ARTICLE
Online Neuroscience Instruction: Insights, Lessons Learned, and Moving Forward

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Prior to the COVID-19 pandemic, most of us had little to no experience with online teaching. With the realization that we would need to teach our students remotely during the pandemic, we needed to develop our online teaching skills and apply this knowledge to create effective online classes for our students. Tulane University's Center for Engaged Learning and Teaching (CELT, http://celt.tulane.edu) and its Innovative Learning Center (ILC, http://it.tulane.edu/innovative-learning-center) partnered to teach an Online Teaching Training (OTT) course for all instructors. This five-week session covered many of the topics needed to teach an engaging and interactive online course. The training included not only the theory but also practical applications of many resources available to online course instructors. This training prepared me to teach a fully online course for the first time in Summer, 2020 and again the following summer. Student evaluations compared between the Emergency Remote Learning done in quick response to the COVID-19 pandemic (Spring 2020) and the online course after completion of the OTT (Summer 2020) indicated that student experiences were much more positive when taught by a trained instructor. Many of the resources/techniques for online courses can be incorporated into in-person or hybrid classes, and vice versa. Further, sharing ideas among colleagues, especially as new resources become available, is critical for the success of all instructors. In this article I share my lessons learned, insights, and thoughts for moving forward as we approach a new era of neuroscience instruction.

Key words: online teaching; Zoom; learning objectives; pedagogy; teaching software; CANVAS; concept maps; case studies; rubrics; engaged learning; 2020 FUN Virtual Conference

Prior to the pandemic, I and many of my colleagues had negative feelings about online instruction. Some of our misgivings were due to the fact that we had never taught or taken an online class. Many also feared losing our "sage on the stage" roles. We like the personal relationships built with students when we can see them "in-person". How can an online class be as effective as a "live" class, we thought? When our university decided to evaluate transfer courses based solely on their content and not their delivery method, we begrudgingly accepted the new rule, but we doubted these courses would be as good. Shortly thereafter, in March 2020, we had no choice but to teach some variation of an online class. Most faculty just gave their lectures using Zoom and did their best to get through the spring semester! Fortunately, we had developed good relationships with our students before the pandemic, so we worked hard to maintain and improve these connections with emails, phone calls and Zoom office hours. We did our best to learn from our colleagues who were experienced in online teaching.

The realization that this pandemic was not going away soon meant we needed to not only accept that online instruction was here to stay, but that we needed to learn how to do it effectively! Fortunately, my university had the financial and knowledge-based resources and infrastructure to help faculty develop the necessary skills. Tulane University's Center for Engaged Learning and Teaching (CELT, http://celt.tulane.edu) and its Innovative Learning Center (ILC, http://it.tulane.edu/innovative-learning-center) partnered to teach an Online Teaching Training course for all instructors. This five-week session covered many of the topics needed to teach an engaging and interactive online course. The instructors introduced us to relevant software, pedagogical theory, and practical tips for engaging students. To encourage full participation in the training, which started before the end of the spring semester, participants were paid a small stipend. The course instructors were very forgiving of our ignorance, frustration, negativity, and angst associated with our learning so many new ideas and techniques. For many of us who took the training, we gained an appreciation for what students go through when they are learning new material from a new instructor with a new way of teaching!

MATERIALS AND METHODS

Because all summer 2020 courses were going to be taught online, all summer course instructors needed to complete the CELT/ILC Online Teaching Training (OTT) course before their classes started. The OTT participants were divided into cohorts, which consisted of 8-10 faculty from across the university who were planning to teach an online summer course, plus representatives from CELT and the ILC. In addition to our weekly Zoom meetings as a cohort, "Teach Anywhere" office hours and One-on-One Consultations were available for faculty to ask questions of CELT and ILC staff. Each week we completed assignments that helped us learn how to develop our CANVAS (course management) sites, create interactive, engaging, and relevant assignments, match our course objectives and

