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Adapting Case Studies for Synchronous and Asynchronous Online Courses

Denise R. Cook-Snyder[1*] **and Daniel G. Ehlinger**[2*]
[1]*Neuroscience Department, Carthage College, Kenosha, WI 53140;* [2]*Department of Psychological Sciences, University of Wisconsin-River Falls, River Falls, WI 54022. *These authors have contributed equally to this work.*
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Case studies are an effective active learning method that increases student engagement and are readily adaptable from in-person to online learning environments. In this perspective, Neuroscience Case Network fellows (NeuroCaseNet; NSF-RCN-UBE Grant #1624104) provide specific examples of how case studies were successfully adