ARTICLE
A Course Design for Remote Teaching Advanced Topics in Neuroscience

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The COVID-19 pandemic pushed educators to engage in remote teaching out of necessity, but as our relationship with teaching technology grows, remote teaching has emerged as a suitable substitute for in-person education. In this manuscript, we detail a course design for remote teaching advanced topics in neuroscience at the undergraduate level. The course and its different features were designed to fulfill a set of learning goals that closely align with those put forth by the Faculty for Undergraduate Neuroscience (FUN) and the American Association for the Advancement of Science (AAAS). Furthermore, these learning goals can be applied to any advanced neuroscience class, regardless of the topic material. To achieve these goals, we created a curriculum with distinct design features. These features included a synchronous lecture-discussion system, asynchronous lesson content videos, guest principal investigators, and deemphasized grading. Instead of traditional examination, the students participated in assignments designed to give them extensive science communication experience. At the end of the course, we indirectly assessed student outcomes using an Instructor Course Evaluation survey distributed by the university. From this survey, we were able to conclude that students' perception of the final course outcome was highly satisfactory, with strong indications that the students believed we met our learning goals. Thus, the course design described herein represents a tool for others wishing to utilize it for remote teaching advanced topics in science.

Keywords: course design; remote learning; remote teaching; YouTube; deemphasized grading; guest principal investigator

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There is a need to continue expanding upon the pedagogical resources available for remote teaching (Ramos, 2021). This is because, over the past two years, the COVID-19 pandemic has repeatedly challenged our ability to rely on "traditional" in-person classes. Most recently, the SARS-CoV-2 Omicron variant drove COVID-19 infection numbers to an all-time high (Tan, 2022), and universities were again grappling with whether classes should be held in-person or through a remote online format. Pushing for in-person learning comes at the cost of student, educator, and staff health, whereas remote courses circumvent this risk. However, resistance to remote learning has become politicized resulting in arguments that remote learning is not an adequate substitute for a traditional classroom (Lossin and Battle, 2020), as well as legislature designed to push in-person education despite teacher shortages (Querry-Thompson, 2022), and student protests over the lack of remote learning options (Gavin, 2022). The renewed surge in COVID and the renewed debate over and resistance to holding remote online classes highlights a need for increasing the pedagogical resources available for remote teaching. This need has inspired us to write about a fully remote course design for teaching upper elective classes on advanced topics in neuroscience that we implemented in the Spring of 2021. Given the student feedback collected at the end of the course, the implementation of this course design worked towards the fulfillment of our learning goals. Additionally, the video content we generated for the asynchronous component of our course is now available on YouTube under the channel "Topics in Neuroscience" where the videos have cumulatively over 23k views (Ramos and Rivera-Rodriguez, 2021).

The explicit learning goals of this course are described herein as they were presented to the students. Our goals were for students to develop:

1. A deeper understanding of the topic material
2. A deeper understanding of modern experimental neuroscience techniques including genetic, molecular, physiological, and behavioral techniques
3. The ability to critically evaluate primary science research literature
4. The ability to synthesize their understanding of scientific research and communicate it in written and oral formats

For our course, the topic material was the neurobiology of somatosensation, but the course design and strategies we describe in this paper can be deployed regardless of the exact nature of the topic. These explicit goals can similarly be applied to any advanced topic neuroscience course. Moreover, these goals closely align with the objectives for intermediate and advanced level courses in neuroscience put forth by the Faculty for Undergraduate Neuroscience (FUN; Wiertelak et al., 2018; Ramirez, 2020). Learning goals #3 and #4 strongly focus on two of the core competencies for undergraduate science education put forth by the American Association for the Advancement of Science and FUN (AAAS, 2011; Kerchner et al., 2012; Ramirez, 2020). In addition to these explicit goals, we had an implicit goal inspired by efforts to increase the retention of students underrepresented in science (Akil et al., 2016). Our implicit goal was to demonstrate to our students that experimental neuroscience research is a pursuit carried out by individuals of all backgrounds. This implicit goal is closely linked with FUN's goal to diversify the student body that is attracted to, and successful in, neuroscience education programs (Wiertelak et al., 2018; Ramirez, 2020).

To achieve these goals, we put together a remote, mixed synchronous-asynchronous online class design that we detail here. The different elements of our curriculum are described closely in the course design section, as well as how these features could work to achieve our learning goals. At the end of the course, students had the option to participate in an "Instructor Course Evaluation" designed to measure the quality of the course. The results of the survey suggest that students understood the learning goals of the course and the course expectations; that they kept up with the course requirements; and that student perception of the final course outcome was highly favorable. Looking through the written student comments for key mentions of course design features, we found that the two most frequently mentioned course features that students self-attributed as being most valuable for their learning were both the synchronous ("Lectures" and/or "Discussion") and asynchronous (lesson content videos) content. Collectively, this manuscript provides a clear framework for the remote teaching of advanced topics in neuroscience, as well as advanced courses in other scientific disciplines.

