WORKSHOP REPORT
The University of Ibadan/Grass Foundation Workshop in Neuroscience Teaching

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The University of Ibadan/Grass Foundation Workshop in Neuroscience Teaching (March 31st to April 2nd, 2017) in Ibadan, Nigeria was sponsored by the Grass Foundation as a "proof of principle" outreach program for young neuroscience faculty at Nigerian universities with limited educational and research resources. The workshop's goal was to introduce low cost equipment for student lab exercises and computational tutorials that could enhance the teaching and research capabilities of local neuroscience educators. Participant assessment of the workshop's activities was very positive and suggested that similar workshops for other faculty from institutions with limited resources could have a great impact on the quality of both the undergraduate and faculty experience.

Key words: teaching workshop, education outreach, neurophysiology, international networking

In the Spring of 2017, we facilitated a three-day faculty workshop (March 31st – April 2nd) hosted at the Department of Veterinary Anatomy of the University of Ibadan, in Ibadan, Nigeria (Figure 1). The Ibadan/Grass Foundation Neurophysiology Workshop was sponsored by the Grass Foundation (http://www.grassfoundation.org/), a longtime supporter of professional development opportunities for young neuroscientists (Pereda et al., 2013). Our objective for the Ibadan workshop was to plant a seed to help create new opportunities for neuroscience education and research in sub-Saharan Africa. In this part of the world STEM (Science, Technology, Engineering and Math) research and education opportunities are limited by financial, political, and infrastructure instability (Sofola, 2014). Teaching faculty from many African countries have very limited resources, preventing them from acquiring modern experimental and computational teaching tools.

The idea for this Ibadan workshop arose during a January 2016, Grass Foundation Neuroscience Outreach Workshop at the Marine Biological Laboratory (MBL) in Woods Hole, MA. The participants were Grass Fellows who were previously supported by the Grass Foundation for summer research at the MBL (https://www.grassfoundation.org/grass-fellowship/grass-fellowship-overview), and who were interested in undergraduate neuroscience education. RD and BRJ were facilitators and JOO was a Grass Fellow (2013) participant at the 2016 workshop. The goal of this workshop was to bring inexpensive neurophysiology hardware and software platforms for hands-on, active learning to neuroscience educators, especially those at institutions with limited resources. The Grass Fellows learned to use inexpensive extracellular recording amplifiers from BackyardBrains (BYB; https://backyardbrains.com/) for student lab exercises in sensory physiology and action potential conduction, and the Neurons in Action software tutorials (Moore and Stuart, 2007) to teach intracellular and intercellular electrical signal transmission in the nervous system.

Figure 1. Faculty facilitators in the 2017 Ibadan/ Grass Foundation Neurophysiology Workshop. From left to right: Rhonda Dzakpasu, James Olopade and Bruce Johnson.

Our "proof-of-principle" project for neuroscience physiology teaching in Nigeria was inspired by the increasing availability of low cost neurophysiological instrumentation, data visualization, acquisition and storage

systems and straight-forward educational laboratory and computation resources. In the student laboratory setting, the combination of sophisticated smartphone circuitry coupled with advanced software applications can serve as data visualization, acquisition, and storage systems. To this end, BYB produces cost effective bio-amplifiers (SpikerBox) that can record action potentials from live animal (and plant) preparations and human muscle, while communicating with smartphones. In the computational sphere, there are well-designed interactive software programs for students that can simulate neural activity in the absence of the neurophysiology wet lab. For example, Neurons in Action 2 (NIA2) is a suite of simulations through which students can examine neuronal excitability and synaptic transmission under a wide range of experimental conditions (Stuart, 2009). We thought that combining the use of BYB equipment and NIA2 in a workshop for neuroscience educators in Nigeria might give young Nigerian neuroscientists new resources to enhance their preparation of future cohorts for graduate study and research.

WORKSHOP PARTICIPANTS
There were 14 participants (8 women and 6 men) from different Nigerian states, some travelling 10 hours to attend the workshop. All of the participants held teaching positions/tutorial duties at a Nigerian university or college. Five of the participants were in the finishing stages of their PhD dissertation. The workshop participants and their home departments and institutions are listed in Appendix I (See also Figure 2).

