NEUROMAKER

NEUROMAKER HAND KIT ALIGNS WITH INDIANA MIDDLE SCHOOL CTE STANDARDS

The Neuromaker Hand Kit brings the technology, experiences, risk taking and engineering of a high tech Brain Machine Interface team into your classroom. Through a series of exciting activities, hands on hardware and connections to real engineers, we hope that our authentic learning pedagogy will make the gap between your students and the technology challenges of the world much smaller.

The Neuromaker Hand Kit curricula brings together modular curriculum units designed to be compatible in multiple different learning environments. Example environments include full semester STEM classes, modules within a Robotics, Biotechnology and Engineering Design class or a free learning environment such as a Maker Space or Afterschool STEM club.

The intent of utilizing the full curriculum of the Neuromaker Hand Kit is to build investigative, inquisitive, and confident attitudes to pair with definitive technical and content knowledge. Students and educators then are given an open challenge in which they must use the frameworks and content knowledge they have learned as a starting point for a capstone project.

To learn more about the Neuromaker Hand Kit or contact us directly, please visit: https://www.neuromakerstem.com/



"There's technology to help these people in the U.S. but why can only 4% of the people who need these things afford them?" A group of 4 engineers sitting in the Harvard Innovation Labs mulled over this question while finishing their first AI algorithm.

Every year hundreds of thousands of people around the USA learn to live their lives with different forms of amputations that require serious rehabilitation and sacrifice. While some are fortunate to afford often very expensive high tech solutions, the vast majority struggle with different forms of mechanical devices that are no more complicated than a metallic hook. Comfortably shaking another's hand, performing household tasks and regaining essential pieces of the human experience require giving technology in a way these people can receive it.

After years of research and development facing this issue, BrainCo engineers created the BrainRobotics AI Dexus Prosthetic, which gives an accessible way for amputees to use cutting edge artificial intelligence and neuroscience to naturally control a prosthetic with their own muscle and brain signals. Since then, amputees using this technology have played the piano for the first time, regained their ability to write calligraphy, and finally given a firm handshake. For these results and more, the BrainRobotics Prosthetic Hand was awarded the Time Magazine Top Inventions of 2019, multiple Consumer Electronics Show awards and has been featured on CNBC, the Today Show and more.

This first innovation was because a group of committed engineers asked themselves how an issue they discovered could be solved. Now, we wish to ask our next question: "How do we inspire and educate the next generation of students to take on more problems in our society?"

To achieve that end, we have created the educational experience in your hand with hardware that builds STEM competencies, curricula that inspires free thinking and a free design challenge that connects your class with MIT and Harvard engineers. We hope you can invite your students to show the intersection of their learning and solving a real world problem within a defined and exciting space. As the great educator John Dewey once said,

"From the standpoint of the child, the great waste in school comes from his inability to utilize the experience he gets outside while on the other hand he is unable to apply in daily life what he is learning in school. That is the isolation of the school--its isolation from life."

* Dewey, J 1915, The School and Society, U of Chicago, Chicago, IL. Lombardi, M 2007, 1st ed. [ebook], available at https://net.educause.edu/ir/library/pdf/ELI3009.pdf, accessed May 2020.

