BRAINTECH INNOVATION CHALLENGE
COURSE SYLLABUS

Create Innovative Solutions to Society's Complex Challenges

Instructor: Program Lead: New York Academy of Sciences
Course Time & Format: 10 weeks; approximately 2-4 hours weekly
Format: Blended; Online
Age Level: 13 - 17 years old

COURSE DESCRIPTION & OBJECTIVES

Innovation Challenges are an introduction to foundational concepts of design thinking with an emphasis on developing and testing new solutions to society's greatest challenges. The BrainTech Innovation Challenge requires students to work in self-selected, distributed teams, requiring cross-cultural communication, dynamic problem solving, deep critical thinking related to society, leadership and project management skills.

Students must first identify their project team and then work together with a mentor to apply design thinking processes to approach real-world brain health problems in an innovation challenge with the Junior Academy. While each student must identify their own role within the team, together they will learn how to identify and map out a real problem and ways to build and test solutions quickly through an iterative, scientific approach. This course requires extensive student collaboration and regular engagement through The Academy's Junior Academy and its online platform, Launchpad.

THE CHALLENGE

Advances in brain technologies are rapidly moving from the lab to meaningful real-world use. Brain wearables, or noninvasive brain-sensing devices, use electroencephalography (EEG) to measure brain activity. These tools are especially good at detecting changes in real time. This makes them useful for catching brain events like seizures, and researchers are exploring their use for early detection of conditions such as epilepsy, sleep disorders, concussion, and memory decline — sometimes even before symptoms appear. Brain-computer interfaces (BCIs), meanwhile, read brain signals and translate them into outputs, helping people move, communicate, or connect with technology in new ways. These devices may be non-invasive or implanted on or inside the brain. Neurostimulation systems apply stimulation (electrical, magnetic, sound, etc.) to neurons or directly to the brain and are already being used in the treatment of pain and epileptic seizures. Brain technologies, which not so long ago felt like science fiction, today offer the potential to transform healthcare and individual human lives. Researchers

are testing these tools for early recognition and monitoring of disease and human-machine interaction.

Of course, as with any new technology, responsible design is essential to realizing the benefits of brain technology. Questions of privacy, autonomy, consent, affordability, and accessibility must also be considered for the end-users. It is critical that these devices be designed with meaningful input from the people who need them most.

The life-changing potential for BCIs and brain wearables is tremendous. BCIs could help people regain their ability to move or even communicate. Brain wearables could recognize and monitor disease and potentially increase the impact of medical intervention and lifestyle changes. How might you design a BCI or brain-focused wearable that enhances accessibility or enables early disease recognition while prioritizing user needs and well-being?

Student Challenge: **To design a brain-computer interface* or brain-focused wearable* that improves everyday life by enhancing accessibility or enabling earlier disease recognition or monitoring.**

Students will work collaboratively to consider the following when designing their teams' solution:

- How will you include input from the people or communities that your solution is intended to serve?
- Does your solution maintain human dignity and prioritize consent, privacy, and well-being for the user?
- What safety issues does your solution bring up and how will you mitigate them?
- Will distance from a major city or large medical research facilities limit which people can easily access your solution? Will your innovation be useful to those who live in rural areas? Can patients use your solution without being constantly monitored by an in-person, highly trained specialist?
- How can you make your solution accessible to the most people even during the trials phase?
- How affordable is your solution? Will the cost make your solution inaccessible for those with lower economic means? How can you overcome this challenge?

**This is a conceptual design challenge. Teams must not construct or test invasive or neurostimulation devices, test brain-monitoring devices on people (or any other living organism), or collect identifiable health or neural data. Any physical prototype should be nonfunctional and used only to illustrate the proposed design.*

LEARNING OBJECTIVES

INNOVATION CHALLENGE LEARNING OBJECTIVES *At the end of this course, students will be able to*:

- Develop critical thinking and problem-solving skills through brainstorming techniques to develop ideas and design a solution to a complex problem.
- Develop their own arguments and analyze competing perspectives to a complex problem with supporting evidence.
- Develop a deeper, personal civic identity and clearly identify their role in their community.
- Develop a solution that could play a part in transforming a specific societal need regarding a larger issue that is transferable to a specific community and larger global community.
- Use data and insights of an inquiry to answer a research question using scientific terms in charts, tables, or graphs.
- Utilize a social justice lens when applicable to interpret the data and critically think about which groups are not represented around decision making.
- Effectively communicate ideas, data and insights using various forms of media.
- Effectively collaborate with team members with empathy and mutual respect, and develop an expanded perspective about how people from other countries see the world.
- Effectively communicate challenge specific variables that impact the environment, society, and economy including examples of the effect on local communities.
- Understand how to apply Design Thinking methods to understand what users need, and how to develop solutions to meet those needs.
- Learn how to actively listen, work through any disagreements, and solicit input from people in creative ways to generate new ideas.
- Learn how to test ideas and develop rapid prototypes.
- Identify corresponding careers connected to Innovation Challenge.

COURSE OUTLINE

TIME	TOPIC	ASSIGNMENTS	FORMAT
Week 1	• Getting Started w/Junior Academy • Onboarding	• Join Launchpad Platform • Review Junior Academy Orientation • Attend Virtual Kick Off Week • Complete Course Pre-Survey	Individual
PHASE 1 Challenge Team Formation			
Week 2	Challenge introduction	• Complete Required Weekly Reading	Collaborative

	• Background on your Challenge • Finding Mentors & Experts • Reaching out to experts	• Engage in Launchpad Discussions • Complete activities found in resource library	
Week 3	Team Building • Forming Your Team • Holding a Virtual Team Building • Creating a Team Comm's Plan	• Engage in Launchpad Discussions • Hold 1st Team Meeting • Complete Required Weekly Reading • Due Milestone #1: Team Dynamics	Collaborative
PHASE 2 Research, Brainstorm & Plan			
Week 4	Researching • Gathering relevant and diverse materials, articles, books, and sources • Developing research questions and interviewing	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading	Individual Collaborative
Week 5	Brainstorming • Team Concept Brainstorm • Develop How "Might We" Ideas • Building Team Empathy	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading	Collaborative
Week 6	Design & Plan • Categorizing & Bundling Ideas • Deciding & creating your concept • Developing a user testing plan	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading • Due: Milestone #2: Design & Test Plan	Individual Collaborative
PHASE 3 Build, Test & Analyze			
Week 7	Build • Creating a Prototype • Build storyboard & journey map • Identifying your variables • Rapid Prototyping	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading	Collaborative
Week 8	Test & Analyze • Conducting User Testing • Getting User Feedback • Analyzing your data Results	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading • Due: Milestone #3 Analyze Results	Collaborative
PHASE 4 Iterate & Develop Final Projects			
Week 9	Iterate • Modifying your concept design based on your results • Refining & re-test your prototype	• Engage in Launchpad Discussions • Engage/Meet with your Team • Complete Required Weekly Reading	Individual Collaborative
Week 10	Develop Final Project	• Due: Executive Summary	Individual

	• Creating draft of Final Project • Project Feedback & revision • Submitting Final Project • Complete Course Post-Survey	• Due: Final Team Presentation • Due: Personal Reflection • Complete Course Post-Survey	Collaborative
New York Academy Challenge Final Project Review & Grading			

COURSE ASSIGNMENTS	**% of FINAL GRADE**
Milestone #1: Team Dynamics: This assignment is focused on team building and planning for how students will work together.	10%
Milestone #2: Design & Test Plan: This assignment is focused on the Team's proposed solution, hypothesis and test plan.	10%
Milestone #3: Build, Test & Analyze: This assignment is focused on building, testing and analyzing data related to your solution.	10%
Team Collaboration & Online Engagement throughout course	20%
Final Presentation, Executive Summary & Personal Reflection Final Presentation Rubric	50%
(100%) **Final Grade**	

GRADING POLICY

Late-work policy: Milestones 1-3 are allowed to be submitted late for point deduction. Late submissions of the Final Solution Presentation for this course will not be accepted after the due date unless previously arranged with **the Academy** for extenuating circumstances. It is important to stay up-to-date on assignments since much of the work builds on previous assignments and will impact students' ability to be effective in providing solutions for their teams' projects.

