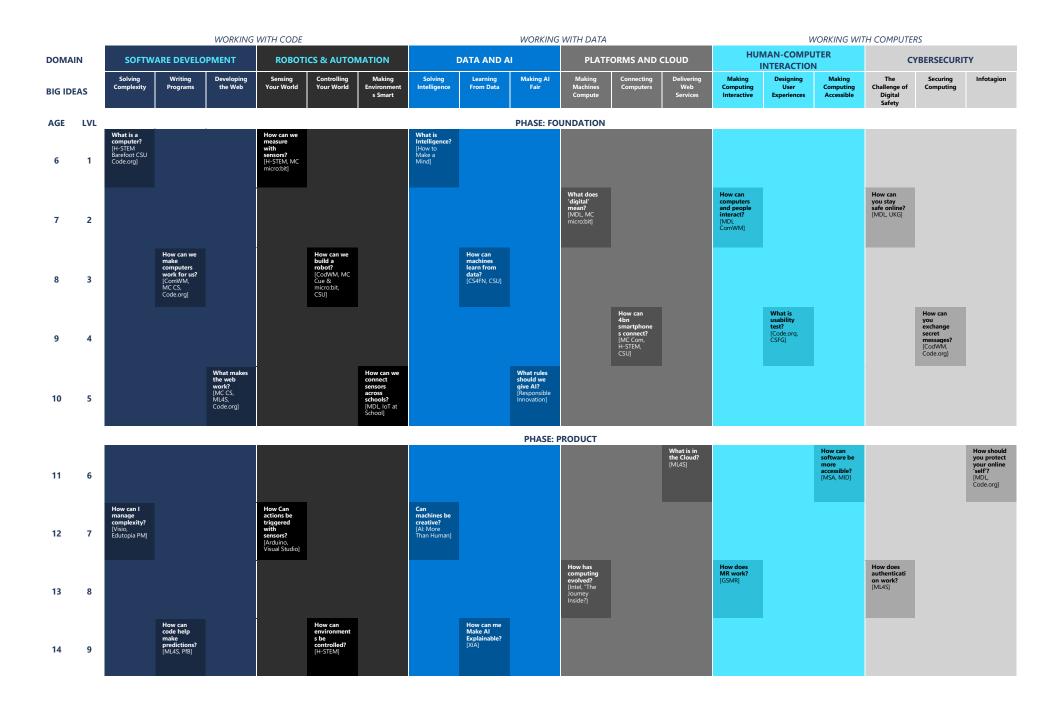# Microsoft Computer Science

Curriculum Toolkit

CURRICULUM CONTENT OBJECTIVES

This section describes the content of the curriculum framework itself, and explains the subjects covered in each of the Big Ideas, as well as the Big Questions that each Big Idea contains. To begin, the following figures depict the overview, and then give a chronological view through MCSF. Finally, there is a detailed explanation of the six Domains, each of which contain three learning pathways – the Big Ideas – and the Big Questions contained within them.

DOMAIN	SOFTWARE DEVELOPMENT			ROBOTICS & AUTOMATION			DATA AND AI			PLATFORMS AND CLOUD			HUMAN-COMPUTER INTERACTION			CYBERSECURITY		
BIG IDEAS	Solving Complexity	Writing Programs	Developing the Web	Sensing Your World	Controlling Your World	Making Environments Smart	Solving Intelligence	Learning From Data	Making AI Fair	Making Machines Compute	Connecting Computers	Delivering Web Services	Making Computing Interactive	Designing User Experiences	Making Computing Accessible	The Challenge of Digital Safety	Securing Computing	Infotagion

AGE **LVL**

PHASE: FOUNDATION

AGE	LVL	
6	1	**What is a computer?** [H-STEM Barefoot CSU Code.org] — **How can we measure with sensors?** [H-STEM, MC micro:bit] — **What is Intelligence?** [How to Make a Mind]
7	2	**What does 'digital' mean?** [MDL, MC micro:bit] — **How can computers and people interact?** [MDL ComWM] — **How can you stay safe online?** [MDL, UKG]
8	3	**How can we make computers work for us?** [ComWM, MC CS, Code.org] — **How can we build a robot?** [CodWM, MC Cue & micro:bit, CSU] — **How can machines learn from data?** [CS4FN, CSU]
9	4	**How can 4bn smartphones connect?** [MC Com, H-STEM, CSU] — **What is usability test?** [Code.org, CSFG] — **How can you exchange secret messages?** [CodWM, Code.org]
10	5	**What makes the web work?** [MC CS, ML4S, Code.org] — **How can we connect sensors across schools?** [MDL, IoT at School] — **What rules should we give AI?** [Responsible Innovation]

PHASE: PRODUCT

AGE	LVL	
11	6	**What is in the Cloud?** [ML4S] — **How can software be more accessible?** [MSA, MID] — **How should you protect your online 'self'?** [MDL, Code.org]
12	7	**How can I manage complexity?** [Visio, Edutopia PM] — **How Can actions be triggered with sensors?** [Arduino, Visual Studio] — **Can machines be creative?** [AI: More Than Human]
13	8	**How has computing evolved?** [Intel, "The Journey Inside?"] — **How does MR work?** [GSMR] — **How does authentication work?** [ML4S]
14	9	**How can code help make predictions?** [ML4S, PfB] — **How can environments be controlled?** [H-STEM] — **How can me Make AI Explainable?** [XIA]

PHASE: PROJECT (IMAGINE CUP JUNIOR)

15 / 10

LAB (10HR): How can we use code to predict a pandemic? [ML4S, Power BI] *3. Good Health and Well-Being*

LAB (10HR): How can admin tasks be automated? [ML4S] *8. Decent Work and Economic Growth*

LAB (10HR): How can bots alert farmers to weather conditions? [ICJ, ML4S, H-STEM] *13. Zero Hunger*

LAB (10HR): How can we build a LAN in a disaster zone? [ML4S, FCN, QS AVN] *3. Good Health and Well-Being*

LAB (10HR): How should you design interfaces for safety critical systems? [NASA] *3. Good Health and Well-Being*

LAB (10HR): How can data be secured? [Code.org] *9. Industry, Innovation and Infrastructure*

16 / 11

SPRINT (10HR): Build Software to monitor air quality [ICJ, ML4S, AEF] *13. Climate Action*

SPRINT (10HR): Make online spaces safe for girls and women [ICJ, AEF] *5. Achieve gender equality and empower all women and girls*

SPRINT (10HR): Diagnose a medical problem with Machine Learning [ICJ] *3. Good Health and Well-Being*

SPRINT (10HR): Build a web service that helps protect endangered species [ICJ, ML4S] *15. Life on Land*

SPRINT (10HR): Build a mobile app for users to identify endangered species [ML4S] *15. Life on Land*

SPRINT (10HR): Build an Agriculture 4.0 solution based on IoT [SDG] *2. Zero Hunger*

PHASE: BUSINESS (IMAGINE CUP)

17 / 12

LAB (6:40HR): How can we build circular economies? [GitHub Student Developer Pack] *12. Responsible consumption and production*

LAB (6:40HR): How can code reduce hospital waiting lists? [ML4S, CS4FN] *3. Good Health and Well-Being*

LAB (6:40HR): How can an app help provide clean water and sanitation? [w3schools, Azure] *9. Industry, Innovation and Infrastructure*

LAB (6:40HR): How can vehicles control themselves? [RCL, AiAD] *6. Clean Water and Sanitation*

LAB (6:40HR): Can robots unlock the secrets of the oceans? [AIRL, ItR] *14. Life Below Water*

LAB (6:40HR): Can cities be smart? [MCN, AIoT, AIoTDK] *11. Sustainable Cities and Communities*

LAB (6:40HR): What is the Master Algorithm? [DLvML] *8. Decent Work and Economic Growth*

LAB (6:40HR): How can ML be used to classify Earth images? [ML4S, H-STEM] *13. Climate Action*

LAB (6:40HR): Where has AI been fair and unfair? [RAI, RML] *16. Peace, Justice and Strong Institutions*

LAB (6:40HR): How small and fast can computers sustainably go? [IQ (pro)] *13. Climate Action*

LAB (6:40HR): How can the Internet of Clean Energy work? [ML4S, IDL, Ker, NNR] *7. Affordable Clean Energy*

LAB (6:40HR): How can an Open API be used to reduce poverty? [ML4S] *1. No Poverty*

LAB (6:40HR): Can haptics help surgeons and dentists? [ML4S, MTRS] *3. Good Health and Well-Being*

LAB (6:40HR): Can we stop mobile phones ruling our lives? [AEF 3, Xmarin, Fluent] *9. Industry, Innovation and Infrastructure*

LAB (6:40HR): How can computing help deal with an impairment? [H_STEM, AEF, SeeingAI] *10. Reduced Inequalities*

LAB (6:40HR): Can smart contracts stop environmental damage? [ABS, BB, BW] *12. Responsible Production and Consumption*

LAB (6:40HR): How might quantum change cyber security? [QDK, SPC, PQC] *9. Industry, Innovation and Infrastructure*

LAB (6:40HR): How can we prevent online abuse, censorship and extremism? [Infotagion] *16. Peace, Justice and Strong Institutions*

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PITCH (40HR): Design and build a digital product that addresses an SDG based on Software Development and Robotics and Automation

PITCH (40HR): Design and build a digital product that addresses an SDG based on Data and AI and Platforms and Cloud

PITCH (40HR): Design and build a digital product that addresses an SDG based on HCI and Cyber-Security

CHRONOLOGICAL VIEW

FOUNDATION

LEVEL				LEVEL			
1	What is a computer?	How can we measure with sensors?	What is Intelligence?	2	What does 'digital' mean?	How can computers and people interact?	How can you stay safe online?
3	How can we make computers work for us?	How can we build a robot?	How can machines learn from data?	4	How can 4bn smartphones connect?	What is a usability test?	How can you exchange secret messages?
5	What makes the web work?	How can we connect sensors across schools?	What rules should we give AI?				

PRODUCT

LEVEL				LEVEL			
6	What in in the Cloud?	How can software be more accessible?	How should you protect your online 'self'?	7	How can I manage complexity?	How can actions be triggered with sensors?	Can machines be creative?
8	How has computing evolved?	How does MR work?	How does authentication work?	9	How can code help make predictions?	How can environments be controlled?	How can we make AI explainable?

PROJECT

LEVEL				LEVEL			
10	How can we use code to predict a pandemic?	How can admin tasks be automated?	How can bots alert farmers to weather conditions?	10	How can we build LAN in a disaster zone?	How should you design interfaces for safety-critical systems?	How can data be secured?
11	Build software to monitor air quality	Make online spaces safe for girls and women	Diagnose a medical problem with Machine Learning	11	Build a web service that helps protect an endangered species	Build a mobile app for users to identify endangered species	Build an Agriculture 4.0 solution based on IoT

BUSINESS

LEVEL				LEVEL			
12	How can we build circular economies?	How can code reduce hospital waiting lists?	How can an app help provide clean water and sanitation?	12	How can vehicles control themselves?	Can robots unlock the secrets of the ocean?	Can cities be smart?
12	What is the Master Algorithm?	How can ML be used to classify Earth images?	Where has AI been fair and unfair?	12	How small and fast can computers sustainably go?	How can the Internet of Clean Energy work?	How can an Open API be used to reduce poverty?
12	Can haptics help surgeons and dentists?	Can we stop mobile phones ruling our lives?	How can computing help deal with an impairment?	12	Can smart contracts stop environmental damage?	How might quantum change cybersecurity?	How can we prevent online abuse, censorship and extremism?
13	*Design and build a digital product that addresses an SDG based on Software Development and Robotics Automation*				*Design and build a digital product that addresses an SDG based on Data and AI and Platforms and Cloud*		*Design and build a digital product that addresses an SDG based on HCI and Cybersecurity*

KEY

SOFTWARE DEVELOPMENT	ROBOTICS & AUTOMATION	DATA AND AI	PLATFORMS AND CLOUD	HUMAN-COMPUTER INTERACTION	CYBERSECURITY

*Sprints   *Pitches

CONCEPTUAL VIEW

DOMAIN	SOFTWARE DEVELOPMENT	ROBOTICS & AUTOMATION	DATA AND AI
BIG IDEA	Solving Complexity Writing Programs Developing the Web	Sensing Your World Controlling Your World Making Environments Smart	Solving Intelligence Learning from Data Making AI Fair

DOMAIN	PLATFORMS AND CLOUD	HUMAN-COMPUTER INTERACTION	CYBERSECURITY
BIG IDEA	Making Machines Compute Connecting Computers Delivering Web Services	Making Computing Interactive Designing User Experiences Making Computing Accessible	The Challenge of Digital Safety Securing Computing Infotagion

The following sections describe the Big Ideas and the Big Questions contained within them.

Domain //

Software Development

The development of software is at the heart of the MCSF.

In today's technology-rich world, many schools have begun teaching coding, the language we use to instruct computers. It's a skill that is in high demand, and there are many examples of schools across the world teaching it in ways that are relevant and engaging for students. But just teaching coding is not enough. Students need to learn how to solve problems with software.

SOFTWARE DEVELOPMENT

This Domain uses three Big Ideas for developing and applying software development skills.

- Solving Complexity
- Writing Programs
- Developing the Web

LEVEL (K)	SOLVING COMPLEXITY	WRITING PROGRAMS	DEVELOPING THE WEB
1	What is a computer?		
2			
3		How do we make computers work for us?	
4			
5			What makes the web work?
6			
7	How can I manage complexity?		
8			
9		How can code help make predictions?	
10		How can we use code to predict a pandemic?	
12	How can we build circular economies?	How can code reduce hospital waiting lists?	How can an app help provide clean water and sanitation?

SOLVING COMPLEXITY

LEVEL (K)	SOLVING COMPLEXITY	PHASE
1	What is a computer?	Foundation
7	How can I manage complexity?	Product
12	How can we build circular economies?	Business

The Big Idea around solving complexity includes algorithmic thinking and the use of tools and methods that support and help organize the program-writing process. It is the natural conceptual and chronological starting point of the MCSF because it is a prerequisite to developing software that contains the ability to manage the complexities involved. Furthermore, one of the main reasons that computers exist is to help humans solve complex problems.

Developing software is getting ever more complex as applications become more powerful and include increasing numbers of features. So how does a computer science professional manage complexity, deal with constant change, and implement software into larger systems in a consistent, systematic way that ensures a high-quality result? One way is to employ Process Patterns.

Process Patterns can be defined as the set of activities, actions, and tasks followed in the development of software – communication, planning, modeling, development, and deployment.

The foundation of Process Patterns is to understand what a "computer" actually is in terms of its processes and how they can be programmed. Some of the learning activities here can be "unplugged," such as those teaching students about binary numbers, searching, and sorting.[i]

Further down this learning pathway, students should learn to use tools to map knowledge. For example, this could include using Microsoft Visio for planning, to create mind maps and flow charts, or to make knowledge-graphing tools for modeling. In this learning path, students will also learn about project management methodologies such as Agile and Scrum.

DOMAIN   **BIG IDEA**

SOFTWARE DEVELOPMENT // SOLVING COMPLEXITY

LEVEL 1: WHAT IS A COMPUTER? (10 HOURS)

Learning goal Understand the process of computing – input, memory, process, output – Computational Thinking, MCSF

Supplementary goals

- Have a basic understanding of the word "computer"
- Know what an algorithm is
- Know what binary is
- Build a simple circuit and switch

Concepts

- A computer operates by using electronic components, data, and algorithms.
- The core operation of computing involves electrical switches.
- The fundamental processes of computing are input, process, and output. The process phase involves the transfer of data in and out of memory.
- A computer can carry out "thinking" type activities based on instructions called algorithms and binary data.
- Digital data can be saved onto a computer's memory: voices, images (your photos), video, words, and numbers.