Neuromaker Hand Curriculum Modules

Project Guided Assembly	Students learn base knowledge in mechanical engineering and electrical engineering through the build of an arduino powered mechanical hand. Students build in groups, provide peer feedback and undergo a debugging and evaluation process.
Biotech and Biomedical Exploration	Students learn fundamental knowledge in Neuroscience, Brain Machine Interfaces, human hand constraints and prosthetics through guided presentations, hardware applications and sharing activities. Students apply this knowledge to design their own Biomedical application and present their solution.
Engineering Design	Students learn the fundamentals of the engineering design process, prototyping, 3D printing, circuits, manufacturing process and methods of bringing an idea to a physical product. Students finish the module with a challenge to design and present their own idea.
Life and Physical Sciences	Students learn and explore the physical world with different hands on experiments involving friction, energy, potential energy, kinetic energy, forms of energy and laws of motion. Additional exploration into human body systems is also provided.
Introduction to Programming	Students learn programming concepts within a block based programming environment. Sequences, events, loops, conditionals and variables are presented and implemented into a virtual activity and physical hardware activity.
Applied Artificial Intelligence	Students learn the conceptual and foundational concepts of Artificial Intelligence guided by the AI4K12 “five big ideas” AI learning standards. Students then progress through hands-on activities which enable them to implement 3 different AI applications to different projects. Finally, students demonstrate their understanding of AI concepts by working on three different AI challenges inspired by real world combinations of AI and advanced prosthetics.
Applied 3D Printing Exploration	Students learn the use of CAD software and 3D printing execution via project based learning challenges. Students are presented with the Southampton Hand Assessment Protocol (SHAP) test that real engineers must pass in order to create a medically approved prosthetic hand. Students will be challenged with 3D printing different extensions and attachments to their NeuroMaker Hand in order to pass this test. 3D printing files, sample solutions, video walkthroughs and more are provided.
NeuroMaker Creative Challenge	Students are tasked with using the knowledge and skills they have gained to design their own prototype that solves a real world challenge. Students have the option to present their solution in the form of a scientific paper and 2 minute video to BrainCo Harvard and MIT educated engineers and educators for real world feedback.

CTE Standard Alignment	Module	Classes	Main Question	Real World Connection
Domain 1 - General Engineering and Technology Concepts				
ETE 1.1 Illustrate the purpose of technology and engineering in society	**Engineering Design**	**Documentation Project**	How is this engineering solution or product beneficial to society?	Students present their prosthetic solutions to their peers and explain their design considerations for their intended users.
	Applied Artificial Intelligence	What is AI?, What Careers Use AI Technology?, Neuroethics, **Big Ideas in AI**	How do AI technologies impact society?	Students examine the value of different AI technologies and discuss how adoption of these technologies would impact society at large & healthcare.
ETE 1.2 Identify how engineering and technology impacts individuals, society, and the environment.	**Biotech and Biomedical Exploration**	Brain Machine Interface, Biomedical Tech, **Prosthetics Technology**, Biomedical Engineering Workshop	Which prosthetic is best for an amputee?	Students must evaluate the effectiveness of different prosthetics for individuals facing different societal and environmental issues.
	Life and Physical Sciences	What is Energy?, Where is the Energy?, Motion and Friction, **Exploring Static Friction**, Body Systems	How do material changes impact system response?	Students experiment & learn how different material choices can increase or decrease the friction coefficient, impacting the prosthetic's grasping abilities.
	Applied Artificial Intelligence	Intro to Hand Gesture Recognition, Intro to Text Recognition, **Intro to Speech Recognition**	How can AI be applied to improve communication?	Students explore how speech recognition AI can improve an individual's communication & productivity. They practice programming the Neuromaker Hand to recognize specific commands.
ETE 1.3 Apply the universal systems model when studying areas of engineering and technology.	**Introduction to Programming**	Setting up a Programming Environment, Intro Rock, Paper, Scissors, Conditionals, Functions and Variables, **Programming Project Part**	What is required in a computer program that involves user input data?	Students apply theory programming knowledge to develop their own interactive game which asks for user inputs and responds by moving the Neuromaker Hand or video game sprite accordingly.

