EDITORIAL
Case Studies and Neuroscience Education: Tools for Effective Teaching

Eric P. Wiertelak[1], Kristen E. Frenzel[2], and Leah A. Roesch[2]
[1]Department of Psychology and Neuroscience Studies Program, Macalester College, Saint Paul, MN 55105; [2]Neuroscience and Behavioral Biology Program, Emory University, Atlanta, GA 30322.

The undergraduate neuroscience curriculum accomplishes much in the short space of a college student's career. However, an ever-expanding societal appreciation of the scale of neuroscience provides neuroscience faculty with an information stream that defies curricula to be based on anything approaching a comprehensive content base. Moreover, curricula intended to satisfy such a mission would fall short of other important goals for higher education and the STEM disciplines in particular, such as: to promote general scientific literacy; to build facility with the process of doing science; to develop habits of mind that encourage sound reasoning, and to refine written and oral communication skills. But, what additional methods can we find time to adopt and employ to better accomplish delivering so much, and in so little time? *JUNE* has had as its mission to enable faculty to learn about innovations in neuroscience education, and to exchange information about best practices. It is with the mission of providing faculty with mechanisms to facilitate their efforts to deliver the neuroscience curricula that we launch a new section for neuroscience: *Case Studies*. This new, regular feature of *JUNE* will highlight case studies for undergraduate neuroscience curricula. Our goal for this new section is to provide a hub of information and resources for case writers, case study users and those curious about case studies and how they are implemented in the classroom. In launching this new section, *JUNE* intends to support and expand the community that uses and values these curricular tools and to start conversations about best practices, assessments, and implementation. Each edition will feature one to three articles describing new cases. The new cases may be in a wide variety of formats encompassing a range of neuroscience concepts, but all case studies articles published in this new section will be rigorously peer reviewed. All case materials, which include the case study as the students would receive it and detailed classroom implementation notes will be available by request to instructors at cases.at.june@gmail.com.

The term "case studies" is not meant to evoke traditional thoughts of clinical case studies, with one patient used to describe a particular clinical malady. Case-based instructional methods use realistic narratives to engage students in solving problems, building analytical skills, and working cooperatively in a self-directed way (Herreid, 1994; Duch et al., 2001; Torp and Sage, 2002) and have been shown to improve student performance and to strengthen science process skills in K-12 classes, undergraduate classes, and in medical school (Barrows, 1985; Blosser, 1988; Blumenfeld et al., 1991; Gallagher et al., 1995; Hmelo and Ferrari, 1997; Ram, 1999; Duch et al., 2001). In 2014, a comprehensive meta-analysis of 225 studies provided strong evidence in support of "active learning as the preferred empirically validated teaching practice" in STEM disciplines (Freeman et al., 2014), and case-based methods are strong examples of these teaching practices (Handelsman et al., 2004).

In 2012, a group of members of the Faculty for Undergraduate Neuroscience (FUN) met and developed a set of core competencies and surveyed the neuroscience community for evaluation of these competencies (Kerchner et al., 2012; Ledbetter, 2012). The authors qualify these findings as a "first pass" at developing a discipline-wide set of core concepts and competencies; the ideas can be used as a framework for curricular design and assessment. What emerged was a consensus that certain neuroscience concepts, e.g., how neurons communicate, and process skills, including critical thinking, analytical and communication skills are critical for a complete neuroscience education. Case-based instructional methods support the integration of discipline-specific content knowledge with scientific skills development, including quantitative literacy, understanding neuroscience as an evidence-based discipline, understanding neuroscience as a collaborative, interdisciplinary process, and understanding the relationship between science and society (AAAS, 2010; NRC, 2011).

Our new Case Studies section introduces two new *JUNE* section editors, co-authors of this editorial, Leah Roesch and Kristen Frenzel, both lecture-track faculty in the Neuroscience and Behavioral Biology Program at Emory University. Both have been developing and promoting innovative curricula for undergraduate neuroscience for several years (Roesch and Frenzel, 2014, 2015). Frustrated at the lack of available case studies for teaching neuroscience, they set out, with support from NSF through the Science Case Network (NSF RCN-UBE Project #1344208), to recruit and support a cohort of faculty from across the U.S. who would create, adopt and adapt case studies for particular use in neuroscience undergraduate courses. After an exciting and productive experience with the 2014-2015 cohort of faculty, Frenzel and Roesch are now working with *JUNE* to support the vetting and dissemination of case studies for teaching neuroscience. With respect to neuroscience-specific case studies, a recent count of available cases from the National Center for Case Study Teaching in Science (NCCSTS) and University of Delaware case study/Problem-Based Learning (PBL) repository sites retrieved a total of 42 cases tagged as "neuroscience," compared with 344 cases

tagged as “biology,” supporting the contention that there is a lack of available neuroscience specific cases. This underwhelming current number of cases primarily consists of physiology cases posted in isolation without recent updates nor any discussion or context as to how the cases fit into a neuroscience curriculum. It is our hope that the *JUNE* Case Studies section will create a place for educators to not only publish high-quality cases, but to draw attention to this pedagogy and allow authors to create a context for the curriculum in their neuroscience classes.