WORKSHOP PROGRAM
The workshop started on the afternoon of March 31, with introductions of the facilitators and participants. This was followed by four, 45-minute lectures on the following topics:
   i.   How the brain perceives the outside world - RD
   ii. Synaptic transmission – BRJ
   iii. The art of communication in the teaching of neuroscience: Why practical matters – JOO (Figure 3) (practicals are synonymous with laboratory exercises here)
   iv. Biological Electricity and the Hodgkin-Huxley Model – RD

After dinner, there was a lively Q&A session about the lecture material, and participants discussed teaching experiences at their home institutions.

We continued the next morning with a recapitulation of the previous day's lectures and answered participants' questions that arose over night. The rest of the morning and early afternoon (with breaks) was devoted to the use of BYB amplifiers for student laboratory exercises, with participants working in pairs (Figure 4). We used the SpikerBox package to record extracellular action potentials from the classic cockroach leg mechanoreceptive afferent preparation (Linder and Palka, 1992; Ramos et al., 2007; see BYB: https://backyardbrains.com/experiments/somatotopy), and smartphones to visualize the electrical signals from the different preparations. The use of the smartphones proved to be a wise choice for data visualization because there were

Figure 2. Faculty facilitators and participants in the 2017 Ibadan/ Grass Foundation Neurophysiology Workshop.

Figure 3. Professor James Olopade lecturing to participants in the 2017 Ibadan/ Grass Foundation Neurophysiology Workshop.

problems getting Windows based laptops to interface properly with the SpikerBox output.

After lunch, we used the 2-Channel SpikerBoxes to record action potentials from the classic earth worm preparation (Kladt et al., 2010; see BYB: https://backyardbrains.com/experiments/speed). With two-

Figure 4. Participants at work in the 2017 Ibadan/ Grass Foundation Neurophysiology Workshop.

channel SpikerBox amplifiers, participants were able to estimate giant axon conduction velocity. This exercise was followed by recording of human EMGs with Muscle SpikerBoxes. All the cockroaches and earthworms used in the lab exercises were gathered from the surrounding outdoor area by Prof. Olopade's lab assistants.

The last part of the practical workshop focused on NIA2 computer tutorials. RD gave an introduction and overview of the software package. BRJ presented how the neurophysiology lab course he teaches at Cornell integrates NIA2 tutorials into its curriculum. The participants worked through the "Membrane, Equilibrium" and the "Na^{2+} Action Potential" tutorials in NIA2 as an introduction to this simulation software.

We closed the practical portion of the workshop with a lengthy discussion on the following topics:

1. Suggestions and discussion of how to implement these activities in an undergraduate neuroscience curriculum.
2. Issues relating to the work/life balance that junior faculty need to manage for successful careers.
3. Opportunities at the MBL for the Grass Fellowship summer program as well as advanced summer courses. One of the workshop participants, Joan David Adekanmbi is a Grass fellow (2012), and she also provided insight into the MBL experience for young neuroscientists.

At the end of the day, we distributed certificates for workshop participation to our participants (Figure 5). We distributed one SpikerBox bundle we brought overseas to each participant to take home. This allowed them to work with the system on their own.

The next day, RD and BRJ spent the morning meeting with interested workshop participants to answer individual questions about the workshop material, and discussing how we could support their further professional development and strategies for pursuing research opportunities in the U. S.
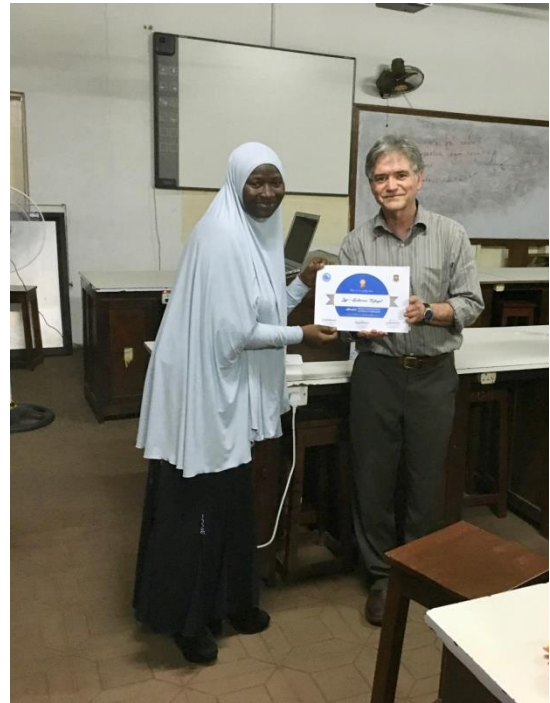

Figure 5. Suliamon Rukayat, from the Department of Anatomy, University of Ilorin, Nigeria, receiving her workshop completion certificate from Bruce Johnson.