Re-grade policy: If a student thinks there has been a technical error in the grading of an assignment, they should email program administration at the Academy within one week of receiving the graded assignment, otherwise the assignment will not be regraded. Feedback is provided upon request.

REQUIRED READING LIST

Students are expected to read and refer to a wide variety of texts throughout this course; all of which can be found in the Launchpad Resource Library.

Please see a sample of the Resource Library reading list for this challenge:

Week 1

Launchpad Platform, Launchpad

Junior Academy Orientation, Launchpad

Week 2

BrainTech Challenge Background, Launchpad

What is a Brain Computer Interface? (University of Calgary)

Complexity and resilience: How wearable technology could transform brain health monitoring (Simon Fraser University)

Week 3

What is Human Centered Design?, Video Design Kit, Innovation, Design, Engineering & Organization (IDEO)

Design Thinking for Problem Solving, Video Design Kit, Innovation, Design, Engineering & Organization (IDEO)

Week 4

Designing Brain-Computer Interfaces that Connect Neurons to the Digital World (Harvard Medicine)

Navigating the Future of Brain-Computer Interface Technology video (Dana Foundation)

Revolutionizing Brain Health Tracking (Neurable)

EEG (electroencephalogram) (Mayo Clinic)

In-ear EEG wearables for brain activity assessment and cognitive rehabilitation: the emerging role of multimodal embedded intelligence (Frontiers in Human Neuroscience)

New Wearable Brain-Computer Interface (Georgia Tech)

NeuroPace (company that has designed a responsive neurostimulation technology for the treatment of epilepsy)

Wearable Technology for Brain Diseases (American Brain Foundation)

Brain wave-tracking wearable promises to detect your level of focus (New Atlas)

Bridging Bionics Foundation

Wearable Technology and Its Role in Neurologic Care: Emerging Issues in Neurology (Neurology)

Electroencephalogram (EEG) Based Prediction of Attention Deficit Hyperactivity Disorder (ADHD) Using Machine Learning

Electroencephalography Findings in Traumatic Brain Injury

Wearable EEG device s in the detection of mild cognitive impairment: a systematic review (npj Digital Medicine)

Wearable devices in neurological disorders: a narrative review of status quo and perspectives (Annals of Translational Medicine)

Brain Anatomy and How the Brain Works (Johns Hopkins Medicine)

The Allen Institute Brain Map | Open Access Brain Research

Why Neuroethics Matters in the Age of Brain Technology (Dana Foundation)

Your Right to Mental Privacy in the Age of Brain-Sensing Tech | Nita Farahany TED Talk

Ethics of neurotechnology (UNESCO)

Mind over machine: UN urges ethical guardrails for brain tech revolution (United Nations)

Brain Wearables Will Know When Workers Are Losing Focus - Video (Harvard Business Review)

AAN issues guidance on the use of wearable devices (American Academy of Neurology)

Ethical considerations for implantable human brain–computer interfaces (Nature Neuroscience)

Study finds bringing clinical trials closer to patients expands access to research (Mayo Clinic)

Barriers and Improvements Affecting Inclusion and Accessibility in Clinical Trials (Medicover)
Practical Guide to Clinical Trial Accessibility: Making Trial Participation a Standard of Care (ASCO Publications)
Interviewing Experts, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Interviewing Individuals, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Interviewing Groups, Design Kit, Innovation, Design, Engineering & Organization (IDEO)

Week 5

How Might We, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Brainstorming Rules, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
How to Facilitate a Brainstorm, Stanford D School, 2020

Week 6

Bunding Ideas, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Doing a Gut Check, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Creating a Concept, Design Kit, Innovation, Design, Engineering & Organization (IDEO)

Week 7

Determine What to Prototype, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Rapid Prototyping, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Prototype to Test, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Identify a Variable, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Storyboards & Journey Maps, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Tinkercad, Autodesk

Week 8

Get Feedback, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Testing with Users, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
Research Methods, Launchpad

Week 9 - Week 10

Integrate Feedback & Iterate, Design Kit, Innovation, Design, Engineering & Organization (IDEO)
How to Create a Presentation, Launchpad
How to Create Video Presentations, Movavi
Presentation Guidelines, Launchpad