Real World Neuroscience Assignments for Learning What Matters in the REAL WORLD

23.12 (SAT 4-5) ZZ11
SFN 2011 in D.C.

Steve M. Potter

Director, Laboratory for Neuroengineering, Georgia Institute of Technology
Coulter Department of Biomedical Engineering at Georgia Tech and Emory University
Atlanta, GA 30332 steve.potter@bme.gatech.edu

INTRO

What is wrong with most introductory neuroscience curricula?

- Students must remember many "factoids" with little emphasis on connecting the big picture ideas. Most of this is soon forgotten.
- Mostly passive listening to lectures and reading of textbooks.
- Undergrads perceive getting a good grade as the "goal" of the course.
- The course does not prepare them for many of the things we do as neuroscientists, neuroengineers, or clinicians.

The solution: ***Make assignments more relevant to the world outside the lecture hall.***

For the past five years, I have been creating and refining new Real World assignments for Introductory Neuroscience, taught to 40-60 biology and biomedical engineering seniors each Fall at Georgia Tech. Successful assignments and advice are presented here. **(QR codes accompany the examples, allowing you to download documents instantly by scanning them with your smartphone.)** Students learn a lot about real neuroscience research from Special Guest lecturers, and earn extra credit by attending neuro seminars and conferences and writing brief reports. They also enjoyed earning extra credit by going on charity walks to benefit Alzheimer's and ALS research.

IntroNeuro Fall 2011 Alzheimer's Walkers

Contribute a neuro article to Wikipedia

Most of the assignments for IntroNeuro revolve around a semester-long project: to create a **Wikipedia article** on a neuro topic of their choice, from scratch or from an article that is merely a "stub". The History tab in Wikipedia makes it easy to see which parts they contributed. Wikipedia has a "sandbox" for students to practice editing articles, and many tutorials and style guides. Below are the scoring rubric and a list of actual pages created, with a QR code to download a PDF with clickable links to the articles. My students have contributed over 250 articles to the corpus of neuro articles on Wikipedia, and many continue to maintain those pages after graduating.

Georgia Tech IntroNeuro Wikipedia Article Score Sheet

Your total (out of 10):

Student name:
Student's Wiki Handle (from History tab):
Page title:

- ☐ Incorporates good, detailed, recent neurobiological information.
- ☐ 1500<Word Count<3000, not counting refs.
- ☐ Readable by laypeople; jargon is explained or hyperlinked.
- ☐ At least 10 peer reviewed journal refs. (may include review papers)
- ☐ Up-to-date content, at least a couple refs in the last 3 years.
- ☐ Well hyperlinked to other wiki articles.
- ☐ Well formatted, follows Wikipedia style.
- ☐ Good organization, including detailed table of contents and headings.
- ☐ Well written (good grammar, no typos, readable)
- ☐ Outstanding in some way:

Additional comments:

WIKIPEDIA
The Free Encyclopedia

Georgia Institute of Technology -- Department of Biomedical Engineering
BMED/BIOL4752 Fall 2010 **IntroNeuro Wikipedia Articles by Students** Prof. Steve M. Potter

Wiki username, "Page title"