MATERIALS AND METHODS

Course Description, University Context, and Student Demographics

This paper describes the class design implemented for The Neurobiology of Somatosensation (NBOSS), a remote online course. NBOSS was a special one-time offering worth four-credit hours that took place in Spring 2021 at Brandeis University. Brandeis University is a private university with a Research 1 (R1) designation offering a major in Neuroscience for undergraduate students wishing to pursue either a Bachelor of Arts or a Bachelor of Science degree in Neuroscience. The teaching of NBOSS was made possible through the Brandeis University Prize Instructorship (UPI), a program sponsored by the Graduate School of Arts and Sciences that provides advanced doctoral students with the opportunity to design and teach upper-division courses in their area of expertise. The course was designed and taught by the authors of this manuscript to a class of 21 students. A prerequisite for participation in NBOSS was that students take Principles of Neuroscience, a core requirement of undergraduate Neuroscience majors that is often taken in their sophomore year. Consequently, of the 19 students that completed the end-of-course evaluation, 6 were juniors, 13 were seniors, and all 19 were science majors. Additionally, 16 students self-reported that they took NBOSS to satisfy the requirements of their major, and 3 took it for general interest. Several of the students in the course were currently, or had previously, worked in a research lab.

Instructor Course Evaluation Survey

At the conclusion of the course, students voluntarily and anonymously participated in an "Instructor Course Evaluation" survey administered by Brandeis University. The survey consisted of prompts answered on a Likert-type scale and open-ended written feedback. Of the 21 students taking the course, 19 participated in the survey (90.5%). In the results section, we evaluate the outcome of select prompts based on their relevance to the scope of this manuscript; the full questionnaire and its results can be found in Supplementary Materials A of this manuscript.

To gain further insight into what aspects of our curriculum students identified as valuable for their learning, we combed through the written feedback for mentions of specific course design features such as "Lectures" "Discussions" "Videos" and more. We counted these mentions and tabulated the results. To protect our student's rights to privacy, their written feedback is not freely available and was not included in Supplementary Materials A. This information will remain confidential per the request of Brandeis University but can be made available by the authors upon request.

Course Design

Synchronous Lecture-Discussion System

The general outline for one week of our course is illustrated in Figure 1. The course met twice a week for 90-minutes per meeting. These two meetings made up the synchronous component of our design. The first meeting of every week (Meeting 1) was dedicated to a 60- or 70-minute lecture followed by ~10-20 minutes of open-ended discussion. The second meeting of every week (Meeting 2) was spent discussing primary literature (research articles) in a student-led format. A detailed example of course content for 1 week can be found in Supplementary Materials B.

It was communicated to the students that they were expected to attend Meetings 1 and 2 because they were the synchronous components of the course. However, to capitalize on the advantages of remote learning, and for added flexibility in the age of COVID-19, students were informed that they could be excused without penalty from any of the synchronous sessions. All synchronous sessions were held through Zoom (Zoom Video Communications, Inc.) and recorded. After any given synchronous meeting, the recording and lecture material (PowerPoint slides) were uploaded to the online course page hosted by Brandeis University through their Learning and Teaching Technology Environment (LATTE). This way, if a student were absent, they could catch up on the class material on their own time. This is a significant advantage of remote courses.

The objectives of our lectures were two-fold. First, we sought to broadly explore the topic material (for NBOSS this included lectures on touch, itch, pain, etc.). Second, we worked to introduce concepts and context that were important for understanding the selected reading for the week. Therefore, the lectures worked to accomplish learning goals #1 and #2 described in the introduction. When designing lectures, our strategy was to make them broad in scope at the beginning and refine that scope until the experimental premise for that week's reading assignment was clear. Most lectures began by introducing important vocabulary and ended by summarizing recent experimental findings that set the stage for the week's discussion. This worked to give students the foundation necessary for unpacking scientific primary literature. An example lecture outline paired with a selected reading for discussion can be found in Supplementary Materials B.

Course Design

Before	Synchronous		After
Discussion Assignments Posted	Meeting 1: Lecture	Meeting 2: Discussion	Discussion Assignments Posted
	•Broadly Explore Topic	•100% Student Led	
Asynchronous Content Uploaded	•Introduce Concepts & Context Necessary for Discussion	•Moderated by Professor •Featured Guest Stars*	Synchronous Content Uploaded
Asynchronous Content Accessible by Students			

Figure 1. Course Design Outline. This outline depicts 1-week of the course and the different course features that made up a given week. Before the start of any week, discussion assignments were sent to the students and asynchronous videos were made available. During the week, Meeting 1 consisted of a lecture and Meeting 2 was a student-led discussion of primary literature. These discussions occasionally* featured guest principal investigators. After the end of a week, the recordings generated during Meeting 1 and Meeting 2 were made available asynchronously and assignments for the following week were posted.

Traditional lectures are an important and effective part of scientific education (Garside, 1996; Zakrajsek, 1999), but in recent years, pedagogical techniques have shifted away from the passive "sage-on-the-stage" and towards more active roles for students in the classroom (Ramirez, 2020). These contemporary teaching philosophies, often called "active learning" or "constructivism" center the need for students to engage in the construction of their own knowledge by having them actively participate in class (Geer and Rudge, 2002; Ramirez, 2020). Studies on active learning approaches have demonstrated that it enhances student performance in science courses (Freeman et al., 2014; Bradforth et al., 2015; Deslauriers et al., 2019). Because of this, we dedicated Meeting 2 of every week to discussing primary literature in a student-led discussion format.

