FIRIA LABS

Curriculum Overview

Mission Pack:

The Brain Decoded:

A Neural Network Adventure

The Brain Decoded with CodeX Overview

This mission pack is an innovative cross-curricular educational toolkit designed to teach high school students both Python coding and the fascinating intricacies of the human brain. Through an engaging set of lessons, students will explore the inner workings of the human brain, discovering the connections between biological processes and coding principles.

During the missions, students learn about the brain, write programs as simulations of brain activity, and participate in activities that create mental models of how the brain works. The mission pack uses a combination of reading materials, CodeX programs, discussion, physical activities and written responses to create an immersive experience. No programming experience is required, but it is helpful.

Your Brain Decoded kit comes with a CodeX, peripherals (a NeoPixel Ring, a potentiometer and a 180 servo) and their connecting cables. The last mission includes an activity that optionally uses CodeX pods, which can be 3D printed: https://www.thingiverse.com/firia/designs

Mission 1: Brainstorm Bootcamp

During Brainstorm Bootcamp, students learn about CodeSpace and how it will guide them through the objectives with a text editor, objectives panel and goals. Students learn about helpful tools, like the toolbox, CodeTrek and hints. Basic Python programming for the CodeX is introduced, such as turning on pixels and displaying images. Students also use the peripherals that come with the kit: the NeoPixel Ring, 180 Servo, and the Potentiometer. As a final activity, students use radio signals to send messages to each other using the CodeX.

Mission 2: Neuron Navigator

Students learn about neurons and how the brain's inner signals guide everything we do. They will learn the parts of the neuron and how they work together to communicate. Students participate in a physical activity that forms a neural network. They also use the CodeX devices and programs to simulate a single neuron and a neural network.

Mission 3: Synaptic Sparks

During this mission students dive into the chemistry of the brain to see how neurotransmitters and neuromodulators affect mood, memory and behavior. First students learn about chemicals in the brain, like dopamine and serotonin, and how they regulate mood, memory and brain function. Then students use the CodeX device and programs to simulate different scenarios that affect brain activity and observe the results. The mission ends with a memory and reaction time test.

Mission 4: Language Logic

Students explore one of the brain's most fascinating skills: pattern recognition. First students read a short history on the roots of language. Then they use the CodeX device and programs to explore pattern recognition algorithms. Students consider the ethics of pattern recognition and how it is used in society. The mission ends with an English-Spanish partner madlibs activity.

Mission 5: Muscle Magic

During this mission students explore how motor neurons communicate with muscles. Topics covered are action potentials, the effect of neuron diameter, and the central pattern generator. Students use the CodeX device, the 180 servo and the potentiometer to simulate muscle activity and observe results. The mission ends with a "Go No-Go" brain training activity using the CodeX devices and the pods.

Planning and Pacing Guide

The Brain Decoded with CodeX Mission Pack includes five Missions.

- Mission 1 introduces CodeSpace and the CodeX device.
- Missions 2-5 each have a central theme for studying the human brain, and objectives that support the theme.
- All missions involve computer science.
- Missions 2-5 involve English, or Language Arts, extensively with reading materials, written responses, and reflection writing.
- The breakdown of subjects covered in each Mission is listed below. The main subject areas are mapped to standards. The cross-curricular activities are subject-specific, but they are not mapped to a specific standard.
- The suggested time gives time for the lessons in CodeSpace and a day for review. Including extensions and cross curricular activities will extend the amount of time needed.
- Other than Mission 1, each lesson is structured for a single 45-minute class period.
- Because the knowledge base and concepts build on each other from mission to mission, we recommend that the missions be completed in order. However, after Mission 1, they can be assigned out of order.