At the conclusion of this program, the successful online instructor will be able to:
• Identify principles and best practices of online pedagogy
• Create an online course aligning course objectives, learning outcomes, content delivery, learning activities, and assessments in an easy-to-navigate experience for students
• Utilize a variety of technologies to facilitate delivery of the online course and achievement of course learning outcomes

Table 1.   Learning Outcomes for CELT/ILC Online Teaching Training (OTT) Course.

learning outcomes to the course material, address issues of accessibility and inclusivity, and to effectively communicate with our students. Many discussions focused on the available software to incorporate into our online courses. The learning outcomes of the Online Teaching Training are shown in Table 1. The OTT course was taught again in the later part of the summer and again during the academic year. It has been completed by over 400 course instructors to date, with participants from diverse areas within the university (Tulane CELT, personal communications).

My summer course, "Brain and Behavior", was the same class I taught in the spring, and which I had taught several times before as an "in-person" class. Brain and Behavior is the first core course in our Neuroscience major. It also fulfills the biopsychology requirement for our Psychology major and minor. The spring class with seventy-five students consisted of lectures and class discussions. I had used CANVAS to post my power point lectures, points earned from "clicker" questions, exam grades, and announcements. In response to the COVID shutdown, I used Respondus/Lockdown Browser software (https://web.respondus.com/he/lockdownbrowser/) to administer online exams. Although this worked well for me, some of my colleagues do not like using this software, as they are not convinced that it prevents cheating. Further, it requires the use of webcams which not every student has, so its use can be an equity issue. Fortunately, our university was able to provide a webcam to any student who did not have access to one. Most of the students were second semester freshmen or sophomores, majoring in neuroscience or psychology. In contrast, twenty-three students completed my summer online course, and they consisted of rising sophomores to rising seniors. Their majors included anthropology, biomedical engineering, cell and molecular biology, communications, English, finance, homeland security, marketing, neuroscience, philosophy, psychology, psychology and early childhood, and public health. Thus, the background and interest levels varied widely among the students in the summer course.

LESSONS LEARNED

One benefit of working with faculty from different disciplines for our Online Teaching Training was the shared experiences and expertise. For example, while I had used CANVAS for several semesters and was familiar with the Gradebook, Syllabus, Announcements, and Modules tools, I had never used the Discussions feature, in part because I had no idea how to grade student contributions objectively and did not know how they could be used effectively in my science classes. I learned from a history professor in my cohort about how she established rubrics for the submissions, which required students to not only share their own ideas, but to make constructive comments in response to their classmates' posts. This practice not only engages the students with the course content, but also with classmates and the instructor, the three-way interaction concept (Nilson & Goodson, 2018) that was discussed in our OTT! The use of rubrics in CANVAS (https://community.canvaslms.com/t5/Instructor-Guide/tkb-p/Instructor#Rubrics) has made grading discussions as well as other assessments faster and more objective. I also learned how to make much better use of the CANVAS Modules. Other cohort members shared their successes (and frustrations!) about their experiences using different software for video production, online testing, group editing, audience response systems, etc. By learning together as a cohort and from the other course instructors, we gained confidence in our skills, shared what we could, and realized how many resources were available to us. (See Appendix 1).

Participating in a course about teaching and having a specific course to prepare forces one to reflect on the value of the different assignments and consider how they relate to learning objectives. Having used Zoom to give the last lectures in the spring course already taught me that I would lose the benefit of seeing all the students and engaging with them in ways one can in a live lecture setting. Fortunately, I had many useful resources to incorporate other ways to engage the students (Appendix 1). For years a colleague had touted the benefit of Concept Maps (Novak, 1991), but I had never taken the time to learn how to use them. One of our assignments in the Online Teaching Training was to make our own concept map (https://www.youtube.com/watch?v=sZJj6DwCqSU).
Armed with my new knowledge, I added a concept map in the Neuroanatomy Module of my online class. I was pleased to see how effective this assignment was, especially for students who often struggle with neuroanatomical terms and concepts. This method of engagement was helpful for students to learn a lot of information in a more organized way, with each of them organizing the information in a way that made sense to them. Students were not graded on how artistic their maps were, but rather how complete they were and if they had made good attempts at grouping terms and linking concepts. After they submitted their first drafts, the students worked together in Breakout Rooms on Zoom during our class. During these sessions, the students shared their concept maps and made suggestions to each other about additional connections that could be made.