The workflow of our discussions is as follows. First, students would receive their "discussion assignment" one week before we met (Figure 1). These were piecemeal components of the paper, an example of which is included in Supplementary Materials B (bottom). Students were responsible for leading the conversation on their given assignment, and this is what we refer to later in the manuscript as "discussion responsibility". On the day of the journal club, we as the instructors would guide the dialogue, helping students refine their explanations and working to fill any knowledge gaps that the class may have had. This would continue until we finished covering the paper and the discussion assignments were completed.

Discussion assignments were portioned-out with a focus on completing the assigned reading while maintaining a similar degree of breadth and difficulty across the fractions. Because research papers vary in length, content, and complexity, the number of students presenting during a discussion varied. We randomly allocated discussion assignments without repetition until each student had gone at least once, and then the cycle repeated. It worked out such that students had a discussion assignment every other week, minimum. On days when a given student did not have a discussion assignment, their discussion responsibility was to attend the journal club. This format actively engaged the students so that they synthesized their understanding of the assigned readings, communicated this understanding orally, and then allowed for critical discussion as a class. Because of this, our discussions worked to primarily fulfill learning goals #3 and #4.

To facilitate student readiness, we created a "Discussion Guide" (Supplementary Materials C). The discussion guide incorporates similar pedagogical principles to the CREATE approach (Hoskins, 2008; Hartman et al., 2017; Beck, 2019) in that it asks students to critically consider what they are reading and encourages them to answer questions important for understanding the science. In practice, the discussion guide was designed for the students to summarize different aspects of the paper as they read it, and then they could use these notes as talking points in class. Students could complete the guide at their own discretion, whether they had a discussion assignment or not. Some students never used the discussion guide and successfully completed their discussion responsibilities accurately and without issue. Other students completed the guide for every discussion, even when they did not have a discussion assignment.

At the end of the course, we had a total of 10 lectures and 10 student-led discussions. The course syllabus detailing these meetings can be found in Supplementary Materials D.

Asynchronous Lesson Content Videos

A principal component of education in neuroscience, as put forth by FUN, is the need for students to not only learn "what we know" about a given topic, but that they also understand "how we know it" (Wiertelak et al., 2018). Therefore, we created a series of videos that would work in parallel with our lectures and discussions to supplement student understanding of "how we know it". These 5-10-minute-long videos constituted the primary asynchronous content of our course because the students were free to watch them on their own time. Moreover, we made videos pertaining to two categories. One category of videos was designed to help with the growth of professional "soft" science skills, like teaching students "The Sections of a Research Article", or "How to Critically Evaluate a Figure". The other category of videos we created were those made to help impart a practical, working understanding of advanced experimental neuroscience techniques. This latter category included videos like "The Patch Clamp", "Calcium Imaging", and "Extracellular Recordings". Due to their content, these videos supported us in our endeavors to achieve learning goals #2 and #3 (described in the introduction). Videos were made on a weekly basis and uploaded before the start of a given week (Figure 1). For each week, the content of our videos was chosen based on the needs of our students as it pertained to our curriculum. The exact details of what videos were featured and when can be found in our course syllabus (Supplementary Materials D). Ultimately, we produced 10 videos, 4 professional development videos, and 6 on experimental neuroscience techniques.

Featured Guest Principal Investigators (PIs)

If we are to harness our country's diverse talent pool, we must not only recruit students from backgrounds underrepresented in science, but also work to retain those students (Akil et al., 2016; Wiertelak et al., 2018; Ramirez, 2020). It is well documented that people from backgrounds historically underrepresented in science leave academia at disproportionate rates, resulting in a lack of representation at more senior levels (Asai, 2020; Llorens et al., 2021; Deanna et al., 2022). Extensive research on role models and representation has shown that creating diverse and inclusive academic environments leads to positive learning experiences, ultimately resulting in an increase in the retention of students from diverse backgrounds (Rainey et al., 2018; Stout et al., 2018; Linden et al., 2020; Asai, 2020; Trent et al., 2021; Deanna, et al., 2022). Thus, to promote the retention of peoples underrepresented in science, an implicit goal of our course was to demystify the image of scientific researchers and clearly demonstrate to our students that experimental neuroscience research is a pursuit carried out by individuals of all backgrounds. To achieve this goal, we took advantage of the online nature of our class to host people from all over the world through Zoom. We created a curriculum that incorporated the participation of invited principal investigators or "Guest Stars" who were also authors on the research papers discussed during Meeting 2 (Figure 1).

To ensure the creation of a diverse learning environment, the chosen roster of guest PIs included a diverse group of scholars. The invited guests were Drs. Ellen Lumpkin, Shantanu Jadhav, Diana Bautista, Paul Garrity, and Vivekanand Vimal. Coordinating the invitation and scheduling the attendance of guests took place during the creation of our syllabus. The time when a guest participated in our class was chosen based on when their expertise aligned with our curriculum. The exact details of when guests were featured can be found in our course syllabus (Supplementary Materials D).