1. Bbari3, "Perineuronal net"
2. ccarlson6, "Choice-Supportive Bias"
3. jcarlson6, "Transcranial Direct Current Stimulation"
4. Chrisgiardina, "Clinical Neurochemistry"
5. lhsu6, "Subgranular zone"
6. syim1288, "Jumping Frenchmen of Maine"
7. Glh807e, "Activation-synthesis hypothesis"
8. Vkadarar3 "Anti-MAG Peripheral Neuropathy"
9. jkim309, "Apotemnophilia"
10. skoenig3, "Emotional Lateralization"
11. Sliyanagarmage3, "Chronesthesia"
12. Llucx3, "Motor unit plasticity"
13. Pmcmenamin3, "Neurotrophic electrode"
14. TaoPan, "Animal model of depression"
15. spandya3, "Nominal aphasia"
16. Aparekh3 "Secondary Consciousness"
17. Apaschal3, "Sopite syndrome"
18. dhru4you, "ALLOCHIRIA"
19. 13134798, "Vision Restoration Therapy"
20. Courtney Price, "Alternating Hemiplegia of Childhood"
21. Bethany Thames, "Auditory fatigue"
22. Justin Tsay, "THOMAS (neuroscience)"
23. Jvanloozen3, "closed head injury"
24. Swethering3, "Dentate nucleus"
25. jwilliams43, Malleable Intelligence
26. mickeymose "Alzheimer's Disease biomarker"
27. Srbanton, "Aftertaste"
28. JorgeBaro "Neural Adaptation"
29. ameliabickrnese, "Copper Deficiency"
30. NBourgeois, "Diplegia"
31. Aburns3, "Neurofibrillary Tangle"
32. reginachang, "Topographical disorientation"
33. Jconn3, "Body Schema"
34. Adalapati3, "Thin-slicing"
35. Rohit.ganju, "Mnemonist"
36. jgil3, "Primary Consciousness"
37. Christina Graves, "Delta Wave"
38. DjKdeSO, "Sensory stimulation therapy"
39. Jhawes3, "Sensation (psychology)"
40. Ashleyhenry, "Utilization Behavior"
41. Jholcomb6, "Synaptic Plasticity"
42. Mkiani3, "Neurostimulation"
43. Sknabe3, "Neurorobotics"
44. Amonroe3, "Bilingual Interactive Activation Plus (BIA+)"
45. Mohan.k.natrajan, "Neuroplastic effects of pollution"
46. Hpatel35, "Spatial view cells"
47. Glg849v, "Alpha Wave"
48. ctan7, "Somnology"
49. glh742d, "SUNCT"

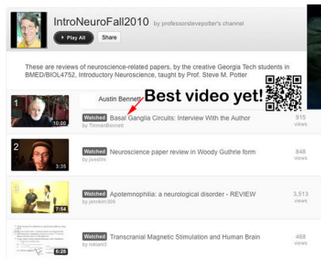
Scan QR code to download this file, with clickable links.

Example of a Wikipedia article created by one of my students, Kirsten Kepple, about MEAs:

Read and present scientific articles

To become an expert in her or his chosen Wikipedia Article topic, each student must search for and critically read quite a few research articles. Some of these they present orally in class, or on YouTube videos. I graded based on the scientific content of the videos, but some of the students put a lot of effort and creativity into their paper review videos, because they knew that the whole world is watching. They enjoyed the assignment more when it was done in pairs or small groups. Some examples are shown below, with a QR code that links to some actual videos.

YouTube videos by my students:
YouTube playlist "IntroNeuroFall2010"



Interview an Expert

After reading some papers in the area of their Wikipedia topic, it is very helpful for students to talk to an expert in that field, to ask questions based on their reading, to get some of the history of the field, and to get pointers to additional useful sources of information. I require that this interview be conducted orally (in person, by phone or Skype or video chat), not via email. This enhances the amount of information transferred, because the rarefied emotional content and slow back and forth of email conversations often results in wasted time and misunderstandings about the level of information needed. Students are given a lot of coaching on how to approach an Expert for an interview, and how to make it beneficial for them as well. Most Experts are happy to help the student build an authoritative Wikipedia article by lending their expertise. For grading, students submit a 1-page summary of the interview, and include advice for next years' students about how to get the most out of the interview. Presenting them with this advice from last year at the outset empowers them to forestall many potential problems. An excerpt is presented below, and a QR code to the file.