In this first edition of the Case Studies Feature, we’ve chosen a PBL case from Frenzel and Roesch. The case, Nora’s Medulla, focuses on basic concepts of neuronal communication. Although Frenzel and Roesch have used the case extensively in a non-majors class, the fundamental nature of the concepts make this case very flexible and widely applicable to many types of classes. Representing the traditional PBL format, the case is broken into scenes and the students work in small groups to investigate each sequential scene. The iterative process of the classic PBL method supports students in posing hypotheses, defending and refuting proposed hypotheses, and evaluating resources. In their article in this issue of *JUNE*, Frenzel and Roesch (2016) describe the case objectives, implementation process, and their assessment strategies.

REFERENCES

AAAS (2010) Vision and change in undergraduate biology education: a call to action. (Brewer C, Smith D, eds). Washington, DC: AAAS.

Barrows HS (1985) How to design a problem-based curriculum for the preclinical years. NY: Springer.

Blosser PE (1988) Teaching Problem Solving--Secondary School Science. In: ERIC Clearinghouse for Science Mathematics and Environmental Education. Columbus, OH.

Blumenfeld PC, Soloway E, Marx RW, Krajcik JS, Guzdial M, Palincsar A (1991) Motivating project-based learning: sustaining the doing, supporting the learning. Educ Psychol 26:369-398.

Duch BJ, Groh SE, Allen DE (2001) The power of problem-based learning. Sterling, VA: Stylus Publishing.

Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, Wenderoth MP (2014) Active learning increases student performance in science, engineering, and mathematics. Proc Natl Acad Sci U S A 111:8410-8415.

Gallagher SA, Sher BT, Stepien WJ, Workman D (1995) Implementing problem-based learning in science classrooms. Sch Sci Math 95:136-146.

Handelsman J, Ebert-May D, Beichner R, Bruns P, Chang A, DeHaan R, Gentile J, Lauffer S, Stewart J, Tilghman SM, Wood WB (2004) Education. Scientific teaching. Science 304:521-522.

Herreid CF (1994) Case studies in science: a novel method of science education. J Coll Sci Teach 23:221-229.

Hmelo CE, Ferrari M (1997) The problem-based learning tutorial: cultivating higher order thinking skills. Journal for the Education of the Gifted 20:401-422.

Kerchner M, Hardwick JC, Thornton JE (2012) Identifying and using 'core competencies' to help design and assess undergraduate neuroscience curricula. J Undergrad Neurosci Educ 11:A27-A37.

Ledbetter ML (2012) Vision and change in undergraduate biology education: a call to action presentation to faculty for undergraduate neuroscience, july 2011. J Undergrad Neurosci Educ 11:A22-A26.

NRC (2011) Promising practices in undergraduate science, technology, engineering and mathematics education. In: National Research Council (Niellson N, ed). Washington, DC: National Academies Press.

Ram P (1999) Problem-based learning in undergraduate education - a sophomore chemistry laboratory. J Chem Educ 76:1122-1126.

Roesch LA, Frenzel KE (2014) Implementation of active pedagogies in an undergraduate neuroscience course for non-science majors. Program No. 24.01 2014 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, Online.

Roesch LA, Frenzel KE (2015) Science case network: creating a working group for case studies in neuroscience. Program No. 23.16 2015 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, Online.

Roesch LA, Frenzel KE (2016) Nora's medulla: a problem based learning case for neuroscience fundamentals. J Undergrad Neurosci Educ 14:143-145.

Torp L, Sage S (2002) Problems as possibilities: problem-based learning for K-16 Education. Alexandria, VA: ASCD.

Received March 10, 2016; revised March 16, 2016; accepted March 16, 2016.

Address correspondence to: Dr. Eric P. Wiertelak, Department of Psychology, Macalester College, 1600 Grand Avenue, St. Paul, MN 55105. Email: Wiertelak@macalester.edu