Mission 1: Brainstorm Bootcamp
Suggested Time: 3-4 days
Main Subject Areas:
Computer science
Cross Curricular Activities:
Language Arts (Obj 1, 2, 3, 4, 5, 6, 7)
Math (Obj 3, 4, 6, 7)
Physical Science (4, 5, 6, 7)

Mission 2: Neuron Navigator
Suggested Time: 6 days
Main Subject Areas:
Life Science (Biology)
Computer Science
English Language Arts
Cross Curricular Activities:
English Language Arts (Obj 1, 2, 5)
Math (Obj 3, 4)
Visual Arts (Obj 1, 2)

Mission 3: Synaptic Sparks
Suggested Time: 7 days
Main Subject Areas:
Physical Science
Computer Science
Engineering
Math
English Language Arts
Health / Physical Education
Cross Curricular Activities:
Math (Obj 2, 3, 4, 5, 6)
English Language Arts (Obj 1, 4, 5, 6)
Visual Arts (Obj 1)
Performing Arts (Obj 5)

Mission 4: Language Logic
Suggested Time: 7 days
Main Subject Areas:
English Language Arts
World Languages (Spanish)
Computer Science
Engineering
Cross Curricular Activities:
Math (Obj 2, 3, 4)
Social Studies/History (Obj 1, 5)
English Language Arts (Obj 1, 3, 5)
Physical Science (Obj 4)
Health (Obj 5)
World Languages (Obj 6)

Mission 5: Muscle Magic
Suggested Time: 7 days
Main Subject Areas:
Physical Science
Computer Science
English Language Arts
Math
Physical Education
Cross Curricular Activities:
Math (Obj 5, 6)
Social Studies/History (Obj 3)
English Language Arts (Obj 1, 4)
Physical Science (Obj 2)
Life Science (Obj 4, 6)
Visual Arts (Obj 1, 3)
Performing Arts (Obj 3)

Mission 1: Brainstorm Bootcamp

Overview:

This mission is all about becoming comfortable with the CodeSpace learning environment, the CodeX device, and Python programming. During Brainstorm Bootcamp, students learn about CodeSpace and how it will guide them through the objectives with a text editor, objectives panel and goals. Students learn about helpful tools, like the toolbox, CodeTrek and hints. Basic Python programming for the CodeX is introduced, such as turning on pixels and displaying images. Students also use the peripherals that come with the kit: the NeoPixel Ring, 180 Servo, and the Potentiometer. As a final activity, students use radio signals to send messages to each other using the CodeX.

Objectives:

Objective 1: Boot Up – This objective introduces the CodeSpace learning environment. They meet their guide Dr. Neuron Sparks.
Goal: Create a new file.

Objective 2: Boot Up II – Students learn about helpful tools in CodeSpace.
Goal: Click on a tool, CodeTrek and hints.

Objective 3: Introducing CodeX – Students connect the CodeX to the computer and CodeSpace.
Goal: Type in code and run their first program.

Objective 4: Code Action – Students use the buttons to light up pixels and display images.
Goal: Write a new program that uses buttons as input.

Objective 5: Plug In – This objective uses the NeoPixel Ring peripheral.
Goal: Write a program that lights up the pixels on the NeoPixel Ring.

Objective 6: Plug In... more! – This objective uses the 180 servo and potentiometer.
Goal: Write a program that uses the potentiometer to control the 180 servo.

Objective 7: Link Up – Students use the radio channel on their CodeX devices to send and receive messages to and from their classmates.
Goal: Write a program to send and receive radio messages.

Preparation and Materials:

- Create a class on the teacher dashboard.
- Students need a computer / laptop with the Chrome web browser.
- Make sure the students can successfully login to http://make.firialabs.com, create a student account and join the class with the code.
- Each student (or pair) needs a CodeX, peripherals and connecting cables.
- Supplemental materials found at learn.firialabs.com
  - Getting started with CodeSpace webpage – setting up a classroom, etc.
  - Getting Started in CodeSpace slide deck (for students)

Standards addressed in the mission:

Computer Science 9-12.CS.1, CS.2, AP.15, AP.16, AP.17

Mission Assessments:

Programs: first_program (Obj 3), button_fun (Obj 4), pixel_ring_fun (Obj 5), servo_fun (Obj 6), class_connect (Obj 7)
Brainstorm Bootcamp Mission Quiz

Mission 2: Neuron Navigator

Overview:

This mission introduces the neuron. Students learn the part of a neuron and how they work together to communicate with each other. Students participate in a physical activity that represents a neural network, and then use the CodeX to model a neuron and simulate a neural network. Python programming concepts used are custom modules, functions, displaying text, global variables and parameters. The NeoPixel Ring is used during the neuron model program, and the radio signal is used during the neural network simulations. As a final activity, the class forms a neural network using the CodeX devices as neurons to send and receive signals.