Expert Interviews - Advice from Students 1

Introductory Neuroscience -- Prof. Potter -- Fall 2010

Jennifer Carlson
"Some advice I would give next year students for conducting their interviews would be to not be intimidated. I was very intimidated to interview an expert in a field I knew very little about, but it turned out that Dr. Rorden was excited to share his knowledge of this topic and point me to places where I could learn more. Also, I would advise to make the list of questions before hand and send them to the expert so that both he and you are prepared for the interview. Finally, I believe that one reason the interview was so beneficial was because it was done face to face. Try to find an expert in the area that you can interview face to face. It is easier to show your interest in the topic in person than over the phone."

Seth Koenig
"Sending questions before hand definitely may help make the interview more relaxed. It's very helpful to hear an expert talk about research on your topic rather than read articles because interviews are interactive and you can respond and change questions as the interview progresses."

Savannah Cookson
"This process proved that persistence is key when trying to contact an expert, and was good practice for contacting graduate school professors and research companies."

Bethany Thames
"My recommendation for students in the future would be to be very clear when explaining what you want to gain from the interview. I think that I was able to schedule mine so easily (besides just quick responses and cooperation from the clinic staff), because I initially was upfront about what I needed to get out of the talk. That way, the most qualified person was able to get in touch with me. If I had simply stated that I wanted to interview someone in their department, I think that the process would have taken much longer."

Scan QR code to download this file, with clickable links.

Read and review a neuro book

Busy college seniors usually don't read technical books unless they have to. But this is an important activity for all practicing neuroscientists, for keeping current or learning a new subfield. Each student is required to choose and read a neuro book, preferably one that will help them write their Wikipedia article. Then they must write a detailed review of it on Amazon.com, of the sort that typically get "most helpful review" status. To get used to our scientific tradition of being publicly accountable for things we say, they must use their Real Name on the review. Some students are chosen to present their reviews to the class orally. Several reported that their book somehow "changed their life".

PEER REVIEW ASSIGNMENT

The students' book reviews on Amazon are graded by each other (see rubric below). Each student critically reads and ranks 5 of them, according the the Book Review Assignment Instructions. Although all reviews are all good, some must be ranked as poorer than others, and get fewer points. This is an exercise in the peer review process scientists use for reviewing grant applications. Providing civil and productive feedback to the book review author is emphasized. By grading others' book reviews, and hearing oral presentations, the students are exposed to other books they may wish to read, but would not have gone looking for otherwise.

amazon.com

Neuro Book Review on Amazon.com **Assignment Instructions**

- Your review should be at least 1000 words (about 2 pages at 12 point), well organized, well written, and should include:
- An informative title
- Your Real Name™
- A rating, 1-5 stars
- A brief summary of the point of your review in the first sentence or two.
- Your overall opinion of the book.
- A synopsis of the parts of the book.
- Explanation of the style and structure of the book.
- Your opinions on specific parts or aspects of the book. (this is the meat of your review, and should be easy to scan: headers, separate paragraphs, etc.)
- Some useful or interesting quotes from the book.
- A summary of your opinions/review.
- A recommendation for potential readers (whether to get, how to read it, or anything else you want to say straight to them.)
- Anything else you want to put in there that you feel is appropriate and useful for a book review.
- No copying from other reviews—all must be in your own words (except book quotes, obviously, which should be marked as such)
- Feel free to slam the book if you unfortunately chose a bad book. But keep your language civil and informative.

IntroNeuro Fall 2011 *Amazon Book Reviews* *Prof. Steve Potter*

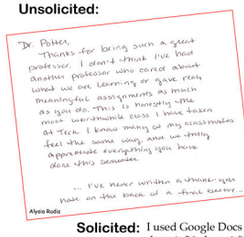
The student's names are followed by the book and the book author, and each selection is hyperlinked to the student's actual review on Amazon.

