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Curriculum Resources for Incorporating Cutting-edge Neurotechnologies into Secondary STEM Classrooms

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Eric H. Chudler is a research neuroscientist interested in the neuroactive properties of medicinal plants and herbs and how the brain processes information about pain and nociception. He received his Ph.D. from the Department of Psychology at the University of Washington in Seattle in 1985. He has worked at the National Institutes of Health in Bethesda, Md. (1986-1989) and in the Department of Neurosurgery at Massachusetts General Hospital in Boston, Mass. (1989-1991). Chudler is currently a research associate professor in the Department of Bioengineering and the executive director of the Center for Neurotechnology. He is also a faculty member in the Department of Anesthesiology and Pain Medicine and the Graduate Program in Neuroscience at the University of Washington. In addition to performing basic neuroscience research, he works with other neuroscientists and classroom teachers to develop educational materials to help K-12 students learn about the brain.

Curriculum Resources for Incorporating Cutting-edge Neurotechnologies into Secondary STEM Classrooms (Resource Exchange)

Engaging Students in Contemporary Science & Engineering through Neurotechnologies

Exciting advances in neurotechnologies, once the ideas of science fiction, are now regularly featured in the media, making neural engineering a high-interest and contemporary topic for STEM classrooms. Neurotechnologies such as brain-computer interfaces, deep brain stimulation, retinal implants, smart prosthetic limbs, and artificial neural networks—and the complicated neuroethical considerations associated with their design and use—provide opportunities for transdisciplinary STEM explorations. Within this field, engineers, scientists, computer scientists, ethicists, practitioners, and end-users come together to design devices and therapies for neurological disorders such as stroke, Parkinson's disease, and spinal cord injuries.

Free Curriculum Units for Secondary STEM Educators

A growing library of teacher-authored curriculum units and instructional resources is available *for free* to secondary STEM educators (Grades 6-12). For the past nine years, the Center for Neurotechnology has hosted a Research Experience for Teachers (RET) program at the University of Washington that engages secondary teachers in a seven-week research experience paired with curriculum design. The curriculum units authored by the RET educators are aligned to the Next Generation Science Standards and provide suggestions for integrating neuroscience content, neuroethics, and engineering design challenges. The teachers implemented the lessons in their own classrooms and then revised them based on piloting feedback before the units were published.

Currently, nine teacher-authored curriculum units for secondary STEM courses are available, with more added each year. Many units utilize engaging technologies—such as electromyographically-controlled robotic gripper hands, circuit boards, SnapCircuits, Arduino Uno rigs, and SpikerBoxes—that illustrate basic concepts of the sensorimotor feedback loop. The study of bioethics is integrated into the units through the use of case studies, articles, and discussions. These curriculum units engage students in designing and building models of neuroprosthetics, artificial neural networks, and sensory substitution devices. Curriculum units are available for middle school STEM courses, as well as for high school biology, physics, chemistry, and computer science.

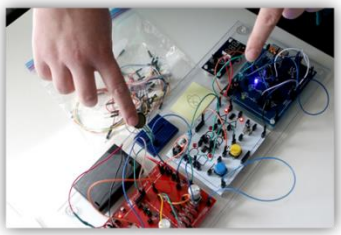
"Students were hooked by the combination of science and ethics. Using circuits, Arduinos/sensors, etc. in designing lessons always helped students feel like they were doing pertinent science. And hearing about current research kept them hooked. They knew the lessons were real and important."

~RET teacher participant

Highlight: Circuitry and Sensory Substitution Curriculum Unit

Time: Two weeks **Lessons:** 4 **Grades:** 10-12 **Focus:** Physics/Cambridge IGCSE Physics

In this unit, physics students extend their knowledge of basic electric circuits by studying the function and use of more complex components [1, 2]. Students are introduced to basic neuroscience principles and use these concepts to design, build, and optimize a prototype of a sensory-substitution device on circuit boards. They present their models on a scientific poster. https://centerforneurotech.uw.edu/education-k-12-lesson-plans/circuitry-and-sensory-substitution.



Highlight: *Exploring Neuroscience and Neurotechnologies at Home* e-book

Chapters: 5 **Grades:** 9-12 **Focus:** Neuroscience and Neurotechnologies

This free, interactive e-book for secondary students contains five chapters: Basics of Neuroscience & Neural Engineering; Brain-Computer Interfaces; Brain and Spinal Cord Stimulation; Neuroethics; and College and Career Pathways [3]. https://centerforneurotech.uw.edu/education-k-12-resources-teachers/neuroscience-neurotechnologies-e-book.

Evaluation Findings

The RET program attracts Grades 6-12 STEM teachers from both public and independent schools, and from urban and suburban settings. We conducted an online survey in 2020 of teachers who had participated in the program from 2013 to 2020. Respondents (N=16) estimated that they had used these curriculum materials with over 3,600 students across grades 5-12. Evaluation results indicate that 93% of RET teachers who authored and used the units "agreed" or "strongly agreed" on a five-point Likert scale that: their students were very interested in the curriculum activities; that the curriculum increased their students' awareness of neural engineering careers; and that the curriculum was a useful teaching resource that used engaging, real life contexts and had strong ties to neural engineering concepts.

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Additional Resources: https://linktr.ee/CenterforNeurotechnology.

References

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