Challenges

- **Computational Thinking** Algorithmic thinking games
- **Data Literacy** Binary numbers, image representation unplugged games
- **Design Thinking** Build a lemon battery and switch circuit

SUPPORTING CONTENT

Microsoft content

- Hacking STEM (H-STEM 1), Lemon Battery and Switch - https://education.microsoft.com/en-us/hackingStem/lesson/8838fbb3

Supplementary content

- Barefoot Computing with Barefoot 5 to 7 yrs., resources and games – e.g., Shopping list, Story sequencing, Dance moves, Pizza party, House patterns, Building blocks, Creating patterns, Barefoot Zoo, Sorting it out, Colorful Kits - https://www.barefootcomputing.org/homelearning
- Computer Science Unplugged (CSU 11), Class simulation of a computer – https://classic.csunplugged.org/class-simulation-computer-unfinished/
- Code.org (CSD Unit 1) – Problem Solving. What is a computer? IO, processes, and storage: https://studio.code.org/s/csd1-2019
- BBC Bitesize Introduction to computational thinking - https://www.bbc.co.uk/bitesize/guides/zp92mp3/revision/2
- https://www.khanacademy.org/computing/ap-computer-science-principles/computers-101/introducing-computers/a/what-is-a-computer
- https://kids.britannica.com/kids/article/computer/352990
- https://kids.kiddle.co/Computer
- https://cacm.acm.org/blogs/blog-cacm/231993-what-children-want-to-know-about-computers/fulltext

DOMAIN   **BIG IDEA**

SOFTWARE DEVELOPMENT // SOLVING COMPLEXITY

LEVEL 7: HOW CAN I MANAGE COMPLEXITY? (10 HOURS)

Learning goal Manage complexity with diagrams, procedures, and tools and know-how to organize, version, share, and reuse code, MCSF

Supplementary goals
- Master visualization methods for supporting creative ideation
- Acquire software skills to create structured processes and plans

Concepts
- Mind Maps
- Flow-charts
- Flow-chart software with Visio

Challenges
- **Computational Thinking** Design a plan in Visio to carry out preparations for a school event or sports game with key activities/actors/dependencies and goals
- **Data Literacy** Gather and structure the necessary inputs for a plan into tables for use in process design
- **Design Thinking** Brainstorm ideas for a themed event to raise money for a local charity

SUPPORTING CONTENT

Microsoft content
- https://support.office.com/en-ie/article/beginner-tutorial-for-visio-bc1605de-d9f3-4c3a-970c-19876386047c

Supplementary content
- https://www.mindmaster.io/
- https://www.edutopia.org/article/project-management-middle-school

DOMAIN   **BIG IDEA**

SOFTWARE DEVELOPMENT // SOLVING COMPLEXITY
LEVEL 12: HOW CAN WE BUILD CIRCULAR ECONOMIES? (6:40 HOURS)
SDG – 12. RESPONSIBLE CONSUMPTION AND PRODUCTION

Learning goals

- Explain the difference between Waterfall, Agile, and Scrum, MCSF
- Collaboratively deploy and manage software artifacts on a code management platform (Git), MCSF
- Apply Business Model Canvas, MCSF

Supplementary goal

- Apply knowledge of project management paradigms to plan and manage software development

Concepts

- A Business Process Map (BPM) is a flow-chart representing the key processes, entities, and decision points of a business process
- Waterfall and Agile are the two key paradigms for management of software projects
- GitHub is a cloud platform used for the collaborative development of code
- The circular economy is an economic system aimed to design out waste and pollution and regenerate natural systems

Challenges

- **Computational Thinking** Collaboratively develop a program to calculate the waste generated in a product's lifecycle
- **Data Literacy** Analyze the cumulative energy and waste outputs of a process through time under differing assumptions
- **Design Thinking** Represent the "as-is" lifecycle of a manufactured good in a business process map and re-envision it as a circular process that minimizes waste

SUPPORTING CONTENT

Microsoft content
- GitHub Student Developer Pack https://education.github.com/pack
- Intro to Git: https://docs.microsoft.com/en-us/learn/modules/implement-code-workflow/
- Lynda 12: Visio 2019 Essential Training https://www.lynda.com/Visio-tutorials/Visio-2019-Essential-Training/743151-2.html
- Lynda 12: Agile Project Management with Microsoft Project https://www.lynda.com/Project-tutorials/Agile-Project-Management-Microsoft-Project/368055-2.html
- Lynda 12: Agile Foundations https://www.lynda.com/Project-Management-tutorials/Agile-Foundations/761929-html?srchtrk=index%3a4%0alinktypeid%3a2%0aq%3aagile%0apage%3a1%0as%3arelevance%0asa%3atrue%0aproducttypeid%3a2

WRITING PROGRAMS

LEVEL (K)	WRITING PROGRAMS	PHASE
3	How can we make computers work for us?	Foundation
9	How can code help make predictions?	Product
10	How can we use code to predict a pandemic?	Project
12	How can code reduce hospital waiting lists?	Business

This Big Idea focusses on writing software, progressing from block-based visual, to scripted, then to object-oriented programming and languages (OOP).

Building on their understanding of how a computer works acquired in "Solving Complexity," the foundation of "Writing Programs" is understanding how humans can get computers to work for us through the fundamentals of producing code.

As they progress through this Big Idea, students will cover algorithmic thinking and language concepts including syntax, assignment, control structures, variables, data types, data structures, modeling, functions, loops, statements, operators, and conditional execution.

As students progress further and their skills develop, they will be set increasingly open-ended authentic problems to solve through writing code.

DOMAIN   **BIG IDEA**

SOFTWARE DEVELOPMENT // WRITING PROGRAMS

LEVEL 3: HOW CAN WE MAKE COMPUTERS WORK FOR US? (10 HOURS)

Learning goals

- Write sequences, events, loops, and conditionals, MCSF
- Create programs that include sequences, events, loops, and conditionals, CSTA 1A-AP-10
- Use post-tested loops e.g., "until," and a sequence of selection statements in programs including an "if," "then," and "else" statement, CAS P&D 3

Supplementary goals

- Understand that humans instruct computers what to do through programming
- Understand that code is determined by design goals
- Assemble instructions as building blocks into a program

Concepts

- Essential functions of a computer: input/memory/processor/output
- Structure of a computer program with input, conditions, and output
- Hardware vs. software

Challenges

- **Computational Thinking**
  - Use code to create a moving system
  - Use multiple moving parts to create an animated feature
  - Code Variables, Sprites, Motion, Loops
- **Data Literacy** Count the arrangements, possibilities, and configurations (combinatorics) and find the largest, smallest, best (optimal) solutions
- **Design Thinking** Design a landscape, such as a maze, that your friends can "walk" through

SUPPORTING CONTENT

Microsoft content

- Computing With Minecraft (ComWM 3): Unit 3, Use loops to code more efficiently, calculate in-game actions
- Computing with Minecraft (ComWM 4): Unit 4 and 5, Use code to design a moving system
- Computing with Minecraft (ComWM 5): Unit 5, Use multiple moving parts to create an animated feature
- MakeCode CS Intro 1 – https://arcade.makecode.com/courses/csintro

Supplementary content

- Clever Computers – https://www.digitaltechnologieshub.edu.au/teachers/lesson-ideas/clever-computers
- https://kids.britannica.com/kids/article/computer/352990
- Bebras International Challenge https://www.bebras.org/

DOMAIN   **BIG IDEA**

SOFTWARE DEVELOPMENT // WRITING PROGRAMS

LEVEL 9*:* HOW CAN CODE MAKE PREDICTIONS? (10 HOURS)

Learning goals

- Develop programs that combine control structures, including nested loops and compound conditionals, CSTA 2-AP-12
- Create interactive data visualizations using software tools to help others better understand real-world phenomena, CTSA 3A-DA-11
- Use algorithms to make predictions by turning probability Concepts into code, MCSF

Supplementary goal

- Understand the difference between classification and regression

Concepts

- Mathematical methods can be converted to code and used to solve problems
- Decision trees
- Regression analysis

Challenges

- **Computational Thinking**
  - Build a decision tree to predict a categorization
  - Predict fraud from credit card data
  - Build a Monty Hall game simulation with code
  - Predict where an object may fall on the ground from a moving aircraft
- **Data Literacy** Analyze climate data with Azure Notebooks
- **Design Thinking** Design user interactions for the computational thinking challenges

SUPPORTING CONTENT

Microsoft content

- Microsoft Learn for Students (ML4S 26), Analyze climate data with Azure Notebooks https://docs.microsoft.com/en-gb/learn/modules/analyze-climate-data-with-azure-notebooks/
- Microsoft Learn for Students (ML4S 27), First-time Python – https://docs.microsoft.com/en-us/learn/modules/intro-to-python/Analyze climate data with Azure Notebooks
- Python for Beginners (PfB) – https://www.youtube.com/playlist?list=PLlrxD0HtieHhS8VzuMCfQD4uJ9yne1mE6

Supplementary content

- Coding into the Australian Maths curriculum project, Pearson

DOMAIN   **BIG IDEA**

SOFTWARE DEVELOPMENT // WRITING PROGRAMS

LEVEL 10: HOW CAN USE CODE TO PREDICT A PANDEMIC? (10 HOURS)
SDG – 3. GOOD HEALTH AND WELL-BEING

Learning goals

- Use data analysis tools and techniques to identify patterns in data representing complex systems, CSTA 3B-DA-05
- Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects, CSTA 3A-AP-17
- Access pre-existing functionality from standard libraries, MCSF

Supplementary goal Create a computational model that represents the relationships among different elements of data collected from a phenomenon or process

Concepts

- Modular programming is a software technique that separates functionality into independent units in order to promote code reusability and extensibility
- Business Intelligence software such as Power BI and Tableau allows the user to interactively create reports and visualizations from data
- A web service serves a program that processes inputs from one program into output used by another and is a building block of web applications
- An SIR model allows the user to model the progress of an epidemic over time using parameters for susceptibility, infection, and recovery

Challenges

- **Computational Thinking** Write an SIR model program in Python that could form the basis for a web service
- **Data Literacy** Create an SIR model in Excel that accepts user inputs parameters and predicts the progress of a pandemic through time
- **Design Thinking** Design and build reports in Power BI to visualize the spread of a disease under different scenarios

SUPPORTING CONTENT

Microsoft content

- Microsoft Learn for Students (ML4S) 11. Import standard library modules – https://docs.microsoft.com/en-us/learn/modules/python-standard-library/
- Microsoft Learn for Students (ML4S) 20, Use visuals in Power BI –https://docs.microsoft.com/en-gb/learn/modules/visuals-in-power-bi/
- Power BI 12 – https://docs.microsoft.com/en-us/power-bi/guided-learning/

Supplementary content

- SIR modelling in Covid-19 Demystified – https://www.learn-tech.courses/p/covid-19-demystified

DOMAIN   **BIG IDEA**

SOFTWARE DEVELOPMENT // WRITING PROGRAMS

LEVEL 12: HOW CAN CODE REDUCE HOSPITAL WAITING LISTS? (6:40 HOURS)
SDG – 3. GOOD HEALTH AND WELL-BEING

Learning goals

- Understand the power of OOP for modelling real-world phenomena, create a DRY OO program with high modularity and extensibility, MCSF
- Explain what a relational database is, and understand the benefits of storing data in multiple tables, CAS D&DR 8

Supplementary goals

- Use object-oriented programming in a modern high-level language such as C++ or Python to represent and solve real-world problems
- Demonstrate the capability to design and organize an object-oriented program for reusability, extensibility, and robustness

Concepts

- Object-Oriented Programming (OOP) is a method of organizing a program around objects rather than functions
- The key differences between OOP and traditional procedural programming are encapsulation, inheritance, and polymorphism
- A key goal of OOP design is DRY (do not repeat yourself) as this promotes the program's maintainability which ensures robustness for enterprise use
- UML (Unified Modeling Language) is used to map out how the program objects behave and relate, providing a visual blueprint for the program.

Challenges

- **Computational Thinking** Write a program to allocate patients and surgeons to surgeries based on matching schedules
- **Data Literacy** Summarize your program results by person/time/role and other dimensions, visualizing the output appropriately
- **Design Thinking** Design a program structure in terms of inputs, modules to perform operations and desired output

SUPPORTING CONTENT

Microsoft content

- Microsoft Learn for Students (ML4S 15), Python Object-Oriented Programming: https://docs.microsoft.com/en-us/learn/modules/python-object-oriented-programming
- Microsoft Learn for Students (ML4S 28), Take your first steps with C#: https://docs.microsoft.com/en-us/learn/paths/csharp-first-steps/

Supplementary content

- CS4FN programming php - http://www.cs4fn.org/fundamentals/programming.php

DEVELOPING THE WEB

LEVEL (K)	DEVELOPING THE WEB	PHASE
5	What makes the web work?	Foundation
12	How can an app help provide clean water and sanitation?	Business

Here, students will get the opportunity to learn how the apps they use on their phones work, and develop skills needed to make the World Wide Web work for them, by learning the skills necessary to build web pages, sites and services as well as developing an understanding of how the Web itself functions.

DOMAIN   **BIG IDEA**

SOFTWARE DEVELOPMENT // DEVELOPING THE WEB

LEVEL 5: WHAT MAKES THE WEB WORK? (10 HOURS)

Learning goal Construct static web pages using HTML and CSS, CAS C&N 5

Supplementary goals

- Appreciate that the World Wide Web is a decentralized web with links between sites and pages
- Understand HTML as the foundation of web pages
- Acquire the capability to create a webpage using HTML, CSS, and JavaScript

Concepts	**Challenges**
- World Wide Web - HTML, CSS, and JavaScript - Hyperlinks	**Computational Thinking** Build a navigable web page with information and pictures about your neighborhood (hyperlink between sections) **Data Literacy** Map desired web page features to HTML tags **Design Thinking** Design a web page to share what you love about your neighborhood

SUPPORTING CONTENT

Microsoft content

- Microsoft Learn for Students (ML4S 16), Build a simple website using HTML, CSS, and JavaScript: https://docs.microsoft.com/en-gb/learn/modules/build-simple-website/
- "MakeCode Computer Science Intro 3, User input, JavaScript, Namespaces, functions, Info and Button Press Events, Array Manipulation: https://arcade.makecode.com/courses/csintro3

Supplementary content

- Code.org (CSD Unit 2), Web Development. HTML, CSS, build a personal portfolio website – https://studio.code.org/s/csd2-2019
- https://websitesetup.org/
- https://techdifferences.com/difference-between-html-and-css.html
- https://www.youtube.com/watch?v=PlxWf493en4
- https://www.w3schools.com/html/default.asp
- http://www.webyurt.com/popular-types-of-websites
- https://kids.britannica.com/students/article/World-Wide-Web-WWW/571030
- https://webfoundation.org/about/vision/history-of-the-web/
- https://kids.britannica.com/kids/article/Internet/353293
- http://www.kidscodeprojects.com/HTML/html.html

DOMAIN   **BIG IDEA**

SOFTWARE DEVELOPMENT // DEVELOPING THE WEB

LEVEL 12: HOW CAN AN APP HELP PROVIDE CLEAN WATER AND SANITATION? (6:40 HOURS)
SDG – 6. CLEAN WATER AND SANITATION

Learning goal Apply JavaScript to create responsive, interactive webpages – Computational Thinking, MCSF

Supplementary goals

- Use a server-side scripting language to read from and write to the database from the application
- Program SQL queries to read from and write to a database

Concepts

- A modern web application consists of three tiers: 1. Web Tier, 2. Application Tier, and 3. Storage Tier
- JavaScript (web tier) allows the programming of complex, interactive features on a website
- A server-side scripting language such as ASP.net, node.js or Python (application tier) allows the web tier to interact with the database and fetch or put data
- An RDBMS (storage tier) is a relational database that persists application data in a structured, relational form accessible by SQL (Structured Query Language)

Challenges

- **Computational Thinking** Write a web application to input, store and display water quality information
- **Data Literacy** Organize data into a relational model for update and querying
- **Design Thinking** Design a web application, diagramming its architecture and functionality

SUPPORTING CONTENT

Microsoft content

- Create a Web App: https://azure.microsoft.com/en-us/get-started/web-app/

Supplementary content

- w3schools SQL: https://www.w3schools.com/sql/
- https://www.khanacademy.org/computing/computer-programming/sql
- https://www.khanacademy.org/computing/computer-programming/programming
- https://www.w3schools.com/js/default.asp
- https://www.w3schools.com/nodejs/default.asp

Domain //

Robotics and Automation

The world of robotics is where CS, applied sciences, engineering, and mathematics come together to offer a rich space for learning. While there are many school programs focusing on physical robotics, there is very little concentrating on the automation of cognitive tasks. Yet cognitive task automation through Robotic Process Automation (RPA) is a major and growing[ii] disruptive force across the world of work.