Prior to participating in our discussions, guests were briefed on our expectations of them and our class norms. During our discussions, guest professors were encouraged to give an introduction providing historical context for the selected reading, including what the research meant personally for their careers. After the introduction, the discussion would then progress in the same student-led format described above. The guest PI would act as an additional instructor that could help manage the conversation and steer students toward an accurate understanding of the material. Guest professors often provided rich behind-the-scenes insight into experiments. Once the discussions were completed, the guest PIs would give our students an opportunity to ask any lingering questions and to network. By hosting these guests, we provided our students with access to a diverse set of role models. This contributed to the achievement of the implicit goal of our course, which parallels FUN's goal to diversify the students that are attracted to, and successful in, neuroscience education programs (Wiertelak et al., 2018; Ramirez, 2020).

Deemphasized Grading

Previous research on examinations in the classroom has demonstrated that exams increase stress in students and negatively impact student mental health (Sarason and Mandler, 1952; Liebert and Morris, 1967; Putwain et al., 2021). These negative effects have likely been exacerbated by the COVID-19 pandemic. Therefore, we were interested in exploring alternative models for evaluating student learning.

We were inspired by the Neurobiology: Mechanisms and Advanced approaches course taught at the Marine Biological Laboratory (MBL) in Woods Hole, MA. In this course, there is no grading or traditional exams. Instead, advanced courses at the MBL immerse students in intensive hands-on investigative training (Nishi et al., 2016). Performance in the course is evaluated using approaches more consistent with "authentic assessment" methods. Authentic assessment, sometimes called practical or direct assessment, is a way of gauging student learning by having them perform "real-world" tasks associated with a given learning goal (Mueller, 2005). We sought to utilize a similar approach where grading was deemphasized, and traditional exams were not incorporated. Instead, we focused on science communication because a fundamental "real-world" component of being a scientist is communicating specialized knowledge. We created a participation-based grading scheme centered around assignments designed to give students extensive science communication experience.

Our approach to grading was communicated to students during our first meeting and re-iterated leading up to assignments. A detailed grading breakdown is depicted in Figure 2 and explained here. Of the final course grade, 20% came from students participating in our weekly journal club discussions (Meeting 2). This grade was a binary Yes/No measure based on whether students fulfilled their discussion responsibilities (described above under Course Design: Synchronous Lecture-Discussion System). Students were

Assignment	Final Grade Percentage	Detailed Breakdown	Learning Goal Focus
Participation in Discussions	20%	Binary Y/N	3, 4
Midterm Paper	40%	Peer Review: 25% Completion: 52.5% Content: 22.5%	1 - 4
Final Presentation	40%	SciComm Lab: 25% Completion: 75%	1 - 4

Figure 2. Detailed Grading Breakdown

given full participation-grade credit for fulfilling their discussion responsibility on the day of our journal clubs. This meant that if a student had a discussion assignment, they were given full credit after leading the conversation when it was their turn. They were not penalized if they struggled with their explanation. Instead, we focused on helping them refine their understanding of the concept before moving on to the next point of discussion. Students that did not have a discussion assignment were given full credit based on attendance.

For our mid-semester assignment, we had students write a midterm paper that was worth 40% of their final course grade. For this midterm paper, students were tasked with writing an essay similar in style to a News and Views (Springer Nature). The subject of their essay was a research article of their choice selected from a pool of timely papers on somatosensation curated by the instructors. These were research papers relevant to our course teachings, but not directly covered in the course. In preparation for the submission of the final draft of their midterm paper, we had students participate in the peer review process. Students were assigned partners to exchange drafts of their midterm with, and then tasked with giving thoughtful feedback on those drafts. Participating in peer review was worth 25% of the final midterm grade. Submission of a final draft represented 52.5% of the final midterm grade. Lastly, 22.5% of the final midterm grade came from our evaluation of the content. In this way, just through participation and completion, students would earn 77.5% of the final midterm grade. This constitutes a significant proportion of the assignment. The rubric used to evaluate the midterm paper is included in Supplementary Materials E.