Objectives:

Objective 1: Neuron Power – This objective introduces the neuron and explains the parts of a neuron. The objective involves reading the material, and no program is required.
Goal: Written response in a file.

Objective 2: Unplugged Chain – Students assume a role of neurons and participate in an activity that simulates a neural network. Students observe how each neuron plays a unique role in efficient brain communication.
Goal: Written reflection on physical activity in a file.

Objective 3: Code a Neuron – Students use the CodeX device to model a neuron. They write a program that cycles through the phases of neuron communication. The NeoPixel Ring is used during this program.
Goal: Program that models the phases of neuron communication.

Objective 4: Neural LinkUP – Students write a program to see how neurons talk to each other. They experience a digital network chain in action.
Goal: Program that uses the radio to send a signal to other CodeX in a chain of neural communication.

Objective 5: Network Test – This objective builds on the last objective by widening the communication from a single chain to a class-wide network.
Goals: Program that uses the radio to send and receive signals, simulating a neural network.

Preparation and Materials:

- Decks of cards (or slips of paper) for the unplugged activity
- Students need a computer / laptop with the Chrome web browser.
- Each student (or pair) needs a CodeX and connecting cables.
- Supplemental materials found at learn.firialabs.com
  - Objective 2 Activity Guide (one per student), Materials, Slides and Teacher Instructions
  - Objective 3 Activity Guide (one per student or programming pair)
  - Objective 4 Activity Guide (one per student or programming pair)
  - Objective 5 Activity Guide (one per student or programming pair)

Standards addressed in the mission:

Computer Science	9-12.AP.15, 9-12.AP.16, 9-12.AP.21
Life Science	LS1.A
ELA	WHST.9-10.2, WHST.11-12.2, WHST.9-10.4

Mission Assessments:

Written responses: neuron_power (Obj 1), unplugged_chain (Obj 2)
Programs: neuron_sim (Obj 3), neural_network1 (Obj 4), neural_network2 (Obj 5)
Neuron Navigator Mission Quiz

Mission 3: Synaptic Sparks

Overview:

This mission dives into the chemistry of the brain, including neurotransmitters and neuromodulators. Students learn how levels of dopamine and serotonin affect mood, memory and behavior. Students use the CodeX device to simulate scenarios and observe their effects. The NeoPixel Ring is used during the brain simulation program. As a final activity, students program and then participate in a memory and reaction tests.

Objectives:

Objective 1: Brain Chemicals – This objective introduces neurotransmitters and neuromodulators and gives students focus questions for the mission.
Goal: Written response in a file.

Objective 2: Mood and Memory – Students write a program that simulates many daily activities. They observe the effects of the activities on neuromodulators, memory and mood.
Goal: Program that simulates daily activities and their effects on mood and memory.

Objective 3: Your Brain on Sunshine – Students learn about the effects of sunshine and nature.
Goal: Program that simulates getting more or less sun, and going on nature walks.

Objective 4: Your Brain on Sleep – This objective discusses the sleep cycles and how sleep patterns affect brain activity.
Goal: Program that simulates sleep cycles and interruptions.

Objective 5: Your Brain on Drugs – Students learn how different types of drugs affect brain chemistry.
Goals: Program that simulates scenarios with different types of drugs and drug use.

Objective 6: Reaction Time! – Students review all the information from the mission and use the CodeX device for a culminating activity.
Goals: Program that gives a memory test followed by a reaction test, and then gives five different scenarios and how they can affect brain function.

