Title: From Neurons to Brain: Redesigning a Neuroscience Course to Enhance Student Learning and Engagement

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Summary: A neuroscience professor integrates online assignments and mini-seminars in a Biological Psychology course to increase student engagement outside the classroom and promote learning about the brain as a system, beyond functional neuroanatomy details.

Background

Brain and Behavior (PSYC 370) is the main psychology course providing an in-depth examination of brain anatomy and the relationship between brain function and behavior. It is a required class for all psychology majors, and in addition, it is one of the core courses for the psychology department’s Behavioral Neuroscience B.S. degree. As such, enrollment typically exceeds 100 students per term.

Throughout the semester, the course aims to help students:
(a) demonstrate an understanding of the principles of biological psychology;
(b) exhibit knowledge of the scientific methods used to answer questions pertaining to the relationship between brain and behavior;
(c) cultivate an understanding of historical and ethical issues that have emerged in neuroscience research; and,
(d) appreciate and evaluate neuroscience findings as they apply to everyday life.

The class has the reputation of being challenging and—due to the nature of the material—it does require a lot of work and memorization. However, I have striven to establish the right balance between connecting student learning with the course objectives and extending that learning beyond simply memorizing course content.

When I taught PSYC 370 in Spring 2012, I found that overall the class reached its intended goals. However, there were several areas that I felt could be strengthened. I found myself devoting a lot of class time to discussing and explaining small details, because students did not appear to have spent time outside of class familiarizing themselves with the material. Moreover, a number of students, especially those taking the course because it is a requirement rather than from an interest in the topic, seemed to wait until the last moment before an exam to attempt to learn all the material. They would then feel overwhelmed by the amount of information to be learned in just a few days. Although some students changed this behavior for the second and third exams, their familiarity with the materials still did not move far beyond memorization. Relatedly, students often seemed to get lost in the details, not fully appreciating the “big picture.” Although they were largely engaged during class sessions, a general focus on the details resulted in students having a hard time addressing bigger questions about neuroscience that could help bring together seemingly disparate information on different aspects of brain function.
To address these two areas of concern, namely (1) increasing student engagement outside the classroom, and (2) promoting learning beyond the details, I decided to rethink the course structure and to implement several changes when I taught it again during Spring 2013.
Implementation

While rethinking PSYC 370's structure, I decided to implement three changes to strengthen those areas that I felt could be improved, and, therefore, increase student engagement. First, I added pre-class quizzes. Second, I improved the grading scheme for a pre-existing assignment. And, third, I added a short “seminar-like” element to the course. I retained exams utilized in previous course iterations to assess student learning.

To facilitate learning outside the classroom, I created and assigned quizzes for each class topic (a total of 11 throughout the semester), which students completed before class; these quizzes consisted of basic multiple-choice questions and were administered and graded automatically through Blackboard. I felt that this element would help ensure that students had some background coming into class, allowing me to focus on complex aspects of course material and to make broad connections across neuroscience’s domains during lecture.

In previous iterations of PSYC 370, online blog posts constituted one of three main course elements I used to promote student engagement and understanding of the material. My GTA and I would provide information on current topics within neuroscience research, and students had to respond to two topics (from five possibilities) via a short blog post. My GTA and I would read through and grade the posts; we mainly assessed them on being on-topic, and on their depth of scholarship in addressing the topic. Although this did work and students generally gave very good feedback on this assignment, I felt that I could have had a more substantial rubric for grading so that the students would receive more comprehensive feedback on their work and have a better grasp of our expectations. To increase student engagement, I also required students to comment on four of six possible topics my GTA and I posted during the semester on my personal blog page. An example post can be accessed here.