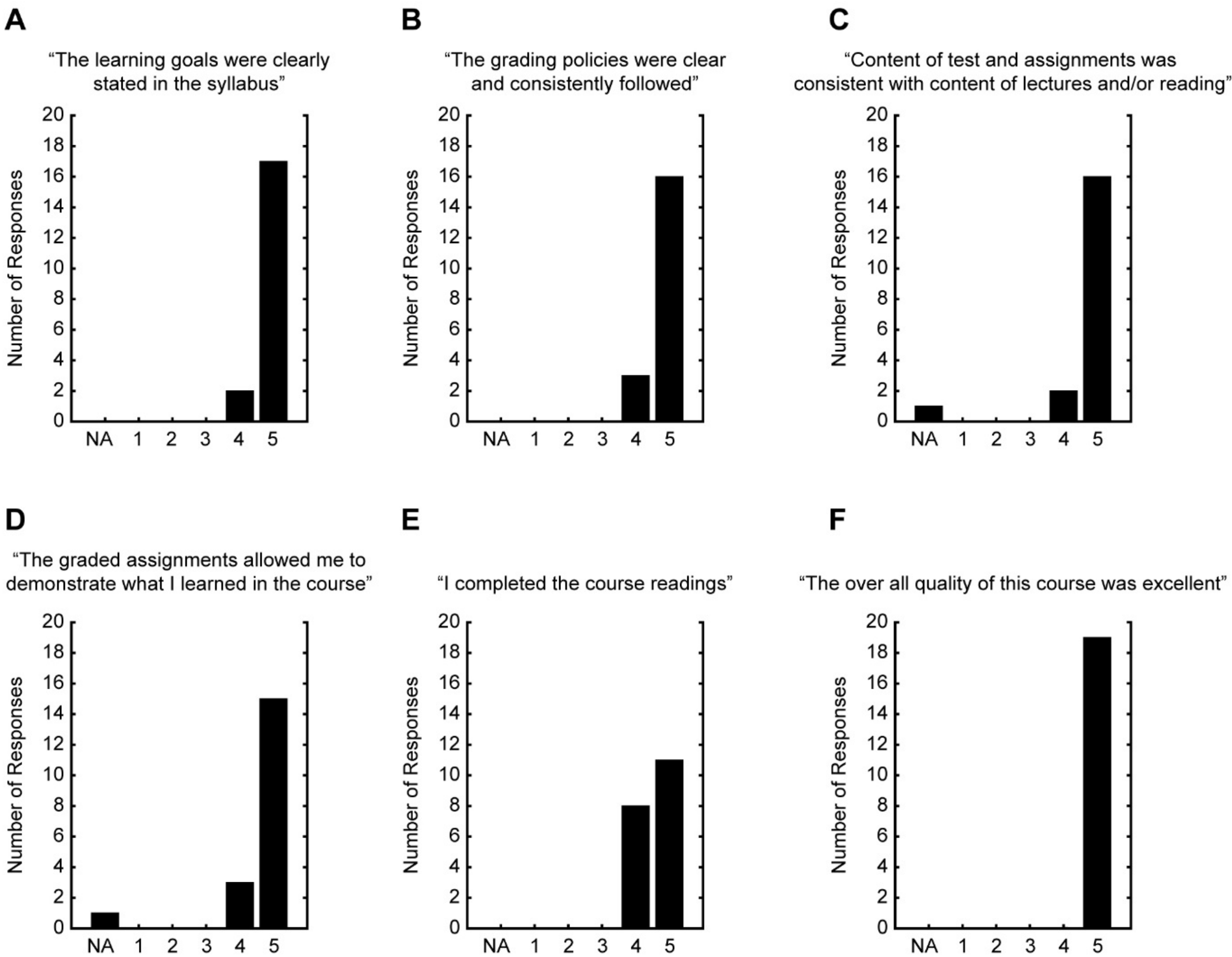
For our end-of-semester assignment, we had students work in teams to prepare a journal club style slideshow presentation that would be presented orally to the class. For this assignment, students were encouraged to select their own research article as long as it fell within the scope of the course. The grading breakdown of their journal club presentation was similar to that of the midterm. The presentation constituted 40% of the final course grade. In preparing their presentation, students were encouraged to visit (virtually) the Brandeis Science Communications Lab. The Brandeis "SciComm" Lab provides coaching in science communication skills. Attending the SciComm lab was worth 25% of the final presentation grade. The remaining 75% of their presentation grade was contingent on the completion of the presentation. All students were given full credit upon the delivery of their presentation. A rubric was made to help guide students in developing the content of their presentation but was not used to grade them (Supplementary Materials F).

Finally, students could earn extra credit points towards their final grade by submitting their completed discussion guides (described above under Course Design: Synchronous Lecture-Discussion System). Students earned 1 extra point per submission of the completed discussion guide. Guides were submitted via an electronic assignment drop box. The drop box closed at the start of our discussions.

Given that a significant proportion of our grading was based on the completion of assignments and participation, it is possible that this worked to potentially relieve examination-induced stress. This does not mean that we did not look over and evaluate the assignments. For both the midterm paper and the end-of-the-semester presentation, students received feedback from both instructors. Lastly, all our assignments were geared towards giving the students extensive written and oral science communication experience with primary literature as the subject matter. Hence, we believe this design worked to advance all four of our learning goals.

Results

This paper puts forth a fully remote, mixed synchronous-asynchronous online class design with an emphasis on participation and a deemphasis on grading. The purpose of this design was to provide flexibility in the age of COVID while working towards important learning goals that align with those put forth by FUN and AAAS. In every classroom and for every course, there are expectations of the students put forth by the instructors that are paramount to the success of the course. In Figure 3, we wanted to assess student understanding of course expectations, course involvement, and course quality. Our learning goals are the foundation of this course design, and when students were presented with the prompt, "The learning goals were clearly stated in the syllabus," the majority of students self-reported that they "Strongly Agree" with this statement (Figure 3A). Moreover, the learning goals were also reinforced verbally during lecture. It is important when following non-traditional models of grading that students clearly understand where their grade is coming from and that this grading adequately assesses their understanding of the course content. We found that when students were presented with the prompts "The grading policies were clear and consistently followed," and "Content of test and assignments was consistent with content of lectures and/or reading," in both instances the majority of students chose "Strongly Agree" (Figures 3B and 3C). Additionally, most students "Strongly Agree" with the prompt, "The graded assignments allowed me to demonstrate what I learned in the course," (Figure 3D). Students also had the opportunity to self-report their participation in the course. All students either "Agree" or "Strongly Agree" that they completed the required course readings (Figure 3E). Lastly, 100% of the students "Strongly Agree" that the overall quality of the course was excellent