Preparation and Materials:

- Flashlights for Objective 3
- Students need a computer, Chrome web browser, a CodeX, NeoPixel Ring and connecting cables.
- Supplemental materials found at learn.firialabs.com
  - Activity Guide (one per student or programming pair) for Objective 2, 3, 4, 5 and 6

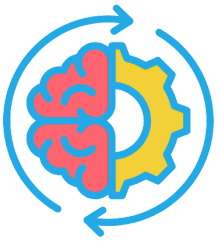
Standards addressed in the mission:

Computer Science	9-12.AP.14, 9-12.AP.16, 9-12.AP.18
Health	1.1.A, 1.1.P, 1.2.A, 2.7.P, 5.2.M, 5.4.P
Physical Science	HS-PS3-1
Science	Science & Engineering Practices
Math	N-Q.1-3
ELA	ELA/Literacy RST.11-12.1, WHST.9-10.2
Physical Education	PE-HS1.1.3

Mission Assessments:

Written response: brain_chemicals (Obj 1)
Programs: brain_sim (Obj 2), sunshine (Obj 3), sleep_stages (Obj 4), drug_sim (Obj 5), reaction_time (Obj 6)
Synaptic Sparks Mission Quiz

Mission 4: Language Logic



Overview:

In this mission we explore pattern recognition and how it relates to language acquisition. Students will discover how the human brain looks for patterns in spoken and written language. They learn about searching algorithms and use the CodeX devices and programs to search for patterns in words, grids, and sound waves. Students also learn about and consider the ethics of using pattern recognition in real-world applications. The final activity is to use English and Spanish words in a partner-madlibs story.

Objectives:

Objective 1: Roots of Language – This objective discusses the evolution of human communication. Students trace the history of language from gestures and facial expressions to a shared proto-language.
Goal: Written response in a file.

Objective 2: Pattern Recognition – Students learn about the parts of the brain that work together to make sense of patterns in everything from faces to language. The concept of algorithm is introduced.
Goal: Program that looks for consecutive repeated letters in a word.

Objective 3: Pattern Detection – Students learn about an advanced search algorithm for detecting patterns.
Goal: Program that searches for a pattern in a grid of characters.

Objective 4: Language Patterns – This objective looks at patterns in spoken language..
Goal: Program that uses pattern detection to search a sound wave (speech) for syllables.

Objective 5: Ethical Considerations – Students research ways that pattern recognition is used in real-world applications and address ethical considerations.
Goals: Two written responses in files.

Objective 6: Language Acquisition – Students learn about areas in the brain that process language. They learn about language acquisition by using patterns and rules.
Goals: Program that has a student input words and uses them in a partner-swap madlibs story.

Preparation and Materials:

- Students need a computer, Chrome web browser, a CodeX and connecting cable.
- Supplemental materials found at learn.firialabs.com
  - Activity Guide (one per student or programming pair) for Objective 2
  - Activity Guide (one per student or programming pair) for Objective 3
  - Activity Guide (one per student or programming pair) for Objective 4
  - Activity Guide (one per student or programming pair) for Objective 6

Standards addressed in the mission:

Computer Science	9-12.DA.8, 9-12.DA.10, 9-12.AP.14, 9-12.IC.24, 9-12.IC.28, 9-12.IC.30
Engineering Design	HS-ETS1-1
ELA	W.9-10.1, W.11-12.1, RST.9-10.4, RST.11-12.4, WHST.9-10.2.a-f, WHST.11-12.2.a-e, HS-LS1-1, HS-LS1-6, L.11-12.3, L.9-10.4, L.11-12.4
World Languages	WL.CM5.N

Mission Assessments:

Written response: language_roots (Obj 1), ethics_prompt1 (Obj 5), ethics_prompt2 (Obj 5)
Programs: repeated_letters (Obj 2), pattern_detect (Obj 3), syllables (Obj 4), partner_madlibs (Obj 6)
Language Logic Mission Quiz

Mission 5: Muscle Magic

Overview:

During this mission students explore how motor neurons communicate with muscles. Topics covered are action potentials, the effect of neuron diameter, and the central pattern generator. Students use the CodeX device, the 180 servo and the potentiometer to simulate muscle activity and observe results. The mission ends with a “Go No-Go” brain training activity using the CodeX devices and the pods.

Objectives:

Objective 1: Motor Neurons – This objective discusses motor neurons and communication with muscles.
Goal: Written response in a file.