Finally, I wanted to add an element to the class content that would provide a chance to directly connect course material with bigger issues and with other areas of psychology. Therefore, I incorporated “mini-courses,” short seminar-style classes covering material in addition to that covered in the larger class. Students signed up and were required to attend and participate in a mini-course, lasting three weeks, with one hour-long meeting per week. Three graduate students lead the mini-courses focusing on their area of psychology among the main neuroscience domains covered in the course: behavioral, cognitive, and clinical neuroscience. Each graduate student worked with me closely to develop three lectures that reflected a particular broad or applied topic within each domain. The graduate instructors also used their own research to provide the students with concrete examples of applied work in neuroscience. They delivered a short lecture on the topic and also led the group in discussions based on mini-course-specific readings. The students were required to submit a 500-word report on the information they learned during each week of the mini-course, as well as make connections with the larger class. Template forms for these reports were provided to the students, along with a comprehensive grading rubric. Students were also asked for feedback on the specific course attended, in addition to feedback on the larger course. My goal for the mini-courses was to benefit the undergraduate students, by allowing them to see how the material in this course could be applicable to their own work...
and interests, as well as the graduate students, by providing additional experience leading a small class. Critically, I wanted to incorporate an in-class component that would allow students to integrate materials from the course to real-world applications of neuroscience.
Student Work

Pre-Class Quizzes: For the pre-class quizzes, I selected questions associated with the materials available in the course textbook. The questions were in line with the level of difficulty and the format of those I included in the three course exams. My objective was to give students some practice throughout the course with the kinds of questions they would face during the exams, which would help them plan and adjust their studying accordingly. Following each question, the students were also provided with feedback as to whether their response was correct or incorrect, and they were directed to the specific page(s) in the textbook and notes where the answer could be found. The average student performance (percent) across all 11 quizzes was 71% (standard deviation 20%) and the median performance was 77%. Given that all answers were easily accessible in the textbook and other course materials, students who took the time to read through a given chapter, understand it thoroughly, and find the answers to the quiz questions, typically scored > 90% on this assignment. Students who looked for the quiz answers through keywords or the book glossary were typically less successful in their performance.

Blog Posts: In the Spring 2012 course iteration, students received points for simply completing the blog assignment in a timely and scholarly manner. Students who completed the assignment successfully referenced the brain, in addition to other biological, developmental, or environmental factors that may underlie sociopathic behavior, for example; they also elaborated on the question of whether sociopaths should be held responsible for their actions by providing clear and specific explanations as to why they agreed or disagreed with this statement. This is more obvious in example 1 relative to example 2. In contrast, students who completed this assignment less successfully referenced the brain very generally in their responses. In addition, their answers did not use scholarly language and were not well organized. Critically, they focused more on sociological aspects of the question that were not directly related to course topics or the post’s main theme.

To provide students with more comprehensive feedback on their work, in the Spring 2013 course, I created a substantial rubric for grading student responses. Students who successfully completed the assignment submitted significantly lengthier and more comprehensive responses. Critically, they specifically referenced neuroanatomical details as well as neuroscience methodology in their answers, and they even incorporated information they had learned from the additional optional readings or from other classes (e.g., see reference to the MacDonald Triad of Sociopathy in example 2). In addition, they approached the question of punishment from the perspective of psychology, emphasizing the potential role of neuroscience and its methodologies in adjudicating social debates such as the one discussed in this post. In contrast, students who were less successful did not include in their responses any reference to the brain or discussed methodology, and focused almost exclusively on the social aspects of the debate without making any connections with psychology. Overall, performance on this assignment throughout the semester exceeded 90%. Critically, students who received low scores on their work earlier in the semester had the opportunity to discuss with the GTA the reasons for their scores
(according to the rubric), and they were able to improve the quality and depth of the responses they submitted later in the semester, thus earning higher grades.

**Mini-Courses:** Student attendance for the three sessions of a given mini-course approached 100%. Students were provided with report template files in which they were asked to enter their responses, and these reports were graded according to a rubric, which was available to the students before the first meeting of their chosen mini-course. More than ¾ of the class achieved over 95% on this assignment. Students who successfully completed the assignment referenced specific readings and course materials, provided responses that conformed to the required length limit, and included an in-depth assessment of how the materials covered in the mini-course related to information they learned in the main class lectures. Students who were less successful provided reports that were lacking in depth, were relatively short, and lacked specific references to mini-course materials.