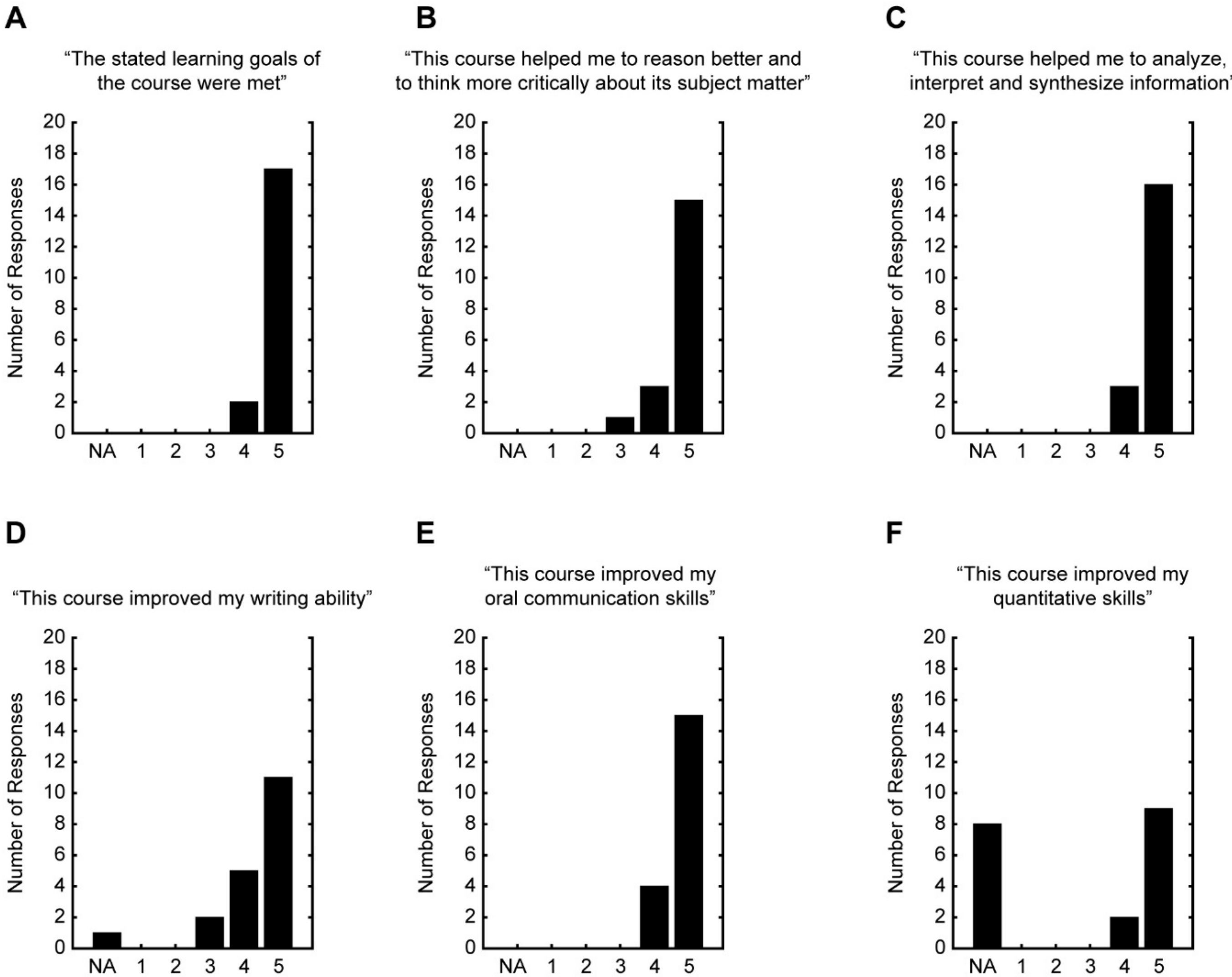


Key: NA = Not Applicable; 1 = Strongly Disagree;
2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

Figure 3. Assessing student understanding of course expectations, course involvement, and course quality. The data was replotted from the Instructor Course Evaluation survey administered by Brandeis University. The data was collected using a Likert-scale, where NA = Not Applicable; 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

(Figure 3F). This is a significant result for a course that did not hold traditional in-person meetings. Taken together, these results indicate that students understood what the goals of the course were, what was expected of them, and how they were going to be evaluated. Furthermore, these results suggest that students felt their evaluation was consistent with course expectations, and not arbitrary.

Next, we set out to evaluate prompts from the Instructor Course Evaluation survey that would allow us to assess student perception of course outcomes. We specifically focused on prompts with language that aligned with our learning goals. When presented with the prompt, "The stated learning goals of the course were met," the majority of students replied by selecting "Strongly Agree" (Figure 4A). Similarly, when presented with the prompts "This course helped me to reason better and to think more critically about its subject matter," and "This course helped me to analyze, interpret and synthesize information," in both instances, the majority of students "Strongly Agree" with these statements (Figure 4B and 4C). These prompts get at the core of our learning goals, which were to communicate an understanding of the topic material and then teach students how to synthesize their understanding of this information such that they could then communicate it. Along these lines, learning goal #4 was specifically for students to "synthesize their understanding of scientific research and communicate it in written and oral formats," and when students were presented with the prompts, "This course