Objective 2: Motor Neuron Signals – Students learn about action potentials and how the diameter of a motor neuron impacts the speed of the signals.
Goal: Program that demonstrates the relationship between neuron diameter and action potential speed.

Objective 3: Neural Rhythms – Students learn about the rhythm generator circuit and rhythms created when synchronized neurons take turns firing.
Goal: Program that simulates a neural rhythm pattern.

Objective 4: Muscle Response – This objective discusses reflexes and the central pattern generator.
Goal: Program that simulates chewing and the CPG that sets it in motion.

Objective 5: Athletic Reaction – Students learn about motor neuron recruitment during different activities..
Goal: Program that generates a graph depicting motor neuron recruitment for activities of different speeds.

Objective 6: Reaction Revolution – This objective summarizes the learning in the mission pack and discusses training your brain to focus and perform better through practice.
Goal: Program that trains your brain to focus and perform during “Go No-Go” practice sessions.

Preparation and Materials:

- Students need a computer, Chrome web browser, a CodeX device, the potentiometer and 180 servo.
- Optional: 3D printed CodeX pods https://www.thingiverse.com/firia/designs
- Supplemental materials found at learn.firialabs.com
  - Activity Guide (one per student or programming pair) for Objective 2
  - Activity Guide (one per student or programming pair) for Objective 3
  - Activity Guide (one per student or programming pair) for Objective 4
  - Activity Guide (one per student or programming pair) for Objective 5
  - Activity Guide (one per student or programming pair) for Objective 6

Standards addressed in the mission:

Computer Science	9-12.DA.10, 9-12.AP.12, 9-12.AP.13, 9-12.AP.14
Physical Science	LS1.A, HS-LS1-2, HS-PS4-5, Science & Engineering Practices, Crosscutting Concepts
ELA	RST.11-12.1, RST.11-12.2
Math	S-ID.2
PE	PE-HS1.1.3

Mission Assessments:

Written response: motor_neurons (Obj 1)
Programs: action_potentials (Obj 2), neural_rhythms (Obj 3), chewing_sim (Obj 4), athlete_reaction (Ojb 5), train_your_brain (Obj 6)
Language Muscle Magic Mission Quiz

Appendix A: Required Resources

Computer Resources

Each student will need:

- A computer with the Chrome web browser.
- Chromebooks work great – just make sure they are up to date.
- Windows 10 or Windows 11 will work with no additional drivers needed.
- A current Mac OS will also work with no additional drivers needed.
- A USB port is used to connect and program the CodeX. The CodeX comes with a USB to USB-C cable. If your laptop or computer has any other configuration, you will need a cable that has USB-C on one end.

Software Resources

- The interactive textbook and text editor is web-based. Make sure the website is not blocked.
- An email is required for signing in and saving work. It can be a gmail account, but any email will work.
- A per device license is needed to access the curriculum.

Physical Resources

The missions can be completed by individual students or student pairs utilizing pair programming. Each student or student pair needs:

- A CodeX device and USB-C cable
- A license for the curriculum in CodeSpace
- A set of peripherals from the Brain Kit:
    - A NeoPixel Ring and connecting wires
    - A potentiometer and divider board and connecting cables
    - A 180 servo and connecting cable
- Materials needed but not included:
    - Decks of cards or slips of paper for neuron signals (Mission 2, Objective 2)
    - A flashlight or light source (Mission 3, Objective 3)
    - (optional) 4 AA batteries for the CodeX

The classroom needs a set of at least 5 pods for the CodeX devices. The pods can be used as class, or shared between groups of students for the final activity (Mission 6 Objective 6). You can also 3D print more pods. The stl file is available in Thingaverse.

Notes

- When the CodeX is plugged into a computer, it will appear as a USB mass storage device, similar to a flash drive. This is not required for normal classroom use. So don't worry if your school has a policy preventing flash drives. You just close the pop-up window and continue.
- Occasionally Firia Labs will provide a software update that requires updating the core software on the CodeX. At those times you will need the flash drive feature to update the software, so you will need to use a computer with USB drive access. Often a teacher's computer is used to update all the CodeX.