**Overall Performance:** Relative to the Spring 2012 iteration, the inclusion of pre-class quizzes did not significantly increase the Spring 2013 student exam scores. Although the quizzes resulted in students engaging with the material weeks in advance of a given exam, students did not dramatically alter their studying habits prior to each exam. Overall, student performance was better, relative to the previous course iteration; however, this likely reflects different proportions in the grade distribution by assignment, according to which exams were weighted less to allow for the inclusion of other assignments, such as the pre-class quizzes and the mini-course reports.
Reflections

Overall, the three changes I implemented achieved my course redesign goals. Specifically, the inclusion of pre-class quizzes encouraged students to familiarize themselves with course content prior to lecture and to begin studying several weeks prior to a scheduled exam. This allowed me greater flexibility to devote class time to clarifying difficult concepts and providing in depth discussions of course materials. Nevertheless, although it was more productive to explain complex concepts to students who had some exposure to the information due to the pre-class quizzes, the nature of the materials still required substantial explanation and examples during lecture to enhance clarity and support student understanding.

On the other hand, the quizzes did not significantly improve student exam performance. One possible explanation for this outcome is that students could complete the quizzes with an open book, which does not simulate the kind of learning required to perform well on the exams. In addition, although the quizzes helped some students realize early on in the course the amount of time they would need to devote to studying, for others they provided a sense of overconfidence, which discouraged substantial engagement with course content prior to the exams. Finally, it is worth noting that over ¾ of the students take this class because it is a requirement and not because they are interested in the topic. As a result, they begin the class with low expectations and are prepared to exert a minimum effort. In this regard, completing the pre-class quizzes and other non-exam assignments is a way to acquire course points without fully engaging with the materials in depth, as would be required for good performance on the exams. As such, the amount of effort placed on studying for the exams did not change relative to past semesters, as students could get a satisfactory grade in the course even if they did not do particularly well on the exams. Thus, a possible way to support better studying habits in the future would be to maintain the pre-class quizzes but also increase the weight of each exam.

With regard to the blog posts, the inclusion of a grading rubric significantly improved the quality of the posts overall. Students specifically made use of their knowledge about brain function and neuroscience methodologies in composing their responses. Moreover, they linked course materials to real-world issues and highlighted in their answers the contributions of this field of psychology to social issues. As this assignment was successful, I am planning on incorporating it again into future course iterations.

The mini-courses were, overall, successful in promoting student engagement outside of the classroom. Importantly, they offered students the opportunity to read original neuroscience literature and get exposed to topics related to the brain. Students offered excellent feedback on this assignment, notwithstanding some concerns regarding scheduling of the mini-course lectures outside of class time. Logistically, the mini-courses required substantial personal involvement and they were rather time consuming for me (i.e., in terms of planning, meeting with the graduate instructors, approving course materials, posting resources for the students, as well as reminders, scheduling the classes, and managing the payment of the graduate instructors). Moreover, their inclusion in a course like PSYC 370 is contingent upon the availability of graduate instructors with the
teaching experience and interests to offer a particular kind of relevant mini-course. If this component were to be included in PSYC 370 or other classes in the future, its implementation would be significantly facilitated by some departmental support, and possibly, the official integration of the mini-courses with a given class, such that students would register for a particular section during their registration for the course. I do think that the mini-courses promoted student engagement; thus, I am willing to explore possible ways to make them part of a future class without them becoming a distraction for the instructor.

One aspect of the course redesign that I would like to work on more substantially in the future is student engagement during class time. Although students provided very positive feedback on videos and case studies discussed during lecture, and, generally, asked questions, the nature of the materials (i.e., neurobiology) is not thematically appropriate or inviting for in-class discussions. Additionally, this particular course was originally intended to provide a survey of multiple topics on the relationships between brain and behavior, which can be overwhelming for most students who do not have sufficient background in biology or are not interested in the topic and simply take the class because it is a graduation requirement. As such, recently, we have restructured our curriculum for biological psychology classes to include three (instead of two) courses. Critically, these courses will be thematically organized in a more intuitive manner (behavioral, clinical, and cognitive neuroscience), such that the instructors will be able to cover less material but in more depth. I anticipate that integrating the changes I implemented in the present course redesign in a more focused class will further support student learning.