Key: NA = Not Applicable; 1 = Strongly Disagree;
2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

Figure 4. Assessing student outcomes. The data was replotted from the Instructor Course Evaluation survey administered by Brandeis University. The data was collected using a Likert-scale, where NA = Not Applicable; 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

improved my writing ability," and, "This course improved my oral communication skills," the majority of students either "Agree" or "Strongly Agree" with these declarations (Figure 4D and 4E). To make a comparison, we assessed a prompt that does not align with the learning goals of this course. We did not set out to improve quantitative skills nor did we perform any data analysis during the course. Thus, when presented with the prompt, "This course improved my quantitative skills," a large proportion of the students (8/19 or 42%) responded with "Not Applicable" (Figure 4F). Collectively, these prompts suggest that students believed we met our learning goals. Additionally, the results reveal that student perception of the course outcome was highly satisfactory, with many students self-reporting improvements in their understanding of the topic material and communication skills. These results provide a positive readout of student experience following the conclusion of the course.

A limitation of the previous results is that we cannot conclude, based on the given prompts, what aspects of the course resulted in student perception of improvement, only that the students reported that it happened. To gain more insight into what aspects of our course design might have been most valuable to students, we turned to the written feedback provided by students. At the end of the survey, the students were presented with two open-ended prompts where they could freely comment on the course. These prompts were, "Please identify those aspects of the course you found most useful or valuable for learning," and, "What suggestions would you make to the instructor (NAME) for

Course Features:	**Number of Mentions**:
"Lectures" and/or "Discussion"	8
"Videos"	6
"Course Design" and/or "Course Structure"	3
"Guest Scientists" and/or "Outside Speakers"	2
"Grading" and/or "Assignments"	2
"Low-Pressure" and/or "Comfortable" and/or "Safe"	5

Figure 5. Counts of Course Feature Mentions. This table contains a list of course features mentioned by the students in their written feedback as being most valuable for their learning and includes the number of times these features were mentioned.

improving the course?". Here, we focus on the results of the former. When students were asked to openly comment about what features of the course, they found most useful or valuable for learning, 14 of the 19 students that took the survey responded. We screened these comments for specific mentions of "Lectures" and/or "Discussions," "Videos," "Course Design" and/or "Course Structure," "Guest Scientists" and/or "Outside Speakers," "Grading" and/or "Assignments," and comments pertaining to the in-class environment including "Low-pressure," "Comfortable," and/or "Safe." The results of this screening are presented in Figure 5.

We found that "Lectures" and/or "Discussions" were the most frequently mentioned features of the course that students identified as most valuable for learning. This was followed by the lesson content videos being the second most valuable feature of the course as cited by students. These results are reassuring given that lectures and discussions made up 100% of the synchronous component of our class. Similarly, the lesson content videos made up most of the course's asynchronous component, minus recordings of the lectures and discussions later uploaded and made available asynchronously. In addition to these features, three students specifically mentioned "Course Design" and/or "Course Structure" as a valuable component of the course. Surprisingly, aspects of the course that we anticipated would be student favorites, such as hosting guest PIs and deemphasizing grading for assignments were both only mentioned twice in the open-ended feedback. Lastly, we counted comments that mentioned the in-class environment, such as students stating that it was "Low-pressure", "Comfortable", and/or "Safe". A total of 5 students mentioned the in-class environment, making it the third most valuable course feature for student learning, as reported by the students (Figure 5). These results provide insight into what aspects of our course design most significantly impacted students.

DISCUSSION

In this paper, we put forth a detailed course design for remote teaching an upper-level neuroscience class with learning goals that closely align with those put forth by FUN and AAAS (AAAS, 2011; Kerchner, Hardwick, and Thornton, 2012; Wiertelak et al., 2018; Ramirez, 2020). To achieve these learning goals, we created a curriculum that combined synchronous lectures and discussions with asynchronous lesson content videos to teach students both "what we know" and "how we know it". Additionally, we wanted to create an inclusive and low-pressure environment for our students, so we featured guest principal investigators from diverse backgrounds and created a mostly participation-based grading scheme. It is important to mention that none of the course features we implemented in our design are novel. Instead, in this manuscript we provide the framework for how to put all these different pieces together in the context of remote teaching, we include the rationale for why we designed the course the way we did, and we evaluate student perception of the outcome. Given the feedback collected, we can conclude that students had a highly favorable impression of our course. The results from the survey strongly suggest that students believed that our learning goals were achieved. A limitation of these results however is that we are not able to conclude that our course design and its different features directly contributed to the accomplishment of our learning goals. Nevertheless, in their written feedback, the students frequently mentioned all the different elements of our course design as being valuable for their learning. One student felt strongly enough to write, "There have been many courses where the structure was explained and made sense, and then the implementation was very poor. This was not one of those classes". The comments from our students would indicate that, at least in part, the course design worked towards the fulfillment of our learning goals.