WORKSHOP ASSESSMENT:

All 14 participants returned our workshop questionnaire, and 13 completed most of the questions. When asked why they were interested in taking the workshop, they chose the following prompts (n): 1) learn more about exercises based on BYB equipment and NIA (10); 2) Learn more about Neurophysiology and Neuroscience (13); 3) network with other life science educations (11). They also commented that they wanted to learn more techniques for neuroscience research, learn more international perspectives in education and research that could help enhance both in Nigeria, and learn more about the physics of Biology, particularly vision.

The workshop participants all returned positive feedback on their personal experience in the workshop. This was expressed in a rating of 6 questions posed on a 5-point Likert scale with: 1) strongly agree, 2) agree, 3) neutral/unsure, 4) disagree, and 5) strongly disagree, and in Yes/No and short answer questions. All participants agreed with almost all the following statements, answering either 1 or 2:

1) Did the workshop meet my expectations (1, n= 11; 2, n = 3).
2) The workshop increased my understanding of neurophysiology (1, n = 11; 2, n = 3).
3) The exercises presented at the workshop are good vehicles for teaching undergraduates principles of neuroscience (1, n =11; 2, n = 2; 3, n = 1).
4) The workshop was well organized, with clear objectives (1, n =12; 2, n = 2).
5) The workshop was of professional value to me (1, n =9; 2, n = 5).

6) Graduate student and post-docs would benefit from taking this workshop (1 =10; 2 = 4).

Only one participant was unsure (ranking of 3) if the hands-on recording or neuronal simulation exercises taught in the workshop were effective neuroscience teaching tools. Twelve of 13 participants (one did not answer) said the workshop would influence how they taught neuroscience to undergraduates, nine wanted to implement SpikerBox recordings from cockroaches, earthworms, and especially EMG muscle recordings from humans, and 4 would use the NIA2 software with their classes. More general comments expressed that the workshop would influence their teaching by changing their class presentations of the synaptic transmission and neuronal excitability material, such as by using more illustrations. They also were interested in more available low-cost tools for teaching and research. One student commented that they could now move from using a smoked drum recording apparatus to the SpikerBox and computer/smart phone for data acquisition and analysis! There were also a few specific comments on what workshop material they probably would not implement in their classes. One felt that any electrophysiological recording technique would be unaffordable, one did not want to use the cockroaches and earthworms in their classes, and another would use the NIA software as their own reference material, but not for students.

Participants thought the workshop was too short. Most wanted more time (4 days were suggested), for more hands-on lab exercises using the SpikerBox and data analysis (especially EMG), and more time to use the NIA software. They wanted to learn to use the equipment for research projects in addition to teaching. If the workshop was not longer, they would sacrifice some of the lectures and NIA exercises for more recording exercises.

Thirteen participants answered that they would take another workshop to learn neuroscience more deeply, to have more hands-on training for teaching, to explore other areas of neuroscience, to advance their career as neuroscientists, and increase their resources for lab teaching. For some this was their first hands-on neuroscience workshop.

All 13 who answered this question would recommend their workshop to other life science educators. Their reasons for recommending the workshop centered on the following themes: other educators, especially junior faculty, would pass on the lab exercises to their students and colleagues, they would become better educators and researchers, they would have more opportunities for professional development, the workshop would help fill educator gaps in neuroscience knowledge, especially neurophysiology, and they wanted to improve their teaching skills.

Additional topics participants suggested for coverage in future workshops included: neuroanatomy, more lab exercises using rodent models, like AP recording, the rat nerve muscle sciatic preparation, and EMGs from rodents, small animal (rodent) behavioral tests, basic immunocytochemistry protocols, computation neuroscience training, including computer models of normal and diseased brain function, brain cell isolation techniques, research proposal writing, especially for international fellowships, other model systems for research and teaching like snails and crustaceans, more details on synaptic transmission and myelination, and more discussion of neuroscience research techniques, their principles and applications.