ROBOTICS AND AUTOMATION

The goal of this Domain is to develop both the physical robotic and RPA skills by using three key Big Ideas:

- Sensing Your World
- Controlling Your World
- Making Environments Smart

LEVEL (K)	SENSING YOUR WORLD	CONTROLLING YOUR WORLD	MAKING ENVIRONMENTS SMART
1	How can we measure with sensors?		
2			
3		How can we build a robot?	
4			
5			How can we connect sensors across schools?
6			
7	How can actions be triggered with sensors?		
8			
9		How can environments be controlled?	
10		How can admin tasks be automated?	
12	How can vehicles control themselves?	Can robots unlock the secrets of the ocean?	Can cities be smart?

SENSING YOUR WORLD

LEVEL (K)	SENSING YOUR WORLD	PHASE
1	How can we measure with sensors?	Foundation
7	How can actions be triggered with sensors?	Product
12	How can vehicles control themselves?	Business

Understanding robotics and automation is predicated on understanding how data can be gathered from sensors and then processed.

At the start of this learning path is understanding how probes can be used to gather data, and how that data can then be visualized. Further along this journey students will learn how autonomous vehicles use sensors extensively and will be introduced to the concept of artificial intelligence. As learners progress the focus broadens to sensing a wide range of physical phenomenon including gases – laying the foundations for the "Making Environments Smart" Big Idea.

DOMAIN	BIG IDEA

ROBOTICS & AUTOMATION // SENSING YOUR WORLD

LEVEL 1: HOW CAN WE MEASURE WITH SENSORS? (10 HOURS)

Learning goals

- Explain that computers collect data from various input devices, including sensors and application software, CAS H&P 3
- Collect, visualize, and explain patterns in data, MCSF
- Recognize that data can be structured in tables to make it useful, CAS D&DR 1

Supplementary goals

- Understand that sensors display values
- Learn how to plug a probe into a computer; measure a physical phenomenon; read, watch, and make sense of the numbers changing
- Predict how numbers will change when sensed conditions change
- Appreciate that data is generated from sensors, and can be visualized
- Know that temperature, light, and sound can be "measured"

Concepts

- Sensors help us understand and control our world
- Sensors use electronics and computers to gather data
- Data from sensors gives us useful information and insights
- Conductivity and the flow electricity in a current

Challenges

- **Computational Thinking**
  - Set up a basic sensing experiment, e.g., using a temperature probe
  - Make a fruit keyboard using micro:bit
  - Use sensors in a Little Bits circuit to trigger an action with a sensor
- **Data Literacy** Appreciate the basics of time series, for example, the change of temperature over time visualized in a spreadsheet
- **Design Thinking** Produce and compare bar charts and line graphs

SUPPORTING CONTENT

Microsoft content

- MakeCode micro:bit – https://makecode.microbit.org/projects/banana-keyboard
- Simplified version of Hacking STEM (H-STEM 7), How are ocean currents formed? – https://education.microsoft.com/en-us/hackingStem/lesson/1fe8a218
- Introducing Data-Streamer – https://support.office.com/en-us/article/data-streamer-c90aebcf-3d44-47ab-a068-549a0b9edfc6

Supplementary content

- Makey Makey lesson 1 to 8 – https://makeymakey.com/pages/how-to
- Getting Started with Little Bits – https://classroom.littlebits.com/kits/educator-quick-start-guide
- Primary Science Curriculum Activities with Sensors, Cambridge University – http://oer.educ.cam.ac.uk/wiki/Primary_Science_Curriculum_Activities_with_Sensors
- Sensors and Graphs in Primary Schools, University of Amsterdam – https://www.iederkindeentalent.nl/wp-content/uploads/2012/06/sciencesensors1.pdf

DOMAIN   **BIG IDEA**

ROBOTICS & AUTOMATION // SENSING YOUR WORLD

LEVEL 7: HOW CAN ACTIONS BE TRIGGERED WITH SENSORS? (10 HOURS)

Learning goals

- Use C code functions, variables, and structures in a control solution, MCSF
- Apply practical experience of a high-level textual language, CAS P&D 5
- Process Serial Data in a control solution, MCSF

Supplementary goals

- Develop and use Arduino skills
- Learn how an ultrasonic sensor works and how to use one in a robot

Concepts

- Sensors help us understand and control our world
- Sensors use electronics and computers to gather data
- Data from sensors gives us useful information and insights
- Conductivity and the flow of electricity in a current

Challenges

- **Computational Thinking** Build a floorbot
- **Data Literacy** Analyze, use, and manipulate serial data from the ultrasonic sensor to trigger motor actions
- **Design Thinking** Design the floorbot and its functions

SUPPORTING CONTENT

Microsoft content

- Obstacle-Avoiding Robot Using Arduino with Ultrasonic Sensor Develop Arduino programs with Microsoft Visual Studio – https://create.arduino.cc/projecthub/chandankumarcmsn/obstacle-avoiding-robot-using-arduino-with-ultrasonic-sensor-af66f1

DOMAIN   **BIG IDEA**

ROBOTICS & AUTOMATION // SENSING YOUR WORLD

LEVEL 1: HOW CAN VEHICLES CONTROL THEMSELVES? (6:40 HOURS)
SDG – 9. INDUSTRY, INNOVATION, AND INFRASTRUCTURE

Learning goals

- Describe how artificial intelligence drives many software and physical systems, CSTA 3B-AP-08
- Integrate different types of sensors in an autonomous system, MCSF

Supplementary goals

- Apply a range of mechatronic skills to solve robotics problems
- Understand that robots comprise mechanical, sensory, and control systems
- Know how robots can be used to automate physical processes in the real world

Concepts

- An autonomous vehicle is one that can operate itself without any human intervention, through the ability to sense its surroundings
- We grade autonomy with five levels from 1: "Driver Assistance" up to 5: "Full Automation"
- AI is central to the control function of autonomous vehicles

Challenges

- **Computational Thinking** Program an embedded computer in a model autonomous vehicle
- **Data Literacy** Analyze data from a model autonomous vehicle
- **Design Thinking** Build high-level blueprints for an autonomous vehicle control system

SUPPORTING CONTENT

Microsoft content

- Robot Challenge Lab: https://aischool.microsoft.com/en-us/autonomous-systems/learning-paths/robot-challenge-lab
- Azure in Autonomous Driving: https://autonomous-driving.org/wp-content/uploads/2018/10/Microsoft_Azure-in-Autonomous-Driving.pdf

CONTROLLING YOUR WORLD

LEVEL (K)	CONTROLLING YOUR WORLD	PHASE
3	How can we build a robot?	Foundation
9	How can environments be controlled?	Product
10	How can admin tasks be automated?	Project
12	Can robots unlock the secrets of the oceans?	Business

Understanding robotics and automation is predicated on understanding how data can be gathered from sensors and then processed.

At the start of this learning path is understanding how probes can be used to gather data, and how that data can then be visualized. Further along this journey students will learn how autonomous vehicles use sensors extensively and will be introduced to the concept of artificial intelligence. As learners progress the focus broadens to sensing a wide range of physical phenomenon including gases – laying the foundations for the "Making Environments Smart" Big Idea.

DOMAIN   **BIG IDEA**

ROBOTICS & AUTOMATION // CONTROLLING YOUR WORLD

LEVEL 3: HOW CAN WE BUILD A ROBOT? (10 HOURS)

Learning goals

- Program robots, MCSF
- Identify your position and calculate the position of a landmark or object relative to your position in the real-world, MCSF

Supplementary goals

- Understand block programming
- Understand how robots use data and algorithms to control movement and execute tasks
- Understand that robots comprise mechanical, sensory, and control systems
- Know how robots can be used to automate physical processes in the real world

Concepts

- Robots are coded
- Changes in data can be used to trigger events
- Robots can be used to automate tasks that humans may otherwise have done

Challenges

- **Computational Thinking**
  - Use a games environment to control events with code
  - Use block-based programming to control a robot
- **Data Literacy**
  - Use Cartesian coordinates with a robot
  - Analyze media reports about the impacts of robots on humanity, trends, and predictions
- **Design Thinking** Design and build a robot toy

SUPPORTING CONTENT

Microsoft content

- Coding With Minecraft (CodWM 3) Unit 3, Coordinates
- MakeCode Cue (MC Cue) – https://www.makewonder.com/robots/cue/explore/
- MakeCode Micro:bit (MC Micro:bit) Toy projects, e.g., https://makecode.microbit.org/projects/robot-unicorn

Supplementary content

- Using robots to teach mathematics https://www.cmu.edu/roboticsacademy/PDFs/Research/SilkSchunn2008a-ASEE-Presentation.pdf
- Computer Science Unplugged (CSU 8), Kidbots –https://csunplugged.org/en/topics/kidbots/

DOMAIN **BIG IDEA**

ROBOTICS & AUTOMATION // CONTROLLING YOUR WORLD

LEVEL 9: HOW CAN ENVIRONMENTS BE CONTROLLED? (10 HOURS)

Learning goals

- Apply combined control technologies in a Cloud-based IoT solution, MCSF
- Develop, apply, interpret, and communicate statistical models, judgements, and arguments, MCSF

Supplementary goals

- Understand the basics of Internet of Things (IoT)
- Know how sensors, data, algorithms, and devices can work together
- Use threshold data trigger alerts and automated responses
- Use data from sensors and big data sets for data-driven decision-making
- Naturally interact with agents and models to get insights

Concepts

- Internet of Things
- Machine Learning
- Smart environments
- Smart agriculture

Challenges

- **Computational Thinking** Work with big data, train models, define events and triggers
- **Data Literacy** Gather and analyze data set **[?]** and use thresholds
- **Design Thinking** Design a smart farm

SUPPORTING CONTENT

Microsoft content

- Hacking STEM (H-STEM 13) Farmbeats – Live video monitoring, sensor control panel and settings, environmental sensors, platform management, automation data sets and visualizations, scripting shells, agent creation, IoT portal, Jupyter notebook, local GUI.

DOMAIN	BIG IDEA

ROBOTICS & AUTOMATION // CONTROLLING YOUR WORLD

LEVEL 10: HOW CAN ADMIN TASKS BE AUTOMATED? (10 HOURS)
SDG – 8. DECENT WORK AND ECONOMIC GROWTH

Learning goal Program an RPA process, MCSF

Supplementary goals

- Demonstrate the ability to automate administrative tasks on a server using a scripting language such as Bash
- Choose and implement appropriate RPA for manual user interface (UI) tasks
- Distinguish the differing solutions for automation and their appropriate use cases

Concepts

- Robotic Process Automation (RPA) handles repetitive business processes by mimicking human actions in common UIs without the need for systems integration
- Bash scripting allows the user access to administer files, users, and functionality on a server
- RPA may be enhanced with AI to create RPA processes that can learn

Challenges

- **Computational Thinking** Write a Bash script to check user activity on a server
- **Data Literacy** Summarize and interpret the output from an administrative Bash script
- **Design Thinking** Choose an appropriate UI workflow for attended/unattended automation using RPA

SUPPORTING CONTENT

Microsoft content

- Microsoft Power Automate – https://flow.microsoft.com/en-us/ui-flows/
- Microsoft Learn for Students (ML4S 30), Introduction to Bash: https://docs.microsoft.com/en-us/learn/modules/bash-introduction/

DOMAIN   **BIG IDEA**

ROBOTICS & AUTOMATION // CONTROLLING YOUR WORLD

LEVEL 12: CAN ROBOTS UNLOCK THE SECRETS OF THE OCEANS? (6:40 HOURS)

Learning goal Apply a range of mechatronic skills to solve robotics problems, MCSF

Supplementary goals

- Demonstrate understanding of the applications of mechatronics for science and industry
- Demonstrate mastery of the basic principles of mechatronics such as sensors, activators, and control systems

Concepts

- Mechatronics combines electrical, ICT, and mechanical engineering to build highly functional robotics
- Mechatronics has broad applications in science and industry ranging from smart elevators to planetary exploration rovers
- A servomechanism (servo) such as an antilock brake uses error-sensing negative feedback to correct its action

Challenges

- **Computational Thinking** Program a robot on the Moveit! Platform to recognize, pick up, and hold objects
- **Data Literacy** Analyze spatial feedback from a robot to determine its position and trajectory
- **Design Thinking** Design a robot to scour the ocean floor for samples using a 3-D design tool such as Gazebo

SUPPORTING CONTENT

Microsoft content

- AI Robot Lab (AIRL): https://aischool.microsoft.com/en-us/autonomous-systems/learning-paths/robot-challenge-lab
- Introduction to Robotics (ItR): https://aischool.microsoft.com/en-us/autonomous-systems/learning-paths/robot-challenge-lab/introduction-to-robotics/gazebo

Supplementary content

- https://www.bbc.co.uk/news/av/technology-48747238/how-robo-boat-tech-could-help-uncover-ocean-secrets

MAKING ENVIRONMENTS SAFE

LEVEL (K)	MAKING ENVIRONMENTS SAFE	PHASE
5	How can we connect sensors across schools?	Foundation
12	Can cities be smart?	Business

Having built foundations of understanding in sensors and robotics, students can use this Big Idea to focus on how to use robotics at-scale in smart cities and smart environments. Key focal points of learning will be to push deeper into Internet of Things, understand open data, and learn about the use of computing to deliver public services.

The authentic problem-based learning context for this Big Idea involves using IoT to address global problems identified in the SDG such as hunger, clean energy, and climate action.

DOMAIN **BIG IDEA**

ROBOTICS & AUTOMATION // MAKING ENVIRONMENTS SAFE
LEVEL 5*: HOW CAN WE CONNECT SENSORS ACROSS SCHOOLS? (10 HOURS)

Learning goal Explain the basic idea of how IoT can be combined with Cloud Computing to aggregate and visualize data from around the world, MCSF

Supplementary goals

- Explain the basics of how sensors can be used to gather environmental data
- Explain the basics of how data can be visualized and used to make decisions

Concepts

- The Cloud
- International collaboration online
- The more data you have, the better insights you will get

Challenges

- **Computational Thinking** Measure, upload, explore, and share weather data between your school and schools in other countries
- **Data Literacy** work across a wide range of metrological units of measurement and build data stories
- **Design Thinking** design weather data experiments and analysis, and visualizations

SUPPORTING CONTENT

Microsoft content

- Microsoft Digital Literacy course (MDL 6) – Collaborate and manage content digitally - https://digital-literacy-courses-en-us.azurewebsites.net/en-us/digitalliteracy/newcourses/06_Collaborate_and_manage_content_digitally/course/SCO1/onlineLauncher.htm

Supplementary content

- IoT@School – https://exploratory.sciencescope.uk
- IoT@School activities – https://exploratory.sciencescope.uk/category/exciting-ways-to-use-iotatschool-in-the-classroom/
- https://www.digitaltechnologieshub.edu.au/teachers/lesson-ideas/eco-calculator

DOMAIN　　　　　　　　　　　　　　　　　　　　**BIG IDEA**

ROBOTICS & AUTOMATION // MAKING ENVIRONMENTS SAFE

LEVEL 12: CAN CITIES BE SMART? (6:40 HOURS)
SDG – 11. SUSTAINABLE CITIES AND COMMUNITIES

Learning goal Apply a range of IoT skills to solve smart city/smart environment problems, MCSF

Supplementary goals

- Demonstrate an understanding of the economic, social, and governmental applications of IoT technology
- Demonstrate an understanding of potential evolution of IoT in the Fourth Industrial Revolution

Concepts

- A Smart City makes intelligent use of information flows, including from IoT devices, to guide civic governance at a strategic, tactical, and operational level
- A Smart Grid makes intelligent use of the data gathered from elements of the grid to distribute and manage energy in order to meet efficiency, renewability, and other goals
- The Industrial Internet of Things (IIoT) is the use of IoT in industrial sectors and applications including medicine and manufacturing
- The Fourth Industrial Revolution is the theory that digital technologies will fuse with the physical and biological spheres to unleash a wave of innovation bringing sustainable economic growth

Challenges

- **Computational Thinking** Write a program to gather data from a sensor device and process it into useful information
- **Data Literacy** Map data structures from raw sensor input into tabular form suitable for analytics
- **Design Thinking** Diagram the components, data flows and software architecture of an IoT system that visualizes environmental conditions in real time

SUPPORTING CONTENT

Microsoft content

- Microsoft CityNext (MCN) – https://partner.microsoft.com/en-us/solutions/citynext#:~:text=Microsoft%20CityNext%20is%20helping%20cities,t to%20accelerate%20innovation%20and%20opportunity.
- Azure IoT Developer Kit – https://microsoft.github.io/azure-iot-developer-kit/
- Introduction to Azure IoT – https://docs.microsoft.com/en-us/learn/paths/introduction-to-azure-iot/

Domain //

Data and AI

There is wide consensus that, as the Royal Society (UK) put it in 2018 "AI will affect occupations at all levels of pay and education," and "all occupations could be transformed by AI to some extent."[iii] This means that children need to be adequately prepared for working with, and using, AI.