Another colleague shared her positive experiences using case studies. For a small fee, instructors have access to resources relevant to teaching neuroscience (and psychology, biology, medical sciences, etc.) available from the National Center for Case Study Teaching in Science

What were the best aspects of remote learning in this course?
The inclusion of easily accessible supplemental lectures
Nice to be able to re-watch videos for the purposes of studying and learning material
N/A This class was much better when it was in person.
I appreciated the many office hours and opportunities for help and appreciate that [instructor] wanted us all to participate in class
What were the biggest challenges of remote learning in this course?
No benefits to learning online
An invasion of privacy to be recorded during exams
More difficult to ask questions, harder to engage with online lecture
Low network speed. (Others mentioned technical difficulties)
Not as good as the in-person lectures
Harder for me to focus when I have to take classes in my bedroom.

Table 2. Course Evaluations – Spring "Emergency Remote Teaching." These are student comments.

(https://sciencecases.lib.buffalo.edu/). (Note that good examples can be found in JUNE, e.g., Wiertelak et al., 2016 and several examples in more recent issues). I used some of these case studies to create group projects, including student presentations on Zoom, and to generate CANVAS discussions (now that I knew how to use rubrics and grade the discussions objectively!). I learned how to use Yuja software (http://yuja.com) to create my own asynchronous materials (e.g., greetings to students, presentation videos, including some with embedded quiz questions). Video production and editing can be done with a variety of other software applications (Appendix 1).   Having taught summer classes before, I adapted previously used in-person assignments to online assignments and maintained the learning benefits to the students. For example, to encourage students to work independently while keeping up with the material in a fast-paced, short summer session, I modified my previously used clicker questions into "check your knowledge quizzes" that students took at the end of each topic. My "Neuroscience in the News" assignments, to get students to evaluate current research as it is presented to the public, was expanded to include both written submission and oral discussion during class. This was a nice "break" from my lecturing and required more active participation from the students.

After my summer online course was finished, I compared the comments received in my spring course evaluations, which were based on "Emergency Remote Teaching" (Table 2) with the comments from the course evaluations, based on an online course taught by a trained instructor (i.e., me!) (Table 3). These comments clearly showed that "just giving Zoom lectures" is not online teaching! Both the students and instructor need to be trained!

In comparison to the comments from students during the

"Emergency Remote Teaching" in the spring (Table 2), the comments from students in the fully online course (Table 3) were more positive and reflected the benefits of my online training. The summer students were given many more opportunities to engage remotely with course content, with me, and with each other. Students in both classes had common concerns related to internet challenges and taking their classes at home, but the summer students were more engaged in the online activities.

INSIGHTS

Despite the stresses of learning to teach online in a short time span, during a pandemic, no less, the efforts paid off. Being a student myself forced me to experience the "uncomfortable" feeling of not always knowing what was expected, making deadlines, reading and considering the feedback that the course instructors provided, and learning from my mistakes. I understood better the frustration students have shared about doing group work. The concepts of "formative and summative assessments" that I had learned previously were reinforced with practical applications for my online course. My use of "check your knowledge quizzes", concept maps, case studies, discussion posts, and group presentations all proved effective in engaging the students. I was exposed to new technologies, some that were applicable to my course, others not, but all gave me knowledge of available resources (Appendix 1).