1. Anangpau, Pradeep - Mathematical Foundations of Neuroscience – G Bard Ermentrout, David H. Terman
2. Barber, Annie - The Human Fossil Record - Volume 3, Craniodental Morphology of Genus Homo (Africa and Asia), Jeffrey H. Schwartz, Ian Tattersall
3. Berry, Zachary - For the Victims: From Neurons to Self - Rodolfo R. Llinas
4. Bhid, Morgan - Hope: Four Keys to a Better Quality of Life for Parkinson's People – Hal Nevison
5. Chung, Andy - Consciousness: A User's Guide – Adam Zeman
6. Cooper, Daniel – Genetics and Genomes of Mental Disorders – Michael C. O'Donovan, Peter D. Kiser
7. Dolinsky, Joseph – Buddha's Brain: The Practical Neuroscience of Happiness, Love, and Wisdom – Rick Hanson
8. Foster, Paul – On Intelligence – Jeff Hawkins, Sandra Blakeslee
9. Foust, J.T. – The Human Brain Book – Rita Carter, Susan Aldridge, Martyn Page, Steve Parker, Jon Ronson
10. Frehning, Kevin – The Limits of Dream: A Scientific Exploration of the Mind/Brain Interface – J.F. Pagel
11. Ghosh, Usman – Consilience: The Unity of Knowledge – Edward Osborne Wilson
12. Ginton, Asaf – An Introduction to the Visual System – Martin J. Tovee
13. Guillulin, Michael – Cognition and Cancer – Christina A. Meyers, James R. Perry
14. Hensel, Allison – Brain Rules for Baby: How to Raise a Smart and Happy Child From Zero to Five – John Medina
15. Hong, Andy – Made to Stick: Why Some Ideas Survive and Others Die – Chip Heath, Dan Heath
16. Jux, David – The Co-ordination and Regulation of Movements – Nikolai Alexandrovich Bernstein
17. Kresak, Mallory – Deep Brain Stimulation: A New Treatment Shows Promise in the Most Difficult Cases – James Taube
18. Lawrence, Kelsey – The Cerebellum and Cognitive Function – Jeremy D. Schmahmann
19. Lee, Susie – Pleasures of the Brain – Morten L. Kringelbach, Kent C. Berridge
20. Lim, Christopher – What's Going On In There? How the Brain and Mind Develop in the First Five Years of Life – Lise Eliot
21. MacDonald, Kunal – The Brain Gate – J. Robert Hatherell
22. McCormick, Courtney – The Mind and the Brain: Neuroplasticity and the Power of Mental Force – Jeffrey M. Schwartz, Sharon Begley
23. McKahen, Michael – Neuroanatomical Textbook: Basics, Neurons, and Neural Tissue – Duane E. Haines, Gloria G. Mihailoff, J.L. Lanoxeso
24. Meléndez Cordoba, Angel – Language and the Brain: Representation and Processing – Helmut Schnelle
25. Morris, Aaron – Brain Repair – Donald G. Stein, Simon Brailowsky, Bruno Will
26. Morris, Emily – Criminals in the Making: Criminality Across the Life Course – John P. Hanlon, Stephen J. Hanlon, Kate E. Daigle
27. Murphy, Patricia – Axon Growth and Guidance – Jonathan Raper
28. Prophit, Chelsea – 100 Questions and Answers about Brain Tumors – Virginia Stark-Vance
29. Ramachandran, Linti – Psychology and Study Guide – Darrell L. Schacter, Daniel T. Gilbert, Daniel M. Wegner
30. Rasala, Michael – Incognito: The Secret Lives of the Brain – David Eagleman
31. Richardson, John A. – Neurology of Thinking – Frank Benson
32. Robertson, Kevin – Synaptic Self: How Our Brains Become Who We Are – Joseph LeDoux
33. Rowson, Sydney – Proust Was a Neuroscientist – Jonah Lehrer
34. Sem, Caitlyn – Counting Sheep – The Science and Pleasures of Sleep and Dreams – Paul Martin
35. Subramanian, Maki – Brain Network Model – David Stennett, Bruce Graham, Andrew Gillies, David Willshaw
36. Tang, Randolph – Eye, Brain, and Vision – David Hubel
37. Tweedlie, Lindsey – Gotting Started With Neurofeedback – John N. Demos
38. Tyburski, Erika – Neurobiology, Pathophysiology, and Treatment – Howard L. Fields, Raymond G. Hill, Paolo Marchettini
39. Vaughn, Lexie – The Science of Addiction: From Neurobiology to Treatment – Carlton K. Erickson
40. Venkatraman, Poornima – Interference and Cognitive Control – Charles E. A. Brainard
41. Wagstaff, William – Spheb. Exploring the Neural Code – Fred Rieke, David Warland, Rob de de Ruyter van Steveninck, William Bialek
42. Whatley, Lance – Control Nervous States Relating Sex and Pain – Richard J. Bodnar, Kathryn Grace Commons, Donald W. Pfaff

