Evaluation of Online Lab Platforms Against Best Practices for an Undergraduate Neurobiology Course

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Introduction

The COVID-10 pandemic has changed the way that traditional college courses, and especially laboratory courses, are taught.

Best practices for online education

Following best practices helps instructors to develop the most effective online instruction, increasing student learning and engagement. Many courses and laboratories have been forced to move online in the past 8 months as COVID mandated remote instruction. Many online neuroscience laboratory resources had already been developed due to the cost- and time-intensive nature of neurobiology laboratory techniques. Instructors can take advantage of these pre-existing online resources during the COVID pandemic.

Neurobiology course and project

The neurobiology course taught at CSB/SJU (Biology 320) offers a laboratory component for the first time in spring 2021. Online laboratory resources may continue to be utilized in parallel with hands-on investigations post-pandemic. This project researched best practices for online undergraduate science laboratory instruction and tested neurobiology online lab platforms against best practices and course goals.
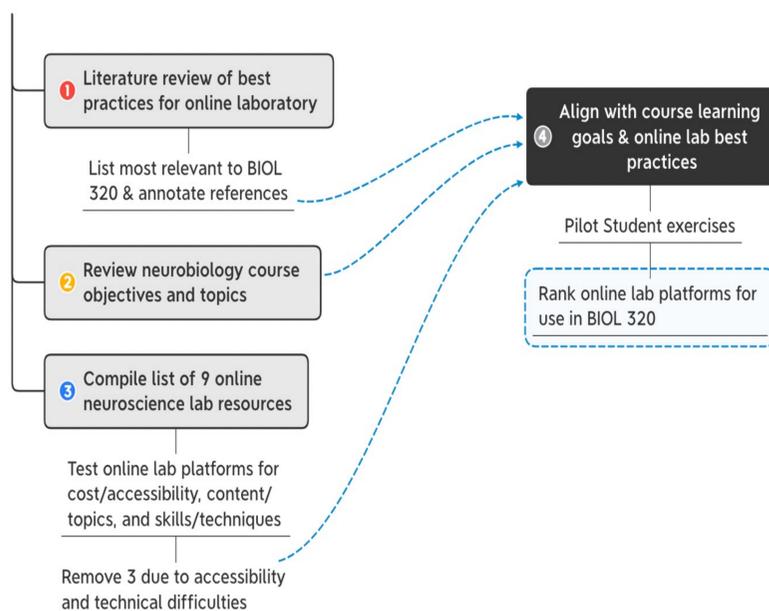
Methods

Figure 1. Methods used to evaluate online neurobiology laboratory platforms against best practices and course goals.

Results
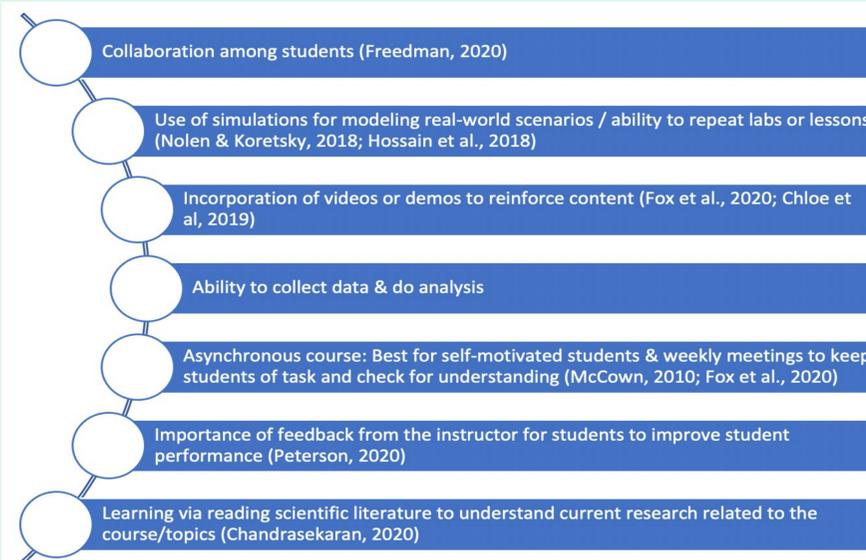
- **Best practices for online education:**

Figure 2. List of best practices for online science laboratories and education.

- **Labs removed for accessibility issues:**
  - NeuroSim5
  - Swimmy
  - UCLA- NSF modules
  - Electrophysiology of the neuron

- **Description of top labs: NeuroWiki & MetaNeuron**
  - Accessible from personal computers & easy-to-use: increases student understanding and facilitates student collaboration
  - Include many simulations for a topic/lesson and/or provides in-depth material for each topic
  - Allow data collection and data analysis
  - Include student exercises & instructor's manuals, with videos & demonstrations of the simulations or concepts

Table 1. Alignment of five neurobiology lab platforms with neurobiology course needs and topics. The criteria were cost/accessibility, topics covered in the platform, alignment to neurobiology course units, skills learned from the simulations, and if a manual was available.

Platform	Cost & Accessibility	Topics covered	Aligned to unit	Skills	Manual/Lesson ideas
MetaNeuron	Free; PC/MAC	Membrane potential, membrane time constant, membrane length constant, axon action potential, axon voltage clamp, Synaptic potential and current	Unit 2: action potential, ion channels, membrane potentials Unit 3: Synapses	Form & test hypothesis, analyze results and view a graph	Yes
Neuromembrane	Free; Webpage	Resting membrane potential, action potential, voltage clamp, EPSP, IPSP, synaptic integration, passive membrane properties	Unit 2: action potential, membrane potentials, graded potentials	Form & test hypothesis, visualize the movement of ions across the membrane via channels	No, but how to use platform
Neuronify	Free; PC/MAC	Use of neurons, synapses, neuron activators, and sensors to create neural networks. Create input summation, control inhibition and detection of stimulus	Unit 2: action potential, graded potential Unit 3: Synapses	Simulate neural networks, utilize measurement tools (voltmeter, spike detector, graph) analyze results	Tutorials/ example circuits
NeuroWiki	Free; Webpage	Membrane simulations, current/voltage clamp, motor neurons, passive vs. active properties, chemical synapses, presynaptic release, mechanoreceptors, muscle simulations	Unit 2: membrane potentials, action potential propagation, ion channels Unit 3: Dendritic integration, Synapses	Formulate and test a hypothesis, analyze results from simulations	Yes
Allen Brain Institute	Free; Website	Detailed atlases of gene expression in adult mouse brain, mouse spinal cord, developing mouse brain, adult human brain, and developing human brain; cell types database, connectivity atlas, in vivo recordings, and datasets from aging, dementia, and TBI brains.	Unit 1: brain circuitry and imaging, literature searches Unit 4: lesson on use of open data with Allen Brain Atlas as example	Understanding how to read MRI images, application of tools to current scientific publications and research	No

Conclusion/ Discussion

The increasing demand for online instruction and remote science laboratories is due to the current pandemic but is likely to change the direction of education for the future. The top-rated online laboratories for neurobiology offer virtual simulations, data analysis, understanding of laboratory techniques, and coverage of numerous course topics. The CSB/SJU Neurobiology course is prepared for either remote or traditional learning via online laboratories that follow best practices for online instruction to promote student engagement and learning.