The Online Teaching Training, my own observations from the summer class, and various discussions with the CELT and ILC staff showed that instructors are not the only ones who need to prepare for a successful online class. Students also must learn how to be successful in their online classes. They need stable internet connections, a dependable computer (ideally with webcam for taking online exams), and a quiet, distraction-free workspace. Students must familiarize themselves with the syllabus and course management system; my first "low stakes" quiz was to test student knowledge of such information (e.g., What % is the final exam worth? Where will you find the Powerpoint presentations that are posted on CANVAS? When is the case study due?). In addition, I learned the importance of building community in the online class (Darby & Lang, 2019) and three-way interactions which lead to success in all courses, especially when teaching online (Nilson & Goodson, 2018). Faculty can foster these interactions in numerous ways (Table 4).

By being a student in an online class, I gained the insights of what my students might experience and saw how they might view my courses, both online and in-person. Having taught neuroscience courses for many years, I often focused on the course content and did not pay as much attention to the delivery method. In my in-person classes, I gave lectures, engaged the class with discussions, and incorporated teaching tricks like "think-pair-share", one-minute papers, clicker questions, and other pedagogy ideas. Teaching online meant using these same methods, but also broadening my understanding of how students learn, their possible distractions and limitations, and coming up with new ways to engage them. Because I felt more connected

What were the best aspects of remote learning in this course?
Recorded lectures
Being held accountable with online quizzes & assignments
Instructor was easy to access, and I enjoyed participation that instructor encourages in the classroom
Class recordings, learning flexibility e.g., through the "check your knowledge quizzes", office hours, chat function of Zoom where it was easy to ask questions and get additional information
Instructor was very engaging and always encouraging to everyone despite being on a screen

What were the biggest challenges of remote learning in this course?
Staying focused (mentioned by a few students)
Studying/test taking
Getting to know fellow classmates (especially those who would not display their face), group work and some group discussions, and technology lags such as slow internet
Forcing myself to study because of the home environment

Other feedback:
Course was very well organized and beneficial. I really enjoyed the presentations we did at the end of the course. Office hours were very helpful.
I preferred having this course online because of how accessible everyone and all of the course material was
I think this class was very close to an in-person experience because I felt that I was able to take in a lot of information and I had access to multiple resources if I needed additional help.
I really liked learning all the information from the course. I feel that it gives me a solid base for my neuroscience major.
Great class even though it was very challenging for me
Difficult material to cover in such a short period of time
Instructor made remote learning almost challenge free
I loved this course and hope to take another class with this instructor.

Table 3. Course Evaluations – Summer Online (with trained instructor). These are student comments.

to those students who "showed their faces" in the Zoom sessions, I asked if these students performed better in the class, overall. Interestingly, of those students who regularly had their videos on during class, all but one earned an A or B. Of those who regularly had their video off, only one earned an A. The others earned C or below. Sometimes internet connections are less stable with the video on, but this small comparison showed me the importance of staying connected, visually, with my students during Zoom sessions. This accountability forces students to focus and pay attention. However, the reasons students turn off their cameras vary, and issues related to equity and inclusion need to be considered (Castelli and Sarvary, 2021).

MOVING FORWARD

Having taken my first online course (about teaching online!) and having taught my first online course, I was much more prepared to not only teach online classes in the future, but to share my ideas with others. My first opportunity was at the 2020 FUN Virtual Conference, where I presented a poster summarizing these experiences. My intent in my poster session was to generate discussions similar to those that my OTT cohort had. Some of the attendees at my session had never taught an online class but were hoping to gain insights. Others were learning as I was. While I felt fairly well-versed at using Zoom and some of the teaching tricks I had acquired over the years, I felt that my knowledge of the available software was as an advanced beginner at best. My poster included my list of pedagogical insights and useful resources. Appendix 1 includes these resources plus several others based on discussions at the FUN conference and with my Tulane colleagues. During my session, we discussed ways to engage students, but I also encouraged participants to take advantage of all the resources available to them. Although using new technology can be intimidating, I encouraged the participants in my session to figure out which methods worked best for their own students, their specific course, and their comfort level/knowledge base.