DATA AND AI

The goal of this Domain is to develop skills in building basic AI systems by using the following Big Ideas:

- Solving Intelligence
- Making AI Fair
- Learning from Data

LEVEL (K)	SOLVING INTELLIGENCE	LEARNING FROM DATA	MAKING AI FAIR
1	What is Intelligence?		
2			
3		How can machines learn from data?	
4			
5			What rules should we give AI?
6			
7	Can machines be creative?		
8			
9		How can we make AI explainable?	
10		How can bots alert farmers to weather conditions?	
12	What is the Master Algorithm?	How can ML be used to classify Earth images?	Where has AI been fair and unfair?

SOLVING INTELLIGENCE

LEVEL (K)	SOLVING INTELLIGENCE	PHASE
1	What is Intelligence?	Foundation
7	Can machines be creative?	Product
12	What is the Master Algorithm?	Business

This Big Idea is about understanding the quest to emulate and surpass human intelligence with machines. Key concepts include understanding the meaning of the words "intelligence" and metacognition, and the distinctions between mind and brain. Building on this understanding of intelligence itself, learners can begin to make sense of machine intelligence.

As they progress in this Big Idea, learners will focus on areas such as Artificial General Intelligence, or The Singularity – and questions such as "can machines be creative?" Most importantly they will understand what AI is and what it is not, and the possibilities and limits of AI.

DOMAIN   **BIG IDEA**

DATA AND AI // SOLVING INTELLIGENCE

LEVEL 1*:* WHAT IS INTELLIGENCE? (10 HOURS)

Learning goal Understand that computers have no intelligence and that computers can do nothing unless a program is executed, CAS H&P

Supplementary goals

- Develop a baseline understanding of the meaning of the word "intelligence"
- Help learners to take control of their learning
- Develop a baseline understanding of machine intelligence

Concepts	**Challenges**
- Metacognition - Mind vs brain - Can machines have thoughts?	**Computational Thinking** - Stack rank objects and living things by how intelligent they are - Play a "human neural network" game - Work out if a given chatbot is a human or a machine by asking it questions **Data Literacy** Understand how simple algorithms can be chained together **Design Thinking** Visually represent different types of thinking processes, comparing the things that computers can do

SUPPORTING CONTENT

- "How to Make a Mind"
- Can AI Guess Your Emotion? https://www.digitaltechnologieshub.edu.au/teachers/lesson-ideas/ai-lesson-plans/can-ai-guess-your-emotion

DOMAIN　　　　　　　　　　**BIG IDEA**

DATA AND AI // SOLVING INTELLIGENCE

LEVEL 7: CAN MACHINES BE CREATIVE? (10 HOURS)

Learning goal Understand how data can be used in the creative world, MCSF

Supplementary goals

- Ask questions about the nature of creativity
- Understand that AI has limits

Concepts

- There are limits to what AI can do
- The Imitation Game
- Divergent vs. convergent thinking

Challenges

- **Computational Thinking** Explain the roles of decomposition, abstraction, pattern recognition and algorithms in computation
- **Data Literacy** Use data to create art
- **Design Thinking** Design images, written pieces, or sound using algorithms

SUPPORTING CONTENT

- ""AI: More Than Human," Barbican virtual exhibition – https://artsandculture.google.com/project/ai-more-than-human
- The Creativity Code, Art and Innovation in the Age of AI, Marcus du Sautoy
- https://aiartists.org/ai-generated-art-tools

DOMAIN   **BIG IDEA**

DATA AND AI // SOLVING INTELLIGENCE

LEVEL 12: WHAT IS THE MASTER ALGORITHM? (6:40 HOURS)
SDG – 8. DECENT WORK AND ECONOMIC GROWTH

Learning goals

- Discuss the "five tribes of AI"
- Demonstrate understanding of the principles of Deep Learning and its power, potential, and limitations, MCSF

Supplementary goals

- Discuss and assess the power and applicability of various AI approaches to practical problems
- Critically analyze the "instrumental goals" of Superintelligence
- Compare the main ideas behind the Master Algorithm and Superintelligence

Concepts

- There are five tribes of AI, each with a different approach: symbolists, connectionists, evolutionaries, Bayesians, and apologizers.
- There is no one correct way to develop AI, but several competing "vectors"
- Deep Learning is the latest "master algorithm" but is it a basis for Artificial General Intelligence?
- Is it possible to have a perfect understanding of how the world works and how people work within the world?

Challenges

- **Computational Thinking** Propose experiments that illustrate the Big Ideas of each of the "five tribes of AI"
- **Data Literacy** Describe the flow of data through a deep learning network for classification problems
- **Design Thinking** Design ways to illustrate the main Big Ideas behind the Master Algorithm and Superintelligence

SUPPORTING CONTENT

Microsoft content

- Deep Learning versus Machine Learning – https://docs.microsoft.com/en-us/azure/machine-learning/concept-deep-learning-vs-machine-learning

Supplementary content

- Recommended by Bill Gates as the two books everyone should read to understand AI
  - *The Master Algorithm: How the Quest for the Ultimate Learning Machine Will Remake Our World*, by Pedro Domingos
  - *Superintelligence,* by Nick Bostrom
- https://www.coursera.org/learn/intro-to-deep-learning
- https://www.datacamp.com

LEARNING FROM DATA

LEVEL (K)	LEARNING FROM DATA	PHASE
3	How can machines learn from data?	Foundation
9	How can we make AI explainable?	Product
10	How can bots alert farmers to weather conditions?	Project
12	How can Machine Learning be used to classify Earth images?	Business

This Big Idea focusses on learning how to build machine learning solutions. At an entry level, the MCSF provides unplugged activities that enable key concepts such as reward-based learning to be learned in a fun way. This Big Idea offers direct connections to students' everyday lives through activities such as examining the data generated on mobile phones and understanding how it is processed by a company that employs artificial intelligence.

Further along the learning pathway, students learn how to write simple machine learning experiments to uncover insights from messy data.

Equipped with an understanding of what AI can and cannot do, an attitude of making sure that AI is fair and the ability to produce basic machine learning solutions, students can then turn their attention to authentic, problem-based learning projects based on SDG goals.

DOMAIN   BIG IDEA

DATA AND AI // LEARNING FROM DATA

LEVEL 3: HOW CAN MACHINES LEARN FROM DATA? (10 HOURS)

Learning goals

- Express probabilities numerically, MCSF
- Understand that data can be learned from, MCSF

Supplementary goals

- Develop an understanding of the idea of machines being able to "learn"
- Appreciate that controlling data and bias is everyone's responsibility

Concepts

- When you use your phone, you are contributing to AI systems
- AI protagonism – control AI or have it done to you
- It's important to have rules to control the use of advanced technology

Challenges

- **Computational Thinking** "Sweet Computer" board game, Chatbot, Turing Test
- **Data Literacy** Play and analyze probability games such as Tic Tac Toe, Rock Paper Scissors, coin tosses and dice throws, chatbots that learn
- **Design Thinking** How to Make a Mind

SUPPORTING CONTENT

- CS4FN – Machine Learning Board Game, http://www.cs4fn.org/machinelearning/sweetlearningcomputer.php
- "How to Make a Mind" learn-tech.io
- Computer Science Unplugged (CSU 10), The Turing Test – https://classic.csunplugged.org/the-turing-test/
- Introduction to Probability https://www.khanacademy.org/math/probability/probability-geometry/probability-basics/a/probability-the-basics
- CS Field Guide, NZ, 2 Artificial Intelligence https://csfieldguide.org.nz/en/chapters/artificial-intelligence/

DOMAIN   **BIG IDEA**

DATA AND AI // LEARNING FROM DATA

LEVEL 9: HOW CAN WE MAKE AI EXPLAINABLE? (10 HOURS)

Learning goals

- Explain how data is encoded from a range of media and used to make predictions, MCSF
- Explain the effects of bias, MCSF
- Discuss issues of bias and accessibility in the design of existing technologies, CSTA 2-IC-21
- Query data on one table using a typical query language, CAS D&DR 5

Supplementary goals

- Know why it is important to understand why AI makes the predictions they do
- Understand the importance of simplification in Computer Science
- Understand the key tenets of Explainable AI (XAI)

Concepts

- AI is complex but needs to be widely understood for ethical, societal, safety, and democratic reasons
- XAI is a methodology with tools that is used to explain artificial intelligence to non-experts
- It is increasingly important for both the producers and consumers of AI to understand it

Challenges

- **Computational Thinking** Explain the roles of decomposition, abstraction, pattern recognition and algorithms in computation
- **Data Literacy** Query messy data in a table, and find bias
- **Design Thinking** Explain a simple Machine Learning model – e.g., KNN in a spreadsheet

SUPPORTING CONTENT

- XAI – learn-tech.io
- Excel KNN in a spreadsheet – learn-tech.io
- DARPA XAI – https://www.darpa.mil/program/explainable-artificial-intelligence

DOMAIN   **BIG IDEA**

DATA AND AI // LEARNING FROM DATA

LEVEL 10: HOW CAN BOTS ALERT FARMERS TO WEATHER CONDITIONS? (10 HOURS)
SDG – 13. ZERO HUNGER

Learning goals

- Evaluate quality, authenticity, and accuracy of data and extrapolate from a trend or pattern
- Use a range of models and charting methods to analyze, predict, and communicate data stories, MCSF
- Clean and prepare textual data for analysis and Machine Learning, MCSF

Supplementary goal Turn sources of data into usable text-based services

Concepts

- A bot is a program that runs automatically often on the internet. A bot may "crawl" for content, engage in conversation (chatbot), or perform repetitive tasks
- IoT data is data that is harvested from machines, typically through sensors, rather than from human activity
- Useful data is often found in unstructured or semi-structured form such as text and streams of sensor data
- Prescriptive real-time analytics provides up-to-date information along with a recommended course of action

Challenges

- **Computational Thinking** Extend the Big Question – "How can we connect sensors across schools?" – by writing a program to convert textual weather reports into tabular data useful for machine learning
- **Data Literacy** Parse IoT data streams and create alerts for anomalous conditions such as extreme winds
- **Design Thinking** Design a process whereby a farmer could get recommendations on crop management based on parsing of real-time weather reports

SUPPORTING CONTENT

Microsoft Content

- Imagine Cup Junior (ICJ) 1, Fundamentals of AI
- Microsoft Learn for Students (ML4S) 17, Foundations of Data Science; https://docs.microsoft.com/en-us/learn/paths/foundations-data-science/
- Microsoft Learn for Students (ML4S) 10, Help remote farmers protect their crops with text message weather alerts using Azure Functions – https://docs.microsoft.com/en-gb/learn/modules/send-crop-weather-alerts
- Hacking STEM (H-STEM 12) – Analyzing Windspeed With Anemometers. Excel, Arduino
- QnA Maker – https://www.qnamaker.ai/

DOMAIN

BIG IDEA

DATA AND AI // LEARNING FROM DATA

LEVEL 12: HOW CAN MACHINE LEARNING BE USED TO CLASSIFY EARTH IMAGES? (6:40 HOURS)
SDG – 13. CLIMATE ACTION

Learning goal Write a Classical Machine Learning algorithm to classify images, MCSF

Supplementary goals

- Transform unstructured data into structured data
- Design supervised learning solutions for classification problems

Concepts

- Supervised machine learning uses patterns in data to label things
- Classification problems are those where the label to be learned by the machine is one of a discrete set of classes
- Multinomial logistic regression is a technique used to predict a target variable with more than 2 classes
- A training data set such as ImageNet consists of pre-labeled data used to train a machine learning model
- A confusion matrix is a technique for summarizing the performance of a classification algorithm
- Image classification is the automatic labeling of images by a pre-trained model

Challenges

- **Computational Thinking** Build a simple image classifier
- **Data Literacy** Interpret the performance of a machine learning model using a confusion matrix
- **Design Thinking** Design a workflow to train and test an image classification model

SUPPORTING CONTENT

Microsoft Content

- Hacking STEM (H-STEM 5), Analyzing the astronauts' photos of Earth to predict climate change – https://education.microsoft.com/en-us/hackingStem/lesson/nv3zo6ad
- Microsoft Learning for Students (ML4S 21), Classify images with the Custom Vision service – https://docs.microsoft.com/en-gb/learn/modules/classify-images-custom-vision/
- ML Crash Course: https://aischool.microsoft.com/en-us/machine-learning/learning-paths/ml-crash-course
- Introduction to AI: https://aischool.microsoft.com/en-us/machine-learning/learning-paths/introduction-to-artificial-intelligence

MAKING AI FAIR

LEVEL (K)	MAKING AI FAIR	PHASE
5	What rules should we give AI?	Foundation
12	Where has AI been fair and unfair?	Business

Here the Big Idea focuses on developing the attitudes and mindsets necessary to ensure that the future development of AI is conducted on ethical grounds. Learners will come to understand that AI can be good or bad, but it is controllable. They will appreciate that controlling bias in the data that feeds AI is everyone's responsibility. They will learn to ask probing questions about the predictions that Machine Learning makes and appreciate the importance of XAI in enabling openness and transparency in the production and use of AI, as well as how AI relates to the law.

DOMAIN   BIG IDEA

DATA AND AI // MAKING AI FAIR

LEVEL 5: WHAT RULES SHOULD WE GIVE AI? (10 HOURS)

Learning goal Explain the concepts of ethics, bias, and fairness in the context of I and automation, MCSF

Supplementary goals

- Develop a baseline understanding of Artificial Intelligence
- Understand that AI can be good or bad, but it is controllable
- Appreciate that controlling bias in data and AI is everyone's responsibility

Concepts

- Leaders and developers have an obligation to make AI ethical
- When you use technology, you are contributing to AI systems
- AI protagonism – control AI or have it done to you

Challenges

- **Computational Thinking** Write guidance for AI developers to ensure that AI is made ethically
- **Data Literacy** Explain how the bias of the programmers influence the fairness of the AI rules
- **Design Thinking** Design a way for people to understand AI fairness rules

SUPPORTING CONTENT

Microsoft Content

- Responsible Innovation: The Next Wave of Design Thinking https://medium.com/microsoft-design/responsible-innovation-the-next-wave-of-design-thinking-86bc9e9a8ae8

Supplementary content

- AI in popular culture
- AI: More Than Human, Barbican, London – https://artsandculture.google.com/project/ai-more-than-human

DOMAIN	BIG IDEA

DATA AND AI // MAKING AI FAIR

LEVEL 12: WHERE HAS AI BEEN FAIR AND UNFAIR? (6:40 HOURS)
SDG – 16. PEACE, JUSTICE AND STRONG INSTITUTIONS

Learning goal Demonstrate a working understanding of XAI and AI Ethics – Design Thinking

Supplementary goals

- Choose the optimal algorithm to balance performance and transparency for a given problem
- Critically assess the recent history of AI ethics and recommend macro and micro approaches to ensuring AI fairness in the future

Concepts

- Responsible Machine Learning encompasses the following values and principles: understand ML models; protect people and their data; control the end-to-end process
- Explainable AI (XAI) is AI that is designed in such a way that its objective and decision-making processes are transparent and understandable by humans
- Local Interpretable Model Agnostic (LIME) library opens up black box models to examine the driving factors behind each prediction
- Algorithmic bias describes the systemic errors that an algorithm may make, which result in unfair outcomes for groups of people, particularly those already marginalized

Challenges

- **Computational Thinking** Explain the performance and explainability trade-off between different predictive learning algorithms
- **Data Literacy** Analyze the outputs from an XAI package such as LIME to assess the explainability of a predictive model
- **Design Thinking** Analyze cases where AI has been clearly unfair, or visibly fair. Design an end-to-end machine learning process that maximizes transparency and ensures fairness

SUPPORTING CONTENT

Microsoft Content

- Responsible AI Resources: https://www.microsoft.com/en-us/ai/responsible-ai-resources?activetab=pivot1%3aprimaryr4
- Responsible Machine Learning: https://docs.microsoft.com/en-us/azure/machine-learning/concept-responsible-ml

Supplementary content

- Explainable AI 'Show Your Workings': https://vimeo.com/368522294
- LIME repository: https://github.com/marcotcr/lime
- FATE: https://www.microsoft.com/en-us/research/theme/fate/

Domain //

Platforms and Cloud

A platform is the environment in which a piece of software is executed, and a group of technologies that are used as a base upon which other applications, processes, or technologies are developed. Anyone wishing to write software for broad use needs to understand how to work with platforms.

