Human-robot interaction
- Limitations of AI for natural interaction

5. Social Impact

- AI technologies are changing business, healthcare, education, and government
- Use of AI is an economic driver that makes new services possible and businesses more efficient
- Humans make numerous technical and ethical decisions when developing AI applications
- **AI technologies impact communities and people in different ways**
- Ethical standards are needed for AI systems that make decisions about people
- AI and robotics will change the way people work, create new jobs, and eliminate some jobs

Extending the color lesson to include the 5 Big Ideas

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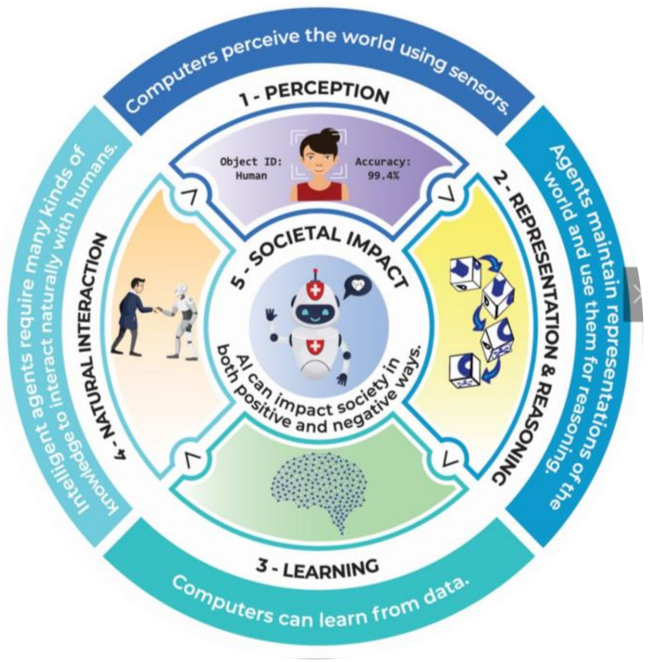

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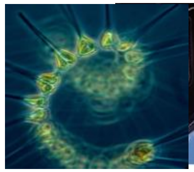
Opportunity to move from the Black Box to Glass Box

Augment existing lesson to include explanations and demonstrations that build mental models of what is happening behind the scenes.

Data as Color



Read the study and visit NASA.gov

Introduction to Color Data With Crayons

Teaching hexadecimal math to explain how computers describe color

Adding the 5 Big Ideas

1. Perception
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- Types of perception: vision
- How perception works: algorithms

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- Types of representations
- Types of reasoning algorithms
- Representation supports reasoning: algorithms operate on representations

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Example Concepts to Unpack

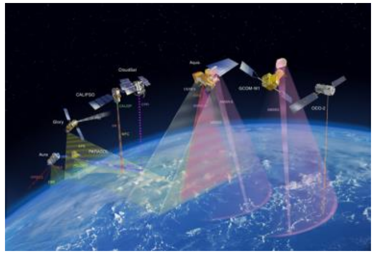
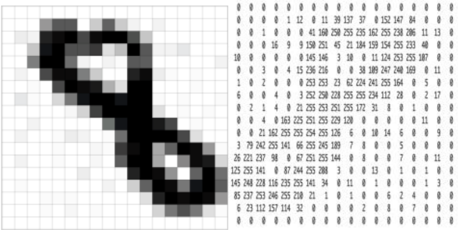
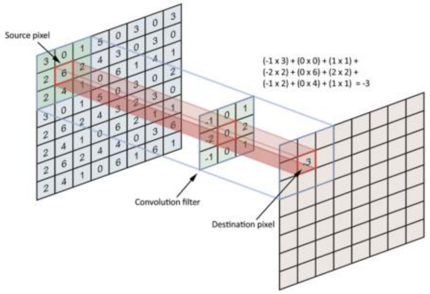


Image sensors and acquisition



Color to Value Conversion



Convolutional Neural Networks

Learnings

Need to add unboxing of AI and Machine Learning concepts to our existing color lesson plan.

Hacking STEM portfolio is ripe to hack and include AI and Machine Learning concept extensions.

Big technical learning curve for educators. Lesson plan consumer and creator pathways require significant professional develop to build confidence and competence.

Need for student and educator facing tool suite which supports learning progression and technical skill acquisition.

Need to figure out how we are going to share the 9 available credits to prepare our students with modern employability skills

THE WASHINGTON STATE BOARD OF EDUCATION

Subject	Number of Credits	Additional Information
English	4	
Math	3	Algebra 1 or Integrated Math 1 Geometry or Integrated Math 2 A 3rd credit of math*
Science	3	At least two lab A 3rd credit of science*
Social Studies	3	U.S. History and Government Contemporary World History, Geography, and Problems .5 credits of Civics .5 credits of Social Studies Elective
Arts	2	Performing or visual arts 1 credit may be a Personalized Pathway Requirements**
World Language	2	Both credits may be a Personalized Pathway Requirements**
Health and Fitness	2	.5 credits of Health 1.5 credits of Fitness Students must earn credit for physical education unless excused per RCW 28A.230.050
Career and Technical Education	1	May be an Occupational Education course that meets the definition of an exploratory course as described in the CTE program standards
Electives	4	

HIGH SCHOOL GRADUATION REQUIREMENTS Class 2020

Knowledge Academics

LIBERAL ARTS

- Literature
- History
- Social Studies
- Science
- Math
- Languages

15 credits

\+

Applied Skills

PRACTICAL ARTS

- Career Education
- Physical Education
- Technical Education
- Fine Arts
- Performing Arts
- **Engineering**
- **Computer Science**
- **Robotics**
- **Artificial Intelligence**
- **Machine Learning**
- **Data Science**
- **Data Collection,**
- **Analysis & Visualization**
- **3D, AR & VR**
- **Internet of Things**

9 credits