Scan QR code to download this file, with clickable links.

Comments from students and alumni

Unsolicited:



"Dr. Potter,
Thanks for being such a great professor. I don't think I've had another professor who cared about what we are learning or gave real meaningful assignments as much as you do. This is honestly one of the most worthwhile class I have taken at Tech. I know many of my classmates feel the same way, and we really appreciate everything you have done this semester.
... I've never written a thank you note on the back of a final exam...
Alysia Rudis

I know for a fact (as MANY students and myself have talked about this many times) that many of us feel that this was by far the absolute best course we have taken at Georgia Tech. You did an amazing job making the class interesting and fun and everything from the lectures to the assignments were all incredible in getting us to learn so much about the brain. --Morgan Wolfe

I absolutely love all these guest lecturers that you invite to come speak to us. You really have renewed my interest in the brain.
--Joe Caubo

Your class opened my eyes to the enormous possibilities in the scientific realm that is neuroscience and spurred within me a thirst to explore the field. Since graduation from Tech, I have been a Master's student in biomedical engineering at Johns Hopkins ... Sir, my small foray into this field has proven the arena of neuroscience to be as intriguing as was conveyed during your course. In more ways than one sir, I owe my passion in the field largely due to your tutelage.
-- Nishant Zachariah

Thanks for such a great class! Even though the tests and assignments were challenging I feel like I learned so much throughout the semester. I had always been sort of interested in neuroscience so I decided to take the class to learn more and I'm really happy that I did. I may even decide to go into neurology if I get into medical school or I might try to get more involved in the ethical side of neuroscience thanks to the book that I read for the class. So thanks once again for such a great semester! -Saira Ahmed

As time goes on, I love brains more and more and love learning about them. This course has made me want to change my goals significantly.... I always thought brains were too "hard" to do something with since everyone's brain is different. But now I'm in love with brains. I probably sound like a crazy person, but I seriously think about brains almost every second of the day.
--Jessica Holcomb

I really enjoyed your class [BMED4752] and definitely learned a lot. I strongly believe that your class was one of the main deciding factors in helping me realize that I wanted to get a PhD in neuroscience and possibly work with patients with Parkinsons Disease.
--Jenny Kim

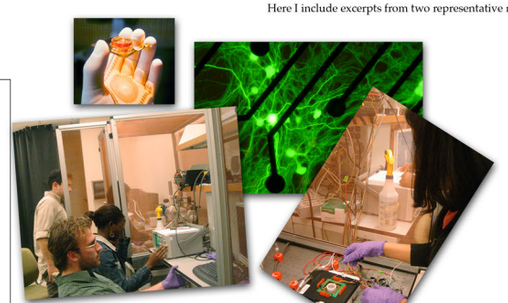
Solicited: I used Google Docs "Forms" feature to poll my alumni (those I could track down). 26 alumni filled out the survey, and 5 pages of excerpts from their responses are downloadable by scanning the QR code at right. Questions I asked them include:

- What are you doing these days? Career goal?
- How would you compare my course to other courses you took?
- How does it influence you today?
- Did the class influence your career path?
- What was the most memorable thing about me or the course?