PLATFORMS AND CLOUD

The goal of this Domain is to develop skills in working with platforms by using the following Big Ideas:

- Making Machines Compute
- Connecting Computers
- Delivering Web Services

LEVEL (K)	MAKING MACHINES COMPUTE	CONNECTING COMPUTERS	DELIVERING WEB SERVICES
1			
2	What does 'digital' mean?		
3			
4		How can 4bn smartphones connect?	
5			
6			What is in the Cloud?
7			
8	How has computing evolved?		
9			
10		How can we build a LAN in a disaster zone?	
12	How small and fast can computers sustainably go?	How can the Internet of Clean Energy work?	How can an Open API be used to reduce poverty?

MAKING MACHINES COMPUTE

LEVEL (K)	SOLVING INTELLIGENCE	PHASE
2	What does 'digital' mean?	Foundation
8	How has computing evolved?	Product
12	How small and fast can computers sustainably go?	Business

This Big Idea explores how hardware works, the components that different platforms are based on and how computing scales are measured. Here students explore the interface between electronics, physics, and computing to understand how code gets executed.

Students will learn that computing exists on a spectrum, at one end of which are embedded devices (SOCs), and at the opposite end are supercomputers used for running massive mathematical models. Content will cover areas such as the units used to measure computing scales, and the consumption and conservation of energy in delivering different types of computing services.

DOMAIN	BIG IDEA

PLATFORMS AND CLOUD // MAKING MACHINES COMPUTE

LEVEL 2: WHAT DOES 'DIGITAL' MEAN? (10 HOURS)

Learning goals

- Use appropriate terminology in identifying and describing the function of common physical components of computing systems, CSTA 1A-CS-02
- Know that digital computers use binary to represent all data, how binary can represent numbers and images, computers transfer data in binary, relationship between binary and file size, CAS D&DR 5

Supplementary goal Develop basic block-based coding skills

Concepts

- The term 'digital' means data expressed as a series of the digits 0 and 1, and refers to elements such as hardware, software, and networks
- Digital hardware and software components can be used to transform data into digital solutions
- Programs are written in high-level (close to English) source code, which is then compiled into an "executable" format in binary
- Executable code is activated in an operating system (e.g., Word executable code is activated in Windows)

Challenges

- **Computational Thinking**
  - Use a computer to search for information.
  - Describe the different parts and types of the computer and their functions, and the difference between operating systems and applications and their functions
- **Data Literacy** Program a micro:bit watch to count and display the number of movements you make
- **Design Thinking** Make a movement counter "watch" with a micro:bit

SUPPORTING CONTENT

Microsoft Content

- Microsoft Digital Literacy (MDL 1), Work with Computers – https://digital-literacy-courses-en-us.azurewebsites.net/en-us/digitalliteracy/newcourses/01_work_with_computers/course/SCO1/onlineLauncher.htm
- Microsoft Digital Literacy (MDL 2), Access information online – https://digital-literacy-courses-en-us.azurewebsites.net/en-us/digitalliteracy/newcourses/02_Access_information_online/course/SCO1/onlineLauncher.htm
- MakeCode micro:bit Watch project – https://makecode.microbit.org/projects/watch

Supplementary Content

- Pearson, Digital Technology Demystified –https://qualifications.pearson.com/en/about-us/qualification-brands/btec-international/learning-hub/artificial-intelligence/digital-technology-de-mystified.html

DOMAIN   **BIG IDEA**

PLATFORMS AND CLOUD // MAKING MACHINES COMPUTE

LEVEL 8: HOW HAS COMPUTING EVOLVED? (10 HOURS)

Learning goals

- Describe how internal and external parts of computing devices function to form a system, CSTA 1B-CS-01
- Understand the main functions of the operating system, CAS H&P 4

Supplementary goals

- Understand how a chip receives readable code to process inputs into outputs
- Understand the fundamental components of a computer
- Understand that while the form of computing changes, the essential aspects persist

Concepts

- The powerful computer then and now (memory/storage/ processor/input/output)
- On-board computers controlling the space rocket
- Computer calculations for trajectory (Mission Control)

Challenges

- **Computational Thinking**
  - Gain a working understanding of the Raspberry Pi
  - Explain the similarities and differences between the NASA 1969 computer and modern computers
  - Compare the features of a Raspberry Pi to the computers used by NASA in 1969
- **Data Literacy** Explain how data inputs are stored and accessed in memory
- **Design Thinking**
  - Design a program that set a rocket's course for the moon
  - Design a science experiment that uses the GPIO functions in a Raspberry Pi

SUPPORTING CONTENT

Microsoft Content

- Setting up a Raspberry Pi – https://docs.microsoft.com/en-us/windows/iot-core/tutorials/rpi

Supplementary Content

- Intel, "The Journey Inside", Introduction to Computers (Intel 1-6) - https://www.intel.com/content/www/us/en/education/k12/the-journey-inside/explore-the-curriculum/intro-to-computers.html
- https://www.realclearscience.com/articles/2019/07/02/your_mobile_phone_vs_apollo _11s_guidance_computer_111026.html
- https://en.wikipedia.org/wiki/Apollo_Guidance_Computer
- https://www.youtube.com/watch?v=g0PIXvjTasI
- https://spaceplace.nasa.gov/dsn-antennas/en/
- https://www.pbs.org/video/how-computers-calculate-the-alu-crash-course-computer-sci-sm5zov/
- https://www.learneroo.com/modules/12/nodes/81
- https://spaceplace.nasa.gov/build-a-spacecraft/en/d

DOMAIN   **BIG IDEA**

PLATFORMS AND CLOUD // MAKING MACHINES COMPUTE

LEVEL 12: HOW SMALL AND FAST CAN COMPUTERS SUSTAINABLY GO? (6:40 HOURS)
SDG – 13. CLIMATE ACTION

Learning goals

- Demonstrate a working understanding of the criticality of factoring energy use into a solution, MCSF
- Demonstrate a basic understanding of quantum computing

Supplementary goals

- Approach sustainable computing problems from several angles including platform choice, computer design, and software design
- Write a simple program for a quantum computer

Concepts

- Moore's Law is the postulation that silicon chip-based computers will double their power density every year
- An integrated circuit (IC) is a small silicon chip that can function as an amplifier, oscillator, timer, microprocessor, or computer memory
- Cloud computing may save energy through resource virtualization and higher utilization although increased demand may cause a net increase in energy usage
- A quantum computer is one that leverages the unique behaviors of subatomic particles (such as entanglement) to process information in terms of probabilities rather than binary states.
- Energy proportionality is a measure of the relationship between power consumed in a computer system, and the rate at which useful work is done
- We use Big O notation to describe the time complexity of an algorithm from which we can infer its energy requirements.

Challenges

- **Computational Thinking** Code a quantum circuit using a quantum development kit
- **Data Literacy** Work out how to minimize the energy costs of a program across multiple platforms, computer, and software implementations
- **Design Thinking** Design a new low-powered, wearable computing device

SUPPORTING CONTENT

Microsoft Content

- Introduction to Quantum Computing (IQ): https://docs.microsoft.com/en-us/quantum/overview/overview

Supplementary Content

- Introduction to Quantum Computing: https://www.ibm.com/quantum-computing/

CONNECTING COMPUTERS

LEVEL (K)	CONNECTING COMPUTERS	PHASE
4	How can 4bn smartphones connect?	Foundation
10	How can we build a LAN in a disaster zone?	Project
12	How can the Internet of Clean Energy work?	Business

The Internet is something we tend to take for granted, but an understanding of its mechanics is essential to Computer Science. In this Big Idea we explore how the hardware, software, and protocols combine to make networks and mobile platforms work. Another key component of this Big Idea is the API and how it can be used in software development.

DOMAIN   BIG IDEA

PLATFORMS AND CLOUD // CONNECTING COMPUTERS

LEVEL 4: HOW CAN 4BN SMARTPHONE CONNECT? (10 HOURS)

Learning goals

- Model how information is broken down into smaller pieces, transmitted as packets through multiple devices over networks and the Internet, and reassembled at the destination, Design Thinking, CSTA 1B-NI-04
- Know that digital computers use binary to represent all data, how binary can represent numbers and images, computers transfer data in binary, relationship between binary and file size, CAS D&DR 5

Supplementary goals

- Gain an appreciation of the rich functionality of the Internet from entertainment to businesses to education
- Understand the Internet as a large collection of connected digital devices and information

Concepts

- When digital systems are connected, they form a network
- The Internet is a physical entity made of computers, connections, and protocols
- Apps on your phone exchange data over the Internet
- The Internet is a platform for providing social value e.g., helping people find each other after an earthquake, or for doctor to perform a surgery remotely

Challenges

- **Computational Thinking** Identify connected devices. Connect micro:bits with wires and with Bluetooth, and transfer data between them
- **Data Literacy** Binary numbers, image representation
- **Design Thinking** Model a packet's journey. Draw a map of the behind-the-scenes connections when you use WhatsApp, showing components and scales

SUPPORTING CONTENT

Microsoft Content

- MakeCode serial data (MC Com 1) - https://makecode.microbit.org/device/serial
- MakeCode bluetooth pairing (MC Com 2) - https://makecode.microbit.org/reference/bluetooth/bluetooth-pairing
- Hacking STEM (H-STEM 9), Harnessing Electricity to Communicate – https://www.microsoft.com/en-gb/education/education-workshop/telegraph.aspx

Supplementary Content

- Connecting micro:bits with wires – https://microbit.nominetresearch.uk/networking-book-online/wiredcommunication/wiredcommunication/
- Computer Science Unplugged (CSU 1) Binary Numbers https://csunplugged.org/en/topics/binary-numbers/
- CSU 3 Image Representation https://csunplugged.org/en/topics/image-representation/
- Binary https://www.digitaltechnologieshub.edu.au/teachers/lesson-ideas/using-binary-to-create-on-off-pictures
- There and Back Again: A Packet's Tale https://www.youtube.com/watch?v=ewrBalT_eBM
- https://edu.gcfglobal.org/en/internetbasics/what-is-the-internet/1/
- https://www.monitis.com/blog/what-will-the-future-internet-look-like/

DOMAIN
                                                                                BIG IDEA

PLATFORMS AND CLOUD // CONNECTING COMPUTERS

LEVEL 10: HOW CAN WE BUILD A LAN IN A DISASTER ZONE? (10 HOURS)
SDG – 3. GOOD HEALTH AND WELL-BEING

Learning goals

- Demonstrate an understanding of the relative merits of different network methods, the role of Internet protocols and how packets, IP addresses, and memory works, MCSF
- Understand data transmission between digital computers over networks, including the Internet i.e., IP addresses and packet switching, CAS C&N 5
- Explain the names of hardware e.g., hubs, routers, switches, and the names of protocols e.g., SMTP, iMAP, POP, FTP, TCP/IP, associated with networking computer systems, CAS C&N 5

Concepts

- Networks are architected in layers from device to Local Area Networks to the Internet and back to devices
- Peer-to-Peer Networks share work and privileges across all nodes (computers) in the network
- A Client/Server Network is one where a server hosts resources accessed by clients (service requestors) and, in the case of local networks, may control the clients
- A low-power, wide-area network for low-powered edge devices (e.g., LoRa) can provide rescue teams communication even in the absence of a cellular network

Challenges

- **Computational Thinking**
    - Set up a physical or virtual network to manage and utilize limited resources
    - Set up policies that manage people and resources
    - Model ways to bring hardware such as sensors and cameras into the network
- **Data Literacy** Manage data access across a network
- **Design Thinking** Draw a diagram for a low energy network of devices that could be used to robustly transmit data to and from a disaster zone

SUPPORTING CONTENT

Microsoft Content

- Microsoft Learn for Students (ML4S) 3 – 9
    - 3. Architecture and service guarantees – https://docs.microsoft.com/en-gb/learn/modules/intro-to-azure-networking
    - 4. Compute options
    - 5. Storage options
    - 6. Manage services with the Azure portal
    - 7. Security, responsibility, and trust in Azure
    - 8. Networking options
    - 9. Apply and monitor infrastructure standards with Azure Policy

- Fundamentals of Computer Networking: https://docs.microsoft.com/en-us/learn/modules/network-fundamentals/
- Quickstart: Create a virtual network using the Azure portal – https://docs.microsoft.com/en-us/azure/virtual-network/quick-create-portal

Supplementary Content

- https://www.mdpi.com/2227-7080/5/4/65/pdf
- https://ieeexplore.ieee.org/document/8647177

DOMAIN   **BIG IDEA**

PLATFORMS AND CLOUD // CONNECTING COMPUTERS

LEVEL 12: HOW CAN THE INTERNET OF CLEAN ENERGY WORK? (6:40 HOURS)
SDG – 7. AFFORDABLE CLEAN ENERGY

Learning goal Create parameters for a Neural Network to solve a predictive modelling problem, MCSF

Supplementary goals

- Demonstrate understanding of the key concepts of neural network architectures
- Map appropriate software and hardware to complex problems

Concepts

- Intermittent production from renewable energy sources creates a challenge to balance energy supply and demand
- Root Mean Squared Error (RMSE) is a key measure of model performance for a prediction problem
- A neural network is a machine learning architecture inspired by biological neurons that can be used for predictions.
- Deep neural networks (Deep Learning) use many layers of neurons to enhance model performance
- Tensorflow is a powerful Deep Learning library available in Python, C and other programming languages
- Keras is a Python API that provides an intuitive interface to powerful Deep Learning solvers

Challenges

- **Computational Thinking** Train a deep neural network to predict energy consumption
- **Data Literacy** Calculate and interpret performance metrics for regression outputs
- **Design Thinking** Design a solution to help manage an energy grid containing clean power generation

SUPPORTING CONTENT

Microsoft Content

- Microsoft Learning for Students (ML4S 22), Introduction to Neural Networks – https://docs.microsoft.com/en-gb/learn/modules/introduction-to-neural-networks/
- Microsoft Learning for Students (ML4S 23), Make predictions from complex data with neural networks, https://docs.microsoft.com/en-gb/learn/modules/introduction-to-neural-networks/
- Microsoft Learning for Students (ML4S 24), Introduction To Azure IoT – https://docs.microsoft.com/en-us/learn/paths/introduction-to-azure-iot/
- Intro to Deep Learning: https://aischool.microsoft.com/en-us/machine-learning/learning-paths/build-a-predictive-maintenance-solution-using-deep-learning
- How to Train Keras: https://docs.microsoft.com/en-us/azure/machine-learning/how-to-train-keras
- Neural Network Regression: https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/neural-network-regression

Supplementary Content

- Internet of Clean Energy – https://www.learn-tech.io/internet-of-clean-energy/

DELIVERING WEB SERVICES

LEVEL (K)	DELIVERING WEB SERVICES	PHASE
6	What is in the Cloud?	Foundation
12	How can an Open API be used to reduce poverty?	Business

Here learners are introduced to the concept of the Cloud and given an understanding of how it can be used to deliver services. This Big Idea allows learners to appreciate the links between traditional CS concepts, such a data storage, with modern concepts such as Big Data and virtualization.

Equipped with an understanding of technology "stacks," students can then turn their attention to authentic problem-based learning projects based on SDG goals, exploring how an Open API can be used to reduce poverty, for example.