In the general comments section of the evaluation the participants expressed an appreciation of being part of a "very impactful" workshop and having an "eye-opening" experience. They expressed appreciation that the workshop was interactive, enlightening about teaching and neuroscience concepts, well organized, the time was well managed, and that all facilitators took the time to explain the material in detail.

CLOSING COMMENTS AND FUTURE PLANS

We are deeply grateful to the Grass Foundation for providing the funds for this "proof-of-principle" endeavor to introduce low cost equipment for student lab exercises in a resource-poor teaching environment, and provide training to new faculty in its use. It was inspiring to work with a highly motivated, hardworking, and very industrious group of young academics. Faculty at Nigerian universities teach effectively and creatively, and publish neuroscience research with limited resources compared to universities and colleges in North America and Europe.

There is clearly an academic audience in Nigeria who would greatly benefit from experience to both BYB products and NIA2, and use these resources to enhance their neuroscience teaching and research. We learned that a relatively small effort on our part could dramatically help stimulate and enhance undergraduate neuroscience teaching in Nigeria. We would like to follow up on this workshop and reach out to more neuroscience educators in Africa. We consider that several changes need to be made for a subsequent workshop to be more effective.

1. We would prepare teaching materials that consist of lesson plans and problem sets. These will be given to the faculty to directly implement into their courses. While lesson guidance is presented for the exercises in NIA2, such documentation is not as well developed with the BYB protocols.
2. We will seek funding to bring more low-cost equipment such as the SpikerBoxes for education and research by Nigerian neuroscience faculty, and lead more workshops to reach a broader audience of educators.
3. Another idea is for the 2017 workshop faculty and participants to apply for a grant to develop a Teaching Neurophysiology Toolkit to use in Nigerian university classrooms. The workshop faculty would help in the Toolkit development and visit the home institution of the awardee as short term "teaching assistants." We would bring equipment from the U. S. to leave behind. We could help teach students how to use the equipment and assist with beginning NIA2 lessons to get the students started on the tutorials.

For now, we will continue to help support the workshop participants by bringing them into the CrawFly community with its educational resources. We will also help connect them with broader initiatives in Africa that support the

professional development of young scientists such as: TReND in Africa (http://trendinafrica.org), The African Research Academies for Women (https://www.african womenresearchers.org/), and the International Brain Research Organization- African Centers for Advanced Training in Neuroscience (http://ibro.info/news/ibro-announces-africa-centres-of-excellence-programme/).

The teaching and research challenges facing neuroscientists are not unique to Nigeria. There is certainly a disparity of resources in institutions of higher education even within the U. S. Our goal is to help develop and spread low cost methods of teaching hands-on neuroscience in a variety of teaching environments.

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Appendix 1. Participants in the 2017 University of Ibadan/Grass Foundation Workshop in Neuroscience

	Name	Home Institution
1.	Adebiyi, Olamide E.	Department of Veterinary Physiology, Biochemistry and Pharmacology, University of Ibadan.
2.	Adekanmbi, Joan David	Department of Anatomy, University of Ibadan.
3.	Adekeye, Adeshina Oloruntoba	Department of Anatomy, Afe Babalola University
4.	Adeniyi, Philip Adeyemi	Department of Human Anatomy, Afe Babalola University.
5.	Ladagu, Amany Digal	Department of Veterinary Anatomy, University of Ibadan.
6.	Imam Bukar	Department of Anatomy, University of Ilorin.
7.	Jaji-Sulaimon, Rukayat	Department of Anatomy, University of Ilorin.
8.	Olajide, Olayemi Joseph	Department of Anatomy, University of Ilorin.
9.	Olonode, Elizabeth Toyin	Department of Pharmacology and Therapeutics, Afe Babalola University.
10.	Olopade, Funmilayo Eniola	Department of Anatomy, University of Ibadan.
11.	Oyeleke-Omotola, Mosunmola Busayo	Department of Physiology, Afe Babalola University.
12.	Patrick, Badugu Esther	Department of Pharmacology & Toxicology, Kaduna State University.
13.	Samuel, Onasanwo Adetunji	Department of Physiology, University of Ibadan.
14.	Sangodoyin, Zainab Tosin	Department of Veterinary Physiology, Biochemistry and Pharmacology, University of Ibadan.