One of Tulane's CELT activities is their book club. In advance of Flower Darcy's Zoom visit to Tulane (https://tulane.app.box.com/v/2021sparkingsuccessprogram) in December 2020, we read and discussed her book (co-written with James Lang), "Small Teaching Online" (Darby and Lang, 2019). I found the ideas in this book useful not only for teaching online classes, but also to incorporate into my in-person classes. Instructors of hybrid courses will find them to be useful, as well. The ideas about creating community in the classroom, backward design (starting with the learning outcomes), and providing effective feedback, among other topics described in this book, as well as in James Lang's original "Small Teaching" book (Lang, 2016), have been incredibly helpful in how I design and teach my courses.

Inspired by the many discussions and insights we gained from the summer trainings, my Tulane neuroscience teaching colleagues and I set up an every-other-week session starting in the 2020-2021 academic year which we call THINK (Teaching Help for Innovative Neuroscience Knowledge). At our THINK sessions we share information about new software and new uses of existing software, provide insights about how to address situations that arise in our class, and discuss curricular issues. We use Microsoft Teams (https://www.microsoft.com/en-us/microsoft-teams) to share resources. Having colleagues who are passionate about teaching and concerned about student success and making the time to meet and discuss our ideas, has been incredibly rewarding and helpful.

Preparing for and teaching my first online course had its challenges and frustrations. I was fortunate to have great support from my colleagues, which continues today. I offer these take-home messages that I learned from these experiences: (1) Online teaching training is essential! (and good ideas for online pedagogy often apply to in- person pedagogy!); (2) Many resources are available to help

Student: Instructor – e.g., Zoom office hours; one-on-one discussions; email communication; audience response systems; use of whiteboards to enhance discussions; announcements posted on CANVAS (or other LMS) that provide clear, concise instructions for completing assignments; a "welcome video" posted in the beginning of the semester to introduce instructor to the students; an "about me" page on CANVAS that includes instructor photo, academic training, personal interests; participation in online discussions; surveys to solicit student feedback regarding the course/learning experience; meaningful and actionable feedback on assessments and learning activities
Student: Course Content – e.g., readings; videos; assignments (e.g., concept maps, case studies, check your knowledge quizzes); post-reading reflection exercises to improve student comprehension of content; online discussions; quizzes and meaningful automated feedback; links to websites for students to learn more about a topic
Student: Student – e.g., ice breakers, Zoom break-out rooms; group projects; online discussions; group editing assignments; peer review exercises; synchronous or asynchronous debates; Group Me, iMessage and other software apps to connect students with each other

Table 4. Ways to foster three-way interactions (Nilson & Goodson, 2018) essential for student success in an online course.

instructors, so make a point of talking to other instructors to learn which resources work for them; (3) Students also need to be trained in online instruction; they need guidance of how to navigate the course management system and how to be successful with their assignments; instructors should not make assumptions about what students know about the format of the course that they took so much time to develop; and (4) Practice makes perfect (or at least better!). I taught my Brain and Behavior class online again in summer 2021 and built on my successes from last summer while also improving some of the things that did not go as well as planned. For example, I explained to students that being able to see them helped me know how much they were paying attention and understanding my explanations. Students were much more willing to leave their cameras on, but they also felt safe explaining to me why they could not (internet issues, family members or other distractions in the background, etc.). In addition, I showed them the concept maps from the previous summer to give them an idea of how they might do theirs and devoted more class time for them to share ideas about their own concept maps. Further, I expanded the use of case studies, so they were not just part of the class discussion but also could be used as an option for the students' final project. Perhaps the most helpful modification that I made was to schedule the summative assessments (quizzes, final exam) to be asynchronous, in order to not use my synchronous time with the students.

Because the quizzes and exams were administered using Respondus/Lockdown Browswer software, students could take their assessments any time during the scheduled testing period (approximately 10 hours after our class ended). They understood that they were not to talk about the assessments with classmates until after the testing period was over, and each exam consisted of multiple questions on the same topic, so no exam was identical. Given the small class size, my reminder that they needed to follow our university's honor code, and that students really did not know each other well, I have no reason to believe that they shared information about the exams with each other. This practice of offering asynchronous exams to save time during synchronous meeting sessions has been used by several of my colleagues who have taught online courses.