DOMAIN   **BIG IDEA**

PLATFORMS AND CLOUD // DELIVERING WEB SERVICES

LEVEL 6: WHAT IS IN THE CLOUD? (10 HOURS)

Learning goals

- Understand the concept of "stack"
- Arrange elements of a Cloud-based stack, including a database, in a diagram, MCSF
- Recognize and understand the function of the main internal parts of basic computer architecture, CAS H&P 5
- Use units and scales of computing, MCSF

Supplementary goals

- Understand the outsourcing of work from local computers to the Cloud
- Understand the services available on the cloud (SAAS – Software as a Service)
- Learn how citizens can manage their data and usage of the Cloud

Concepts

- Cloud storage
- Cloud computing
- Software as a Service (SAAS)

Challenges

- **Computational Thinking** Use and explain the Cloud
- **Data Literacy** Explain the physical data storage that sits behind commonly used Cloud services
- **Design Thinking** Draw what happens in the Cloud when you use a service such as Facebook

SUPPORTING CONTENT

Microsoft Content

- Microsoft Learn for Students (ML4S 1), Create an Azure Account - https://docs.microsoft.com/en-us/learn/modules/create-an-azure-account/
- Microsoft Learn for Students (ML4S 2). Principles of Cloud computing https://docs.microsoft.com/en-us/learn/modules/principles-cloud-computing/

Supplementary Content

- https://kids.kiddle.co/Cloud_computing
- https://www.youtube.com/watch?v=TTNgV0O_oTg
- https://www.youtube.com/watch?v=ZnGzxV_dQeg

DOMAIN	BIG IDEA

PLATFORMS AND CLOUD // DELIVERING WEB SERVICES

LEVEL 12: HOW CAN OPEN API BE USED TO REDUCE POVERTY? (6:40 HOURS)
SDG – 1. NO POVERTY

Learning goal write code to ingest data from a public api, mcsf

Supplementary goals

- Use functionality provided through a third-party API in a program
- Create and deploy a simple Web API

Concepts

- A web service is a software application (resource) that is made available on the internet
- A Web API (Application Programming Interface) is a set of standards and protocols that allow a programmer to interact with 3rd party internet resources such as data or functionality
- An open API is a Web API that is made available to the public
- APIs typically exchange data as JSON (JavaScript Object Notation) files

Challenges

- **Computational Thinking** Write a program to ingest, process and store data from various publicly available APIs
- **Data Literacy** Manipulate incoming data and process it into useful summary tables in the database
- **Design Thinking** Using publicly available APIs, design a banking application for people in the developing world who currently don't have a bank account

SUPPORTING CONTENT

Microsoft Content

- Microsoft Learn for Students (ML4S 29), Build an AI web app by using Python and Flask – https://docs.microsoft.com/en-us/learn/modules/python-flask-build-ai-web-app/

Domain //

Human-Computer Interaction

The ways in which people can interact with computing has expanded rapidly in recent times and this trend is set to continue. In the Knowledge Era, human computer interaction (HCI) was almost exclusively by screen, keyboard, and mouse. Now, in the Artificial Intelligence Era, we have broadening ways to interact with computing, for example voice, gesture, haptics, mixed reality (MR) and sentiment.

As computing broadens and proliferates, a key factor that determines the success of a computing solution is how well it is designed in terms of the user experience (UX). As interaction with computers becomes increasingly interwoven with everyday life, it is also essential that developers understand how to make their technology accessible to all. An understanding of how to design HCI is therefore an essential asset for anyone designing and building computing solutions.

HUMAN-COMPUTER INTERACTION

The goal of this Domain is to develop HCI design skills by using the following Big Ideas:

- Making Computing Interactive
- Designing User Experiences
- Making Computing Accessible

LEVEL (K)	MAKING COMPUTING INTERACTIVE	DESIGNING USER EXPERIENCES	MAKING COMPUTING ACCESSIBLE
1			
2	How can computers and people interact?		
3			
4		What is a usability test?	
5			
6			How can software be more accessible?
7			
8	How does mixed reality work?		
9			
10		How should you design interfaces for safety-critical systems?	
12	Can haptics help surgeons and dentist?	Can we stop mobile phones ruling our lives?	How can computing help deal with an impairment?

MAKING COMPUTING INTERACTIVE

LEVEL (K)	MAKING COMPUTING INTERACTIVE	PHASE
2	How can computers and people interact?	Foundation
8	How does MR work?	Product
12	Can haptics help surgeons and dentist?	Business

The key goal of this Big Idea is for students to understand how key HCI technologies work from a scientific point of view. For example, how exactly does a finger swipe on a screen trigger an action, or how exactly can voice control a computing service? Knowing the capabilities and limitations of HCIs such as haptics or tracking is an important capability for aspiring computer scientists to have.

DOMAIN	BIG IDEA
HUMAN-COMPUTER INTERACTION // MAKING COMPUTING INTERACTIVE	
LEVEL 2: HOW CAN COMPUTERS AND PEOPLE INTERACT? (10 HOURS)	

Learning goals

- Explain the relative merits of different types of interface, MCSF
- Seek diverse perspectives for the purpose of improving computational artifacts, CSTA 1B-IC-20
- Select and operate appropriate software to perform a variety of tasks, and recognize that users have different needs and preferences for the technology they use, CSTA 1A-CS-01
- Develop programs with sequences and simple loops, to express ideas or address a problem, CSTA 1A-AP-10

Supplementary goals

- Have an understanding of the word "interface"
- Create digital content, interacting with text, pictures, lists, and other types of objects
- Describe what coding is
- Know simple programming commands
- Create interactive stories and games using graphical programming blocks

Concepts

- People use computing devices to perform a variety of tasks and should select the appropriate app/program to complete these
- A narrative can be weaved into a program with tools such as speech bubbles, sound, and movement commands
- We can set our own goals and develop individualized interactions with computing applications
- Open learning environments such as Minecraft give us the freedom to experiment, encouraging creative self-expression and problem solving

Challenges

- **Computational Thinking** Write programs with sequences and loops
- **Data Literacy** Collect data through surveys and interpret results using a program
- **Design Thinking** Propose ways in which software user interfaces could be improved

SUPPORTING CONTENT

Microsoft Content

- Microsoft Digital Literacy (MDL 3) – Communicate Online https://www.microsoft.com/en-us/DigitalLiteracy/home
- MDL 5 – Create Digital Content https://www.microsoft.com/en-us/DigitalLiteracy/homeCom
- Computing With Minecraft (ComWM 1): Unit 1 – The Agency https://education.minecraft.net/class-resources/computing-with-minecraft
- Computing With Minecraft (ComWM 2): Unit 2 - Create multiple lines of code; Merge multiple types of coding features; Use block code and/or JavaScript as a coding language.

Supplementary Content

- Code.org, (CSD Unit 6), Fitting coding to screens – https://curriculum.code.org/csd-1718/unit6/2/
- CSG, HCI - https://csfieldguide.org.nz/en/chapters/human-computer-interaction/

DOMAIN	BIG IDEA
HUMAN-COMPUTER INTERACTION // MAKING COMPUTING INTERACTIVE	
LEVEL 8*: HOW DOES MIXED REALITY (MR) WORK? (10 HOURS)*	

Learning goal Use reverse engineering to understand a solution, MCSF

Supplementary goals

- Understand how virtual and augmented reality (XR) work
- Learn how to work with mixed reality systems

Concepts

- However impressive a piece of technology, it can be explained by engineering and technical principles
- 6DoF (six degrees of freedom), pitch, yaw, and roll
- The need for low latency for XR to be effective
- Understand what a hologram is

Challenges

- **Computational Thinking**
    - o Take apart a VR headset and analyze the components
    - o Explain how the headset recreates a real world-type environment
    - o Build an e-fashion item that displays head tracking data
    - o Explain how eye tracking works
- **Data Literacy** Explain how objects can be defined in three-dimensional space
- **Design Thinking**
    - o Produce content for a mixed reality environment
    - o Research and explain use cases where MR is an appropriate part of a solution

SUPPORTING CONTENT

Microsoft Content

- Get Started with Mixed Reality (GSMR) – https://docs.microsoft.com/en-us/windows/mixed-reality/

DOMAIN   **BIG IDEA**

HUMAN-COMPUTER INTERACTION // MAKING COMPUTING INTERACTIVE

LEVEL 12: CAN HAPTICS HELP SURGEONS AND DENTISTS? (10 HOURS)
SDG – 3. GOOD HEALTH AND WELL-BEING

Learning goal Have a working understanding of haptics, tracking and other advanced HCI technology, MCSF

Supplementary goals

- Conceptualize and design multimodal interactive systems
- Write a simple program for non-traditional interactivity with the user

Concepts

- Haptics refers to the use of technology that simulates the senses of touch and motion, especially to simulate a physical sensation from a remote connection
- Telesurgery utilizes wireless networking and robotic technology to connect surgeons and patients who are distantly located from one another
- Multimodal interactive systems allow the user to interact with a computer through multiple modes such as touch, gestures, speech, or keyboard input
- 5G (fifth generation) mobile networks have increased speed and coverage and reduced latency which allows real-time control of IoT devices even in hazardous situations
- Material Design is a visual language that synthesizes the classic principles of good design with the innovation of technology and science

Challenges

- **Computational Thinking** Write a program designed to use haptic inputs and outputs
- **Data Literacy** Analyze the information transmission requirements for remote surgery in terms of bandwidth and latency
- **Design Thinking** Design the user experience (UX) for a surgeon who will undertake remote surgery

SUPPORTING CONTENT

Microsoft Content

- Microsoft Learn for Students (ML4S 24), Introduction to Azure IoT: https://docs.microsoft.com/en-us/learn/paths/introduction-to-azure-iot/

Supplementary Content

- Medium (MTRS), Ericsson and King's College London demonstrate 5G tactile robotic surgery – https://www.ericsson.com/en/press-releases/2016/6/ericsson-and-kings-college-london-demonstrate-5g-tactile-robotic-surgery
- Material Design for Haptics: https://material.io/design/platform-guidance/android-haptics.html
- https://www.computer.org/csdl/magazine/co/2012/04/mco2012040021/13rRUxBJhq2
- https://medium.muz.li/haptic-ux-the-design-guide-for-building-touch-experiences-84639aa4a1b8?gi=36abc49f83b

DESIGNING USER EXPERIENCES

LEVEL (K)	DESIGNING USER EXPERIENCES	PHASE
4	What is a usability test?	Foundation
10	How should you design interfaces for safety-critical systems?	Project
12	Can we stop mobile phones ruling our lives?	Business

Ultimately there is little point in learning CS unless people are going to use your products. Therefore, this Big Idea is about developing skills in usability testing, user-centric design, and interface design.

DOMAIN	BIG IDEA

HUMAN-COMPUTER INTERACTION // DESIGNING USER EXPERIENCES

LEVEL 4: WHAT IS A USABILITY TEST? (10 HOURS)

Learning goals

- Think of ways to improve the accessibility and usability of computing, MCSF
- Evaluate the trustworthiness of digital content and consider the usability of visual design features when designing and creating digital artefacts for a known audience, CAS IT 6
- Recommend improvements to the design of computing devices, based on analysis of how users interact with the devices, CSTA – 2-CS-01

Supplementary goals

- Be aware of the need to consider different perspectives, ability levels, points of view, and disabilities in the development of inclusive technology
- Recognize that collaboration and sharing of ideas allow the benefit of diverse perspective

Concepts

- Human-computer interaction (HCI) is about trying to make programs useful, usable, and accessible to humans
- Evaluating interface is best done by getting feedback from lots of potential users
- Usability heuristics in user interface design
- User Experience (UX) is about interactions with the device or application, and the aim is to make a product intuitive

Challenges

- **Computational Thinking** Design and explain an app that uses UX design principles
- **Data Literacy** Use focus groups or surveys and the Statistical Investigation Process to evaluate usability
- **Design Thinking** Identify users and considerations that may be significant, evaluate interfaces using think aloud protocols and the cognitive walkthrough

SUPPORTING CONTENT

Microsoft Content

- Microsoft Design – https://www.microsoft.com/design
- Microsoft Fluent Design System – https://www.microsoft.com/design/fluent/#/

Supplementary Content

- Code.org (CSD Unit 4) – The Design Process, User-Centered Design, UX, prototyping, testing – https://studio.code.org/s/csd4-2019
- Code.org CSD Unit 6 – Physical Computing. Fitting coding to screens and using virtual sensor data https://studio.code.org/s/csd6-2019
- CS Field Guide (NZ), (CSFG 1), Human-Computer Interaction https://csfieldguide.org.nz/en/chapters/human-computer-interaction/
- Jakob Nielsen, Usability Heuristics https://www.nngroup.com/articles/ten-usability-heuristics/
- Statistical Investigation Process https://new.censusatschool.org.nz/resource/statistical-investigation/

DOMAIN   **BIG IDEA**

HUMAN-COMPUTER INTERACTION // DESIGNING USER EXPERIENCES

LEVEL 10: HOW SHOULD YOU DESIGN INTERFACES FOR SAFETY-CRITICAL SYSTEMS? (10 HOURS)
SDG – 3. GOOD HEALTH AND WELL-BEING

Learning goals

- Recommend improvements to the design of computing devices, based on an analysis of how users interact with the devices, CSTA 2-CS-01
- Apply principles of UX design, MCSF
- Understand the importance of fail-safe and zero errors in safety-critical systems, MCSF

Concepts

- Safety-critical systems are those systems whose failure could result in loss of life, significant property damage, or damage to the environment.
- Aircraft, cars, weapons systems, medical devices, and nuclear power plants are the traditional examples of safety-critical software systems.
- Software developed for these types of use cases need to be certified as safety-critical
- Developers need to write software and design interfaces to take account of safety
- Safety-critical software development is a methodical, process-driven field of software development

Challenges

- **Computational Thinking**
  - Produce a set of rules for testing and certifying safety-critical software
  - Build a prototype interface for a safety-critical system
- **Data Literacy** Use statistical methods to assess the effectiveness of a safety-critical interface design
- **Design Thinking** Design interfaces for a safety-critical system

SUPPORTING CONTENT

- NASA Software Safety Guidebook – https://standards.nasa.gov/standard/nasa/nasa-gb-871913
- Safety-Critical Software - https://smallbusinessprogramming.com/safety-critical-software-15-things-every-developer-should-know/

DOMAIN	BIG IDEA
HUMAN-COMPUTER INTERACTION // DESIGNING USER EXPERIENCES	
LEVEL 12: CAN WE STOP MOBILE PHONES RULING OUR LIVES? (6:40 HOURS)	
SDG – 9. INDUSTRY, INNOVATION AND INFRASTRUCTURE	

Learning goals Use user-centric design methods, MCSF

Supplementary goals

- Design an application that prioritizes human and societal needs
- Write a simple mobile application

Concepts

- Time Well Spent is a human-centric measure of application usage
- Platforms such as Xmarin for iOS and Android facilitate development and deployment of mobile apps
- Open source design frameworks such as Fluent Design System facilitate design of mobile apps

Challenges

- **Computational Thinking** Develop and deploy a simple mobile application that "nudges" mobile phone behavior towards less but better-quality use
- **Data Literacy** Understand the dataflows in and out of your app
- **Design Thinking** Design the app so that it will foster mental wellness

SUPPORTING CONTENT

Microsoft Content

- DigiGirlz Alice Envisions the Future (AEF 3), Good Health and Well Being, screen time
- Create a Mobile App with Xmarin (Xmarin): https://docs.microsoft.com/en-us/learn/modules/create-a-mobile-app-with-xamarin-forms/
- Fluent – https://www.microsoft.com/design/fluent/#/

Supplementary Content

- https://learnappmaking.com/how-to-make-an-app/
- https://buildfire.com/how-to-create-a-mobile-app/
- https://humanetech.com/

MAKING COMPUTING ACCESSIBLE

LEVEL (K)	MAKING COMPUTING ACCESSIBLE	PHASE
6	How can software be more accessible?	Foundation
12	How can computing help deal with an impairment?	Business

It's essential that everyone can benefit from computing and this Big Idea is about developing design skills for making computing accessible to those with disabilities or impairments. Key knowledge and skills in this Big Idea focus on understanding different types of disability or impairment and on developing an appreciation of how computing can help.

With a good understanding of how HCI technologies work, user-centric design skills and an appropriate attitude towards making computing accessible, students can then tackle authentic PBL challenges linked to UN SDG goals.