	Applied Artificial Intelligence	Intro to Text Recognition, Intro to Speech Recognition, Creating an AI Autonomous Hand, AI Gestures in ASL, **Build an AI Rock, Paper, Scissors Partner**	How does AI programming differ from traditional programming?	Students must train an algorithm, program different commands and then use appropriate sensor inputs to complete their challenge.
ETE 1.4 Demonstrate safe practices and procedures with tools and equipment.	**Project Guided Assembly**	Structural Assembly, **Electrical Assembly**, Tendon Connections and Hand Structure, Reflection and Debugging	What components are required to control the motion of the Neuromaker Hand?	Students learn to read technical diagrams outlining wiring & electrical component connections and work together to complete electronic assembly.
CS2: Students will integrate engineering and technology into academic fields, including the STEM disciplines. (ETE 2.1 - ETE 2.2)	**Project Guided Assembly**	**Reflection and Debugging**	How well does the prosthetic match the product specifications?	Students evaluate the quality of their Neuromaker Hand builds and test the functioning of basic features.
	Biotech and Biomedical Exploration	Biomedical Engineering Workshop, **Biomedical Engineering Project Presentation**	What are current problems with prosthetics on the market?	Students collaborate in teams to work on engineering an upper limb prosthetic prototype and create written technical reports & presentations.
	Engineering Design	**Documentation Project**	How do you simplify your project to showcase to colleagues & potential investors?	Students collaborate in teams to design their own version of the Neuromaker Hand and document & share their process through their group blog.
Domain 2 - Engineering Design and Development				
CS4: Students will apply engineering principles when planning, developing, implementing, and analyzing technological solutions. (ETE 4.1 - ETE	**Biotech and Biomedical Exploration**	Biomedical Tech, **Biomedical Engineering Workshop**, Biomedical Engineering Project	How do you design a product incorporating user feedback?	Students evaluate current prosthetic technologies & design solutions to improve prosthetics for specific user needs.

4.5)		Presentation		
	Engineering Design	**What is the Engineering Design Process,** Engineering Prototypes, Introduction to 3D Printing, Introduction to Manufacturing, Documentation Project	What is the Engineering Design Process?	Students learn the logic behind the engineering design process and methods to measure the effectiveness of different solutions. Students as a group are then tasked with brainstorming solutions to different provided activities.
ETE –5.1 Differentiate between the functions of motors, gears, sensors, wheels and control systems.	**Engineering Design**	**Introduction to Circuits and PCBs**	What Controls the Fingers of a Robotic Hand?	Students are introduced to principles of electric circuits, types of electrical circuits, sensors, motors and microcontroller board. Investigations are carried out through applications with the Neuromaker Hand as they apply to biomechanical movement.
ETE –5.2 Interpret a technical document to build a working prototype of an automated system.	**Project Guided Assembly**	Structural Assembly, Electrical Assembly, Tendon Connections and Hand Structure, **Reflection and Debugging**	Does your model work as intended?	Students follow technical diagrams outlining the build of the Neuromaker Hand, a prototype of the BrainRobotics prosthetics hand.
Domain 3 - Producing and Using Technology				
CS6: Students will select, use, create, and evaluate transportation technologies. (ETE-6.1 - ETE-6.3)	**Future Direction**	May be incorporated with the addition of partner materials	—	—

CS7: Students will select, use, create, and evaluate construction technologies. (ETE-7.1 - ETE-7.3)	**Future Direction**	May be incorporated with the addition of partner materials	—	—
ETE –8.1 Investigate various types of manufacturing systems including continuous, batch, and custom.	**Engineering Design**	Introduction to 3D Printing, **Introduction to Manufacturing**	Which manufacturing process should you use?	Students are introduced to standard large scale manufacturing processes including; injection molding, sand cast, CNC, plasma cutting and sheet metal forming. Real life concepts modern assembly lines are explored.
ETE –8.2 Utilize appropriate designs, techniques, tools, materials, and processes for manufacturing systems.	**Project Guided Assembly**	**Structural Assembly**	How can the structure of a biological system be modeled?	Students are presented with a learning and build guide which they must use to build the mechanical portion of their mechatronic prosthetic prototype as a team.
ETE –8.3 Produce simulations, models, and/or prototypes for specific manufacturing systems.	**Future Direction**	May be incorporated with the addition of partner materials	—	—
ETE –8.4 Describe and create a logistical path a product takes from its point of origin to its destination.	**Engineering Design**	Introduction to 3D Printing, **Introduction to Manufacturing**	How are products manufactured?	Students are introduced to how common materials and products are manufactured on a large scale including injection molding, sand cast, CNC, plasma cutting and sheet metal forming. Real life concepts like modern assembly lines are explored.
ETE –9.1 Investigate various types of biotechnologies including agricultural, genetics, medical, and imaging technologies.	**Biotech and Biomedical Exploration**	**Brain Machine Interface**, Biomedical Tech, Prosthetics Technology, Prosthetics and Human Grip, Biomedical Engineering Workshop	How do we acquire brain signal data?	Students learn about different types of brain signal data acquisition and current applications for BMI in medicine & research.
	Engineering Design	**Introduction to 3D Printing,** Introduction to Manufacturing	In what fields & professions is 3D printing being used?	Students will evaluate different 3D printing methods and explore which methods make sense for various applications related to manufacturing, medicine, architecture, custom art, and design.