This is an exciting time to be teaching neuroscience. We have colleagues who are excited about pedagogy and willing to share insights. Technologies are being developed to help us turn our creative thoughts into practical applications. We are more aware of the need for accessibility and inclusion (Penner, 2018; Theobald et al. 2020). The pandemic forced us to make substantial changes in the way we share information and engage our students. We already are passionate about our science, so let's share our passion with our students in the most effective ways!

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APPENDIX 1:
RESOURCES FOR ONLINE TEACHING

Annotation/Editing Tools
Hypothesis (https://web.hypothes.is/)
Kami (http://kamiapp.com)
Perusal (https://perusall.com/)
Science in the Classroom AAAS
(https://www.scienceintheclassroom.org/topics/neuroscience-behavior)

Audience response systems (including clickers)
Kahoot (http://kahoot.com)
Poll Everywhere (http://www.polleverywhere.com/)
Quizizz (http://quizizz.com)
Top Hat (http://tophat.com)
Turning Point Technologies
(http://turningtechnologies.com)

Case Studies
National Center for Case Study Teaching in Science
(https://sciencecases.lib.buffalo.edu/)
Several examples in JUNE.

Concept Maps
Invision (http://www.invisionapp.com/)
Lucidspark (http://lucidspark.com/)
Mindmeister (http://www.mindmeister.com)
Visme (http://www.visme.co)

Connection/Sharing Tools
BOX (http://box.com)
Clean Feed (http://cleanfeed.net)
Flipgrid (Flipgrid | Empower Every Voice)
Google Docs (http://www.google.com/docs)
Group Me (http://groupme.com)
iMessage (http://support.apple.com/messages)
Padlet (http://padlet.com)
Share Point (http://www.microsoft.com/en-us/microsoft-365/sharepoint/collaboration)
Slack (http://slack.com)
Sound Jack (http://www.soundjack.eu/)
Skype (www.skype.com)
Teams (http://www.microsoft.com/en-us/microsoft-teams)
What's App (http://whatsapp.com)
Zoom (http://zoom.us)

Equity Diversity and Inclusion sites
https://www.funfaculty.org/content.asp?contentid=193
https://www.blackinneuro.com/
https://advance.washington.edu/brains
https://www.jayegardiner.com/tradingcards.html
https://www.funfaculty.org/blog_home.asp
https://scientistspotlights.org/
https://pulse-community.org/anti-racism
https://qubeshub.org/community/groups/iember/aboutiember
https://www.lifescied.org/doi/full/10.1187/cbe.19-10-0195#.XyQiHAiBNSY

Online Academic Integrity
ASU Teaching Online
(https://teachonline.asu.edu/2020/03/academic-integrity-2/)
Turnitin (https://www.turnitin.com/)

Online Exam/Testing
Jove (has pre-made videos with quiz options;
http://www.jove.com/)
Proctoru (http://www.proctoru.com/)
Peerwise (students create questions to share,
https://peerwise.cs.auckland.ac.nz/?nop)
Quizlet (http://quizlet.com)
Respondus/Lockdown Browser
(http://web.respondus.com/he/lockdownbrowser/)

Presentations & Video Production/Editing
Adobe Premier Pro
(http://www.adobe.com/products/premiere.html)
Adobe Spark (https://spark.adobe.com/)
Canva (http://www.canva.com)
EdPuzzle (http://edpuzzle.com)
Genially (http://genial.ly/)
Powerpoint (http://www.microsoft.com/en-us/microsoft-365/powerpoint)
Prezi (http://prezi.com/)
Yuja (http://yuja.com)
Zoom (http://zoom.us)

Scheduling Tools
Calendly (http://www.calendly.com/)
Doodle Polls (http://doodle.com)
When2meet (http://www.when2meet.com/)