Here, we would like to elaborate on the successes and shortcomings of different elements of our course design. When students were prompted to write about what they found most useful or valuable for their learning, they most frequently mentioned what made up the bulk of our synchronous and asynchronous content. That is, students mostly referred to our lectures, discussions, and lesson content videos. Lectures and discussions of primary literature continue to be the foundation of a scientific education, and our experience directly demonstrates that these teaching strategies can be successfully deployed in an online learning environment. Since the conclusion of the course, our lesson content videos have gone on to be very successful. The videos are available for use by all educators on YouTube under the channel "Topics in Neuroscience" (https://www.youtube.com/c/TopicsinNeuroscience; Ramos and Rivera-Rodriguez, 2021). The channel has the videos sorted into two playlists: "Techniques," for videos about experimental neuroscience techniques and "Professional Development," for videos about soft science skills. The channel currently has over 390 subscribers and the 10 videos cumulatively have over 23,000 views. The success of these videos, specifically the videos about neuroscience techniques, highlights a need within our community to create resources that increase accessibility to this more esoteric knowledge.

Both authors are from backgrounds underrepresented in science and we thus personally understand what that journey is like. We understand the power of role models, of seeing someone like yourself. Studies on role models and representation have demonstrated that creating diverse and inclusive academic environments results in more positive learning experiences, ultimately working to increase the retention of students from underrepresented backgrounds (Rainey et al., 2018; Stout et al., 2018; Linden, Kruskop, and Kitlen, 2020; Asai, 2020; Trent et al., 2021; Deanna, et al., 2022). Therefore, to inspire our students and promote inclusivity, we hosted a diverse series of guest scientists throughout the semester. A short coming of our class was that we did not directly survey the students on their thoughts or feelings regarding our guests. Consequently, it is difficult to make any conclusions on the impact of featuring our guest scientists. Compared to other course design features, it was mentioned less frequently in the written feedback. However, anecdotally, students often stayed for extended periods of time after class to talk with our guests. If we were to teach this class again, or any future course, we would more directly ask for feedback on this aspect of the course.

We were inspired by the success of courses without exams to similarly create a curriculum without traditional examinations (e.g., Branco, 2021). We hoped that by doing away with "tests", we could help alleviate some pandemic-induced stress and provide our students with a more low-pressure learning environment. Instead of exams, we decided to include assignments that would give our students extensive science communication experience and derive a large proportion of the grade for these assignments from participation. Still, it is possible that these assignments could have been perceived as exams, or that they resulted in examination-induced stress. Similar to the inclusion of our guest scientists, compared to other course design features, grading, and our assignments were mentioned less frequently in the written feedback provided by the students. However, with respect to both our grading policies and featuring guests from diverse backgrounds, the intended goal was to improve the environment of our class. In that regard, several students mentioned our class environment, describing it as "low-pressure", "safe", or "comfortable". It is possible that this was a result of the aforementioned course design features but we cannot make that conclusion with the given data.

We recognize that there are two weaknesses that arise from the approach that we took for student evaluation. First, our course can be taken advantage of by students less interested in the topic and more interested in an easy grade. Having evaluated the midterm and final assignments of every student, and worked alongside them during the semester, there were no "red-flag" instances that signaled a student was maliciously taking advantage of our curriculum. This perspective is congruent with the student's own perception of the course and learning goals (Figure 4A, 4B). Secondly, given that our primary method for gauging whether students were learning about somatosensation was based on their communication during discussions and during assignments, this makes learning goals #1 and #4 inextricably linked. Future use of this curriculum should pair our current approach with frequent low-stakes assessments. This type of assessment has been previously shown to provide both students and instructors with an opportunity to measure the comprehension of concepts (Wiggins, 1998; Reviewed in Ramirez, 2020). This would provide a clearer read-out of learning goal #1 while maintaining the advantage of deemphasized grading (i.e., a low-anxiety environment). There are limitations of self-report surveys and Likert-type data that should be taken into consideration by anyone reading this manuscript. First, there exists a well-established relationship between student ratings on a course evaluation and their grade satisfaction (Kogan et al., 2022), such that students with favorable grades rate a class more favorably, and vice versa. Additionally, there are two types of bias associated with Likert-type scales that could influence the results of course evaluations. The first is acquiescence bias, which is defined as a tendency to select a positive response option or "agree" more frequently than to select a response option with a negative connotation (Graeff, 2005). This type of bias is also known as agreement bias. Finally, a second type of bias associated with Likert-type scales and student course evaluations is social desirability bias. This latter bias is when students answer based on what would make them "look good" or what is socially acceptable, instead of responding based on their true feelings (Graeff, 2005). The existence of these biases should be held in consideration when evaluating any data from a course evaluation and when reading this manuscript.

Given that for both authors, this was the first time designing and implementing a curriculum from start to finish, we would like to conclude with a candid reflection sharing our perspective on the experience. The work put into designing this class was initially reactionary. We applied for and were awarded the opportunity to teach a class prior to the start of the COVID-19 pandemic. Eventually, it became clear that we would not be hosting a traditional in-person class as we had hoped. We were at first dismayed by the prospect of remote teaching because we believed it would rob us, and the students, from the "full" experience. We were wrong. By focusing on what advantages there were to gain from teaching a remote course, we were able to have an incredibly rewarding semester. It was obvious to us that when we trusted our students to learn, they did it to the best of their abilities in these challenging times. Moreover, we finished the semester having produce a series of videos that are now a resource available for all educators and they are currently in use by some. Ultimately, we hope this manuscript serves as a template for future educators designing remote courses. Not because they are forced to do so during a pandemic, but because a remote course is a suitable option with its own advantages.

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