Here I include excerpts from two representative responses:

Intro to Neuroscience was completely different from all my other courses because of its real world approach. This approach made the material relevant, interesting, and useful at the same time, therefore making learning a fun process. In addition to learning some great neuroscience, I also picked up on some very practical skills that I greatly value today - such as creating a Wikipedia article, directing, recording, and uploading a YouTube video, interviewing an expert in a neuroscience sub-topic, and writing an Amazon review article based on a book out in the market. I never did any of this in any other course and this made Intro to Neuroscience extremely refreshing and novel.
--Christa Caesar

The real world assignment aspect of the course was one of the most valuable collection of activities I completed as an undergrad to prepare me for life as a graduate student. The real world assignments made a significant impact on me, both at the time of completion and to this day. The process of gathering information, publishing it in a public venue and taking credit/responsibility for the content of the writing was almost an entirely unique concept to me as an undergraduate. To that point my classes had required a significant writing component, however, there was never a requirement to put my name on the line and make my writing available to the public. To my surprise, that actually significantly altered the way I approached the writing and substantially improved the quality of my final product. The assignments motivated me to become engaged in the topic and do an excellent job because I wanted to represent myself well. This is the same process that I am now going through as a graduate student....
--Mike Weiler



Do real research

Neuroengineering Fundamentals (BMED 4400):
A lab course designed to emulate Real World research

This course is for biomedical engineering seniors who have taken physiology and neuroscience courses. Students work in groups of 3 or 4 to devise and carry out complex experiments using dissociated cortical cultures grown on multi-electrode array (MEA) culture dishes. They begin by doing a thorough search of the MEA literature, and must come up with a project that could advance the state of the art in neural interfacing technology, neural information processing, network dynamics, learning and memory, etc. Their proposals are refined for 3 weeks while cultures they prepared develop complex connections and patterns of spontaneous activity. They often must build equipment or develop new methods to carry out their project, and program new analysis tools to mine their multi-unit data. Students use the same equipment used in the Potter lab, including MEA amplifiers and data acquisition systems by MultiChannel Systems, Axion Biosystems, National Instruments. They learn electronics and practice recording arthropod action potentials by soldering and using Backyard Brains Spiker Boxes.

The emphasis throughout is on learning by doing, and actively acquiring needed information from a variety of sources and experts. Students are graded not based on how their experiments progress, but on how well they learn from their successes and failures, as documented in detailed, useful lab notebooks that are passed on to subsequent years' students. There is a lecture component that surveys all the areas where brain tissue and technology meet, and includes a number of guest lectures by neuroengineers about their research.

QR Code for THIS POSTER:

Conclusions

- Undergrads are well able to create lasting artifacts that help teach neuroscience concepts to the world.
- Students enjoy learning by doing, and creating things they are proud of.
- They are much more motivated if they know someone besides their professor will be judging their work.
- Constant exposure to real neuroscience research from guest lecturers and by going to seminars reinforces broad, current concepts in neuroscience in a way that will be remembered after the course is over, and helps students make career decisions.
- By learning ***meta-skills***, students are better prepared for a career in the Real World, whether in academia, industry, medicine, or other fields. These include working as teams, interviewing, finding needed information, critical reading, technical writing, presenting their work, evaluating peers, and being publicly accountable.

Acknowledgments: BMED 4400 was funded by NSF EFRI-COPN grant 0836017 and the Coulter Department of Biomedical Engineering. Thanks to Dr. Nael McCarty, who co-taught IntroNeuro with me 2005-2007. Thanks to my students, who helped smooth out the wrinkles in these assignments and who created such excellent material for all to share. Thanks to the Georgia Tech Class of 1940 and family of W. Howard Ector for an *Outstanding Teacher Award*, and the Georgia Tech Center for Enhancement of Teaching and Learning for promoting this effort. Thanks to Jimmy Wales and crew for creating Wikipedia.
Thanks to my Special Guest lecturers for sharing their research.
If you were one of the Experts interviewed by a student of mine, THANK YOU!