	Applied Artificial Intelligence	Introduction to Hand Gesture Recognition, **Introduction to Speech Recognition**, Creating an AI Autonomous Hand	How is AI related to speech therapies?	Students explore how speech recognition AI can improve an individual's communication & productivity. They practice programming the Neuromaker Hand to recognize specific commands.
ETE –9.2 Examine appropriate designs, techniques, tools, and processes for medical or genetic engineering	**Biotech and Biomedical Exploration**	**Brain Machine Interface**, Biomedical Tech, Prosthetics Technology, Prosthetics and Human Grip, Biomedical Engineering Workshop	How do we make use of brain signal data?	Students discuss potential applications of Brain Machine Interface technology to address unmet needs - in medicine & research.
ETE –9.3 Construct simulations, models, and/or prototypes for specific biotechnology disciplines.	**Project Guided Assembly**	**Tendon Connections and Hand Structure**	How can we model the structure of a biological system?	Students complete their Neuromaker Hand build and understand that they will be using the robotic hand to model real hand behaviors.
	Biotech and Biomedical Exploration	Introduction to Neuroscience, **Body Systems and the Human Hand**	How can we model the mechanics of a biological system?	Students relate the components in the mechatronic prototype to the biological systems in the human body: muscular, skeletal, & neural systems.
CS10: Students will identify, select, and use energy and power technologies. (ETE –10.1 - ETE –10.4)	**Project Guided Assembly**	**Electrical Assembly**	How can the nervous system be modeled electronically?	Students complete the electronic portion of their Neuromaker Hand build and understand that the electronics system will be modeling the neurons going through the arm & hand.
	Engineering Design	**Introduction to Circuits & PCBs**	How do data & energy flow through a system?	Students are introduced to circuits & controls; they will learn about servo motors, Infrared (IR) sensors, microcontrollers, and actuators, and diagram the flow of energy & data through the Neuromaker Hand.

CS11: Students will select, use, create, and evaluate communication technologies (ETE –11.1 - ETE –11.4)	**Introduction to Programming**	Setting up a Programming Environment Introduction Rock, Paper Scissors, Conditionals, **Functions and Variables**, Programming Project	What are the building blocks of a computer program?	Students code their own functions and learn that functions are the building blocks of a computer program and variables store program data.
	Applied Artificial Intelligence	What is AI?, Introduction to Hand Gesture Recognition, Introduction to Text Recognition, Introduction to Speech Recognition, **Creating an AI Autonomous Hand,** AI Gestures in ASL, Build an AI Rock, Paper, Scissors Partner	How do you train a Machine Learning program?	Students will train a model to recognize different daily life items, like a pen, eraser or paper, and then must program different hand gestures to grasp these items like a real prosthetic.
Domain 4 - Engineering and Technology Careers				
CS12: Students will explore engineering and technology related careers (ETE-12.1 - ETE-12.3)	**Applied Artificial Intelligence**	What is AI?, **What Careers Use AI Technology?**, Neuroethics, Big Ideas in AI	What professions & academic domains use AI technology?	Students will learn why they should learn about AI, how AI influences their daily lives, what career options are available and the skills required to build a career in AI.

	Engineering Design	**Introduction to 3D Printing,** Introduction to Manufacturing	In what fields & professions is 3D printing being used?	Students will evaluate the pros & cons of various 3D printing methods and explore methods used in manufacturing, medicine, architecture, custom art, & design.