DOMAIN   BIG IDEA

HUMAN-COMPUTER INTERACTION // MAKING COMPUTING ACCESSIBLE

LEVEL 6: HOW CAN SOFTWARE BE MORE ACCESSIBLE? (10 HOURS)

Learning goals

- Brainstorm ways to improve the accessibility and usability of technology products for the diverse needs and wants of users, CSTA 3A-AP-19
- Recommend improvements to design of computing experiences, MCSF

Supplementary goals

- Understand how screen readers and voice recognition programs work
- Make accessibility a regular part of design workflow
- Design for hearing, vision, mobility, and cognitive issues
- Consider accessibility in layout

Concepts

- When websites, technologies, or tools are poorly designed, they can create barriers that exclude people with disabilities
- Assistive technologies and design methods
- There is a very wide range of disabilities that need to be considered in software design

Challenges

- **Computational Thinking** Re-design a piece of software so it provides equal access and opportunity to people with a diverse range of hearing, movement, sight, and cognitive abilities
- **Data Literacy** Use survey data to inform your re-design
- **Design Thinking** Apply accessible technology design principles in your re-design

SUPPORTING CONTENT

Microsoft Content

- Microsoft Accessibility – https://www.microsoft.com/en-ca/accessibility/default.aspx
- Microsoft Inclusive Design – https://www.microsoft.com/design/inclusive/
- Lynda, UX Accessibility – https://www.lynda.com/Accessibility-tutorials/Foundations-UX-Accessibility/435008-2.html
- Lynda, Accessibility for Web Design - https://www.lynda.com/Web-Design-tutorials/Accessibility-Web-Design/606090-2.html
- https://www.microsoft.com/en-gb/trust-center/compliance/accessibility
- https://www.microsoft.com/en-ca/accessibility/default.aspx
- https://education.microsoft.com/en-us/course/a41ac17d/overview

DOMAIN	BIG IDEA

HUMAN-COMPUTER INTERACTION // MAKING COMPUTING ACCESSIBLE

LEVEL 12: HOW CAN COMPUTING HELP DEAL WITH AN IMPAIRMENT? (6:40 HOURS)
SDG – 10. REDUCED INEQUALITIES

Learning goals Factor-in accessibility when designing solutions, MCSF

Supplementary goals

- Demonstrate knowledge of programming accessible web applications
- Critically assess the accessibility profile of software applications

Concepts

- Technology can play a significant role in helping people with impairments lead better lives
- Having people with impairments integrated into the modern workplace brings diversity benefits
- Open-source design frameworks such as Fluent Design System facilitate user-centered design

Challenges

- **Computational Thinking** Prototype a digital product that specifically addresses one significant impairment
- **Data Literacy** Gather and analyze data about the about the impairment that you are addressing
- **Design Thinking** design a way to help people with a specific impairment lead better lives

SUPPORTING CONTENT

Microsoft Content

- Hacking STEM (H-STEM 10), Building Machines That Emulate Humans. Robotic models to understand the biomechanics of the human hand – https://www.microsoft.com/en-us/education/education-workshop/robotic-hand.aspx
- SeeingAI – https://www.microsoft.com/en-us/ai/seeing-ai
- Digigirlz (AEF 2), Alice Envisions the Future

Supplementary content

- https://reasondigital.com/insights/four-ways-technology-can-help-disabled-people/
- https://www.bbc.co.uk/news/business-35427933

Domain //

Cybersecurity

Cyber-crime earns criminals significantly more income than the combined revenues of Facebook, Amazon, Apple, Netflix, and Google.[iv] At the same time social media is driving misinformation and conspiracy theories, the Dark Web enables extremists and organized crime – something that can be characterized as "infotagion." The combined economic and social damage caused by malicious internet use is vast and growing.[v]

CYBERSECURITY

The goal of this Domain is to develop a broad set of Cybersecurity skills by exploring the following Big Ideas:

- The Challenge of Digital Safety
- Securing Computing
- Infotagion

LEVEL (K)	THE CHALLENGE OF DIGITAL SAFETY	SECURING COMPUTING	INFOTAGION
1			
2	How can you stay safe online?		
3			
4		How can you exchange secret messages?	
5			
6			How should you protect your online 'self'?
7			
8	How does authentication work?		
9			
10		How can data be secured?	
12	Can smart contracts stop environmental damage?	How might quantum change cybersecurity?	How can we prevent online abuse, censorship and extremism?

THE CHALLENGE OF DIGITAL SAFETY

LEVEL (K)	THE CHALLENGE OF DIGITAL SAFETY	PHASE
2	How can you stay safe online?	Foundation
8	How does authentication work?	Product
12	Can smart contracts stop environmental damage?	Business

An essential part of any curriculum today is teaching children how to stay safe online. This Big Idea builds on Internet safety to explore concepts such as trust, authentication, cyber-crime and smart contracts (Blockchain) through scientific and forensic lenses. For example, students will investigate how authentication works.

DOMAIN   **BIG IDEA**

CYBERSECURITY // THE CHALLENGE OF DIGITAL SAFETY

LEVEL 2*: HOW CAN YOU STAY SAFE ONLINE? (10 HOURS)

Learning goals

- Understand that personal data is collected, and that it is important to keep this information secure
- Develop respectful, responsible, and safe behaviors with others online

Concepts

- The Internet connects us to the world, and we need to be careful who we connect with online
- Personal and login information should not be shared with anyone we do not know
- A connected community needs to be respectful, responsible, and safe for all

Challenges

- **Computational Thinking** Analyze and discuss online risks and behaviors
- **Data Literacy** Identify personal data types, data security
- **Design Thinking** Create a Family Tech Agreement

SUPPORTING CONTENT

Microsoft Content

- Microsoft Digital Literacy Course (MDL 4), Participate safely and responsibly online, https://digital-literacy-courses-en-us.azurewebsites.net/en-us/digitalliteracy/newcourses/04_Participate_safely_and_responsibly_online/course/SCO1/onlineLauncher.htm

Supplementary Content

- Code.org, Course 1, Lesson 17, Going Places Safely – https://studio.code.org/s/course1/stage/17/puzzle/1
- UK Government (UKG), Teaching Online Safety in Schools – https://www.gov.uk/government/publications/teaching-online-safety-in-schools
- Australian Digital Technologies Hub, Communicating Online Safely – https://www.digitaltechnologieshub.edu.au/teachers/lesson-ideas/communicating-safely-online

DOMAIN	BIG IDEA

CYBERSECURITY // THE CHALLENGE OF DIGITAL SAFETY

LEVEL 8: HOW DOES AUTHENTICATION WORK? (10 HOURS)

Learning goals

- Explain and use strong passwords to protect devices and information from unauthorized access, CSTA 1A-NI-04
- Discuss real world cybersecurity problems and how personal information can be protected, CSTA 1B-NI-05
- Recommend security measures to address various scenarios based on factors such as efficiency, feasibility, and ethical impacts, CSTA 3A-NI-06

Concepts

- Authentication verifies a user's identity to allow access to confidential data or systems
- There is a range of ways of authenticating identity, each with different merits
- Every security measure involves trade-offs between the accessibility and security of the system

Challenges

- **Computational Thinking** Test authentication factors for a web service
- **Data Literacy** Understand verification of data, cryptography keys, the concept of smart contracts
- **Design Thinking** Design the authentication sub-system for a given web service scenario

SUPPORTING CONTENT

Microsoft Content

- Microsoft Learn for Students (MS4L 7), Security, responsibility, and trust in Azure – https://docs.microsoft.com/en-gb/learn/modules/intro-to-security-in-azure/

DOMAIN	BIG IDEA

CYBERSECURITY // THE CHALLENGE OF DIGITAL SAFETY

LEVEL 12: CAN SMART CONTRACTS STOP ENVIRONMENTAL DAMAGE? (6:40 HOURS)
SDG – 12. RESPONSIBLE PRODUCTION AND CONSUMPTION

Learning goals Design smart contract processes, MCFS

Supplementary goals

- Demonstrate understanding of the fundamentals of Blockchain technologies
- Build and deploy a basic smart contract on the Blockchain

Concepts

- Blockchain is a distributed, decentralized public ledger
- Blockchain relies on public key cryptography to ensure that transactions are secure
- A smart contract is a self-executing contract on Blockchain
- A smart contract is designed to promote contract adherence without the need for third-party enforcement

Challenges

- **Computational Thinking** Write a smart contract using Azure Blockchain Workbench
- **Data Literacy** Understand elliptic curve digital signature algorithm (ECDSA)
- **Design Thinking** Design a smart contract that will make forestry activities transparent to the public

SUPPORTING CONTENT

Microsoft Content

- Azure Blockchain Service: https://docs.microsoft.com/en-us/azure/blockchain/service/send-transaction
- Blockchain Basics: https://azure.microsoft.com/en-us/resources/videos/blockchain-basics/
- Blockchain Workbench: https://docs.microsoft.com/bs-latn-ba/azure/blockchain/workbench/f

SECURING COMPUTING

LEVEL (K)	SECURING COMPTUING	PHASE
4	How can you exchange secret messages?	Foundation
10	How can data be secured?	Project
12	How might quantum change cybersecurity?	Business

With cyber-crime growing, it is extremely important for anyone studying computer science to understand the science of security, which includes concepts such as encryption and ciphers. A key goal of this Big Idea is to enable students to learn how to set up defenses against cyber-attacks and secure sensitive and valuable information.

DOMAIN   **BIG IDEA**

CYBERSECURITY // SECURING COMPUTING

LEVEL 4*:* HOW CAN YOU EXCHANGE SECRET MESSAGES? (10 HOURS)

Learning goals

- Make a cipher work, MCSF
- Discuss real world cybersecurity problems and how personal information can be protected, CSTA 1B-NI-05

Supplementary goals

- Identify and use codes and ciphers to exchange an encrypted message
- Explore patterns, frequencies, and combinations to decrypt a secret message

Concepts

- A key is used to encrypt and decrypt information we want to keep private
- Information sent and received over the Internet is broken down into smaller pieces called packets
- All information stored at the lowest level of the computer is in binary, off or on

Challenges

- **Computational Thinking** Use Caesar Cipher algorithms to exchange secret messages
- **Data Literacy** Frequency analysis
- **Design Thinking** Design a code or cipher

SUPPORTING CONTENT

Microsoft Content

- Coding with Minecraft (CodWM 4) Unit 4: Variables
- Coding with Minecraft (CodWM 5) Unit 5: Conditionals

Supplementary Content

- Computer Science Unplugged (CSU 4, 5, 6), Information Hiding, Cryptographic Protocols, Public Key Encryption – https://csunplugged.org/en/
- Code.org CSD Unit 4, including privacy, encryption, keys and passwords, key cryptography, cybercrime, Simple Encryption – https://curriculum.code.org/csp-19/unit4/
- https://aca.edu.au/resources/cyber-crypto/
- https://groklearning.com/learn/cyber-78-py-crypto/crypto/27/

DOMAIN **BIG IDEA**

CYBERSECURITY // SECURING COMPUTING

LEVEL 10: HOW CAN DATE BE SECURED? (10 HOURS)
SDG – 9. INDUSTRY, INNOVATION, AND INFRASTRUCTURE

Learning goals

- Explain security issues that may lead to compromised systems, CSTA, 3B-AP-18
- Apply multiple methods of encryption to model the secure transmission of information, CSTA, 2-NI-06

Supplementary goal Apply encryption techniques and understand the role of mathematics in encryption

Concepts

- Insecure software development practices pose serious security risks
- Encryption helps protects data you send, receive and store using a device
- Laws govern many aspects of computing, such as privacy, data, property, information, and identity

Challenges

- **Computational Thinking** Research software coding errors: lack of bounds checking, poor input validation, circular references
- **Data Literacy** Prime Number Theory, Divisibility, Steganography
- **Design Thinking** Review case studies or events which present an ethical dilemma in data security

SUPPORTING CONTENT

- Code.org CSD Unit 4, including privacy, encryption, keys and passwords, key cryptography, cyber-crime, Simple Encryption – https://curriculum.code.org/csp-19/unit4/
- https://aca.edu.au/resources/cyber-crypto/
- https://groklearning.com/learn/cyber-78-py-crypto/crypto/27/

DOMAIN　　　　　　　　　　　**BIG IDEA**

CYBERSECURITY // SECURING COMPUTING

LEVEL 12: HOW MIGHT QUANTUM CHANGE CYBERSECURITY? (6:40 HOURS)
SDG – 9. INDUSTRY, INNOVATION, AND INFRASTRUCTURE

Learning goals Explain the fundamentals of quantum computing, MCSF

Supplementary goals

- Demonstrate an understanding of cryptographic algorithms
- Write a basic program on a quantum computer

Concepts

- Quantum Supremacy is the goal of demonstrating that a quantum computer can solve a problem impossible for a classical computer
- Quantum computing is based on the Qubit rather than the Bit
- Shor's Algorithm shows that a quantum computer can find prime factors for large numbers in polynomial time
- Much of today's software including e-commerce is protected by cryptography that could be breached using a quantum computer
- Q# and Qiskit are examples of quantum programming languages that can be run today on real and simulated quantum computers in the cloud
- RSA and ECDSA are examples of vulnerable algorithms in widespread use today

Challenges

- **Computational Thinking** Write a program to play Pong on a simulated quantum computer
- **Data Literacy** Calculate the time complexity of a program to find prime factors on a classical computer
- **Design Thinking** Design a plan to rollout post-quantum cryptography to e-commerce applications

SUPPORTING CONTENT

Microsoft Content

- Getting Started with the Quantum Development Kit: https://docs.microsoft.com/en-us/quantum/welcome
- Security, Privacy and Cryptography: https://www.microsoft.com/en-us/research/research-area/security-privacy-cryptography/?facet%5Btax%5D%5Bmsr-research-area%5D%5B0%5D=13558&sort_by=most-recent
- Post-Quantum Cryptography: https://www.microsoft.com/en-us/research/project/post-quantum-cryptography/

Supplementary Content

- Shor's Algorithm for Quantum: https://qiskit.org/textbook/ch-algorithms/shor.html
- Coding with Qiskit: https://www.youtube.com/playlist?list=PLOFEBzvs-Vvp2xg9-POLJhQwtVktlYGbY
- https://www.cryptomathic.com/news-events/blog/quantum-computing-and-its-impact-on-cryptography

INFOTAGION

LEVEL (K)	INFOTAGION	PHASE
6	How should you protect your online 'self'?	Foundation
12	How can we prevent online abuse, censorship, and extremism?	Business

While our computer systems are under attack from cyber-criminals, science itself is under attack from the misinformation industry which is often sponsored at state level. This Big Idea is about enabling students to understand the mechanics and business models underpinning disinformation and the damage it causes, equipping them with knowledge, skills, and ethics to make the right choices as future developers.

With a good understanding of cybercrime and how to defend against it, students will be equipped to specify and build secure services.

DOMAIN	BIG IDEA

CYBERSECURITY // INFOTAGION

LEVEL 6: HOW SHOULD YOU PROTECT YOUR ONLINE 'SELF'? (10 HOURS)

Learning goals

- Establish ethical protocols for the online world, MCSF
- Compare trade-offs associated with computing technologies that affect people's everyday activities and career options, CSTA 2-IC-20
- Describe trade-offs between allowing information to be public and keeping information private and secure, CSTA 2-IC-23

Concepts

- Security attacks often start with personal information that is publicly available online
- Data from social media is modelled in Machine Learning systems to make predictions
- Using computing technologies has trade-offs, including privacy, communication, and automation

Challenges

- **Computational Thinking** Audit your software and social media settings to analyze your online vulnerability
- **Data Literacy** Critically examine media reports of data breaches, trade-offs, and cyber-risk
- **Design Thinking** Draw up a set of instructions to help people protect themselves online

SUPPORTING CONTENT

Microsoft Content

- Microsoft Digital Learning Course (MDL 4), Participate Safely and Responsibly Online

Supplementary Content

- Code.org, Course 2, Lesson 18, Your Digital Footprint, https://studio.code.org/s/course2/stage/18/puzzle/1
- https://www.esafety.gov.au/educators/classroom-resources/making-good-choices-online
- https://groklearning.com/course/cyber-hs-infosec/

DOMAIN   **BIG IDEA**

CYBERSECURITY // INFOTAGION

LEVEL 12*: HOW CAN WE PREVENT ONLINE ABUSE, CENSORSHIP, AND EXTREMISM? (6:40 HOURS)
SDG – 16. PEACE, JUSTICE AND STRONG INSTITUTIONS

Learning goals Demonstrate an appreciation of technology law, MCSF

Supplementary goals

- Identify the motivations behind people who participate in online abuse and extremism
- Explain the theory and application of law to the cyber-realm

Concepts

- The search algorithms used by social media organizations impact the content viewed by the consumer
- Censorship legislation can be in direct conflict with a person's individual rights
- Responsibility for online safety falls to platform providers, users, and government agencies but the zones of responsibility are not sharply demarcated
- A "receiver operating characteristic" curve, or ROC curve, is a graphical plot that illustrates the diagnostic ability of a binary classifier system as its discrimination threshold is varied

Challenges

- **Computational Thinking** Parameterize and run a machine learning program that will classify content as fake or not fake
- **Data Literacy** Analyze the performance of a fake news classification algorithm using an ROC curve
- **Design Thinking** Design a software feature that allows users to tag fake news, considering at which point (threshold) content should be removed

SUPPORTING CONTENT

Microsoft Content

- How to Understand Automated ML: https://docs.microsoft.com/en-us/azure/machine-learning/how-to-understand-automated-ml
- BBC My World Media Literacy: https://education.microsoft.com/en-us/resource/939cc059

Supplementary Content

- Infotagion: https://infotagion.com/

Project-Phase Sprints,

Business-PhasePitches,

And Content

PROJECT-PHASE SPRINTS

The Level 11 Sprints are intense 10-hour activities that combine taught content and short projects.

To teach the principle that CS solutions combine different disciplines, all the Level 11 Sprints include content under the "Writing Programs" and "Learning from Data" Domains, plus one other Domain so that by the end of the Sprints a range of combinations of disciplines will have been used.

Assessment criteria for each sprint:

- Produce use case scenarios, plan sequences, goals, and outcomes
- Combine hardware, software, and network technologies
- Modify, remix, or incorporate parts of an existing program
- Apply Design Thinking – Empathize, Define, Ideate, Prototype, Test

SOFTWARE DEVELOPMENT			ROBOTICS & AUTOMATION			DATA AND AI			PLATFORMS AND CLOUD			HUMAN-COMPUTER INTERACTION			CYBERSECURITY		
Solving Complexity	Writing Programs	Developing the Web	Sensing Your World	Controlling Your World	Making Environments Smart	Solving Intelligence	Learning From Data	Making AI Fair	Making Machines Compute	Connecting Computers	Delivering Web Services	Making Computing Interactive	Designing User Experiences	Making Computing Accessible	The Challenge of Digital Safety	Securing Computing	Infotagion
SPRINT (10HR): Build Software to monitor air quality [ICJ, ML4S, AEF] *13. Climate Action*																	
SPRINT (10HR): Make online spaces safe for girls and women [ICJ, AEF] *5. Achieve gender equality and empower all women and girls*																	
SPRINT (10HR): Diagnose a medical problem with Machine Learning [ICJ] *3. Good Health and Well-Being*																	
SPRINT (10HR): Build a web service that helps protect endangered species [ICJ, ML4S] *15. Life on Land*																	
SPRINT (10HR): Build a mobile app for users to identify endangered species [ML4S] *15. Life on Land*																	
SPRINT (10HR): Build an Agriculture 4.0 solution based on IoT [SDG] *2. Zero Hunger*																	

DOMAINS	BIG IDEAS
Software Development / Data and AI / Platforms & Cloud	Writing Programs / Learning From Data / Delivering Web Services

LEVEL 11: BUILD SOFTWARE TO MONITOR AIR QUALITY (10 HOURS)
SDG – 13. CLIMATE ACTION

Learning goals

- What Azure Maps is and how to create an account
- The different mapping options in Azure Maps
- How to show a map on a web page using the Azure Maps web SDK
- The GeoJSON format
- How to show a GeoJSON feature collection on a map

Challenge Create a web page to show air quality data using Azure Maps

SUPPORTING CONTENT

Microsoft Content

- Imagine Cup Junior, Module 2, Machine Learning
- Microsoft Learn for Students (ML4S 12), Track global air quality with Azure Maps
  https://docs.microsoft.com/en-gb/learn/modules/azure-maps-track-air-pollution/
- Digigirlz, Alice Envisions the Future, AEF 4

DOMAINS	BIG IDEAS
Software Development / Data and AI / Platforms & Cloud	Writing Programs / Learning From Data / Securing Computing

LEVEL 11: MAKE ONLINE SPACES SAFER FOR GIRLS AND WOMEN(10 HOURS)
SDG – 5. ACHIEVE GENDER EQUALITY AND EMPOWER ALL WOMEN AND GIRLS

Learning goals Develop skills in building secure services for a subset of the public

Challenge Build a digital service for women or girls currently excluded from the digital world, for example, make banking services available for women who are currently shut out of the banking system

SUPPORTING CONTENT

Microsoft Content

- Imagine Cup Junior, Imagine Cup Junior 3, Applying AI. Facial recognition and sentiment analysis
- Digigirlz Alice Envisions the Future, (AEF 1)

DOMAINS	BIG IDEAS
Software Development / Data and AI / Cybersecurity	Writing Programs / Learning From Data / Securing Computing

LEVEL 11: DIAGNOSE A MEDICAL PROBLEM WITH MACHINE LEARNING (10 HOURS)
SDG – 3. GOOD HEALTH AND WELL-BEING

Learning goals

- Understand the role of Computer Science in healthcare
- Develop Deep Learning and Neural Network skills
- Develop XAI skills

- Develop security skills
- Understand the need for balancing explainability with data security

Challenges

- Design a solution to diagnose a medical problem using Deep Learning and neural networks
- Choose an area where there is widely available public and anonymized data

SUPPORTING CONTENT

Microsoft Content

- Imagine Cup Junior, Imagine Cup Junior 4, Deep Learning, and neural networks

Supplementary Content

- Deep Mind at Moorfields Eye Hospital –https://www.moorfields.nhs.uk/content/latest-updates-deepmind-health
- NHS Predict Breast Cancer – https://breast.predict.nhs.uk

DOMAINS	BIG IDEAS
Software Development / Data and AI / Platforms & Cloud	Writing Programs / Learning From Data / Delivering Web Services

LEVEL 11: BUILD A WEB SERVICE THAT HELPS PROTECT AN ENDANGERED SPECIES (10 HOURS)
SDG – 15. LIFE ON LAND

Learning goals Acquire the following toolset skills

- Azure Blob Storage
- Azure Functions Custom Vision Service

- Microsoft Power BI
- SQL Database

Challenge Build a polar bear tracking solution that uploads images from a simulated array of cameras and analyzes the images of polar bears. Visualize the output using Microsoft Power BI

SUPPORTING CONTENT

Microsoft Content

- Imagine Cup Junior 5, AI for Good
- Microsoft Learn for Students (ML4S 13), Track wild polar bears with AI – https://docs.microsoft.com/en-gb/learn/modules/build-ml-model-with-azure-stream-analytics/

DOMAINS	BIG IDEAS
Software Development / Data and AI / Human-Computer Interaction	**Writing Programs / Learning From Data / Designing User Experiences**

LEVEL 11: BUILD A MOBILE APP FOR USERS TO IDENTIFY ENDANGERED SPECIES (10 HOURS)
SDG – 15. LIFE ON LAND

Learning goals Develop the following skills:

- Building a fully functioning machine learning model
- Azure Cognitive Services
- Custom Vision
- UX design

Challenges

- Build a Machine Learning model to identify a bird in an image
- Design a user experience that is friendly to field ornithologists

SUPPORTING CONTENT

Microsoft Content
- Microsoft Learn for Students (ML4S 14), Classify endangered bird species with Custom Vision – https://docs.microsoft.com/en-gb/learn/modules/cv-classify-bird-species/

DOMAINS	BIG IDEAS
Software Development / Data and AI / Platforms & Cloud	**Writing Programs / Making Environments Smarter / Learning From Data**

LEVEL 11: BUILD AN AGRICULTURE 4.0 SOLUTION BASED ON IOT (10 HOURS)
SDG – 2. ZERO HUNGER

Learning goals

- Understand the role of Computer Science in Agriculture 4.0
- Deepen Internet of Things skills
- Integrate a range of hardware and software solution components into a single solution

Challenge Design and build an Urban or Vertical Farming solution

SUPPORTING CONTENT

- Vertical Farm Growing in the Basement of Baltic School – https://baltictriangle.co.uk/baltic-urban-farm/
- Microsoft FarmBeats: Student Kit for Precision Agriculture – https://baltictriangle.co.uk/baltic-urban-farm/

BUSINESS-PHASE PITCHES

The Level 13 Pitches are intense open-ended 40-hour projects that give students working in teams the freedom to tackle any of the SDGs in which they have an interest. Each pitch requires students to combine two domains, so that each domain has been covered by the end of the academic year.

At the end of each Pitch, students will present their products to a "board of investors," which is likely to be made up of teachers, parents, and local businesspeople.

SOFTWARE DEVELOPMENT	ROBOTICS & AUTOMATION	DATA AND AI	PLATFORMS AND CLOUD	HUMAN-COMPUTER INTERACTION	CYBERSECURITY
Solving Complexity	Sensing Your World	Solving Intelligence	Making Machines Compute	Making Computing Interactive	The Challenge of Digital Safety
Writing Programs	Controlling Your World	Learning from Data	Connecting Computers	Designing User Experiences	Securing Computing
Developing the Web	Making Environments Smart	Making AI Fair	Delivering Web Services	Making Computing Accessible	Infotagion

Design and build a digital product that addresses an SDG based on Software Development and Robotics Automation | *Design and build a digital product that addresses an SDG based on Data and AI and Platforms and Cloud* | *Design and build a digital product that addresses an SDG based on HCI and Cybersecurity*

EACH OF THE PITCHES HAS THE FOLLOWING CHARACTERISTICS:

LEVEL 13 **SGD** ANY	**TIME** 40 HOURS
Learning goals • Further develop project management, team-working and solution development skills • Develop entrepreneurial skills and a sense of commercial realism as a context for Computer Science • Develop presentation skills	**Challenges** • Design and build a digital product that addresses an SDG based on Software Development and Robotics and Automation. • Convince a "board of investors" that the product is worth investing in

Supporting Content
- Design a solution to diagnose a medical problem using Deep Learning and neural networks
- Choose an area where there is widely available public and anonymized data

ASSESSMENT CRITERIA FOR EACH PITCH

- Apply sound fundamentals of system organization, architecture, and solution design
- Collaborate effectively in a software team using version control and continuous deployment for commerce-ready software
- Effectively use prototyping
- Pitch convincingly to investors

Students are required to design and build a digital product that addresses an SDG based on:
- "Software Development" and "Robotics and Automation"
- "Data and AI" and "Platforms and Cloud"
- "Human-Computer Interaction" and "Cybersecurity"

CONTENT USED IN THE MCSF

MAKECODE	M:EE	HACKING STEM	DIGIGIRLZ	IMAGINE CUP JUNIOR	MICROSOFT DIGITAL LITERACY COURSE
Cue micro:bit – Toys; Banana Keyboard **Computer Science Intro:** Variable, Sprites, Motion, Loops, User input, JavaScript, Namespaces, functions, Info and Button Press Events, Array Manipulation Serial Data Bluetooth pairing	**Computing with Minecraft:** Describe what coding is; Code an Agent to move in different directions; Use on chat commands; Create multiple lines of code; Merge multiple types of coding features; Use block code and/or; JavaScript as a coding language; Use loops to code more efficiently; Calculate in-game actions; Understand that code is determined by design goals; Use code to design a moving system; Use multiple moving parts to create an animated feature **Coding with Minecraft:** Coordinates Variables Conditionals	Lemon battery and switch Analysing the astronauts' photos of Earth to predict climate change How are ocean currents formed? Salinity and Temp sensors Harnessing Electricity to Communicate Building Machines That Emulate Humans Analysing Windspeed with Anemometers Farmbeats	**Alice Envisions the Future:** Achieve gender equality and empower all women and girls Reduced Inequalities Good Health and Well-Being Climate Action	Preparing data for Machine Learning Intro to Cloud Computing Introduction to AI API, Public Datasets Introduction to Python Machine Learning, Datasets, Supervised, Unsupervised, Clustering, BOTs, Applying AI, Facial Recognition and sentiment analysis, NLP, PowerBI, Deep Learning and Neural Networks, AI for Good, AI for Earth, Fishing, Agriculture, Heritage, Humanitarian	Work with Computers Access information online Communicate online Participate safely and responsibly online Create digital content Collaborate and manage content digitally

MICROSOFT LEARN FOR STUDENTS (ML4S)

Create an Azure account Manage Services with the Azure portal Import standard library modules Build a simple website using HTML, CSS, and JavaScript Introduction to Neural Networks Write your first C# code	Principles of cloud computing Security, responsibility, and trust in Azure Air quality maps Foundations of data science Make predictions from complex data with neural networks Build an AI web app by using Python and Flask	Architecture and service guarantees Networking options Track wild polar bears Create Mobile App with Xmarin Introduction to Azure IoT Introduction to Bash	Compute options Apply and monitor infrastructure standards with Azure Policy Classify endangered bird species with Custom Vision Use visuals in Power BI Analyse climate data with Azure Notebooks	Storage options Weather data alert Python Object Oriented Programming Classify images with Custom Vision service First-time Python

MICROSOFT CONTENT FOR PROFESSIONALS · LYNDA

Fundamentals of Computer Networking MS Power Automate GitHub Student Developer Pack Introduction to Robotics Responsible AI Resources Fluent SPC Security, Privacy and Cryptography	Power BI 1 Fundamentals of Computer Networking Azure Create a Web App Microsoft CityNext Responsible Machine Learning Azure Blockchain Service Post Quantum Cryptography	Responsible Innovation: The Next Wave of Design Thinking QuickStart: Create a virtual network using the Azure portal Robot Challenge Lab Azure IoT Developer Kit Intro to Deep Learning Blockchain Basics Python for Beginners	Microsoft Accessibility Introduction to Quantum Computing Azure in Autonomous Driving Introduction to Azure IoTn-to-azure-iot/ How to Train Keras Blockchain Workbench Get started with Mixed Reality	Microsoft Inclusive Design Post Quantum Cryptography AI Robot Lab Deep Learning Versus Machine Learning Neural Network Regression Getting Started with the Quantum Development Kit	Accessible for Web Design Visio 2019 Essential Training Agile Foundations UX Accessibility Agile Project Management with Microsoft Project

CODE.ORG	CS UNPLUGGED	INTEL "JOURNEY INSIDE"
Course 1, Lesson 17, Going Places Safely	Binary Numbers	1. Introduction to Computers; History of the computer; Four components of a computer; Compare computer "brains" with human brains
Course 2, Lesson 18, Your Digital Footprint	Image Representation	
	Information Hiding	2. Circuits and switches
Problem Solving, What is a computer? IO, processes and storage	Cryptographic Protocols	3. Digital Information
	Public Key Encryption	4. Microprocessors
Web Development, HTML CSS, build a personal portfolio website	Kidbots	5. The Internet
	The Turing Test	6. Technology and Society
The Design Process, User-Centered Design, UX, prototyping, testing	Class Simulation of a Computer	
Physical Computing, Fitting coding to screens and using virtual sensor data		
CS Principles. Big Data and Privacy, Unit 4, Lesson 7, Simple Encryption including Caesar Cipher		

LEARN-TECH	CS4FN	NASA	CS Field Guide NZ
How to Make a Mind XAI SIR Model – Covid-19 Demystified	Machine Learning Board Game Programming php	NASA Safety Guidebook	Human Computer Interaction

THE BARBICAN	UK GOV	BAREFOOT	
AI: More Than Human Virtual Exhibition	UK Government, Teaching Online Safety in Schools	Barefoot – Shopping list, Story sequencing, Dance moves. Pizza party, House patterns, Building blocks, Creating patterns Barefoot zoo Sorting it Out, Colourful Kits	

[i]https://classic.csunplugged.org/activities/

[ii]https://www.statista.com/statistics/740440/worldwide-robotic-process-automation-market-size/

[iii]https://royalsociety.org/-/media/policy/projects/ai-and-work/frontier-review-the-impact-of-AI-on-work.pdf

[iv]https://www.experian.com/blogs/ask-experian/cybercrime-the-1-5-trillion-problem/

[v]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/60943/the-cost-of-cyber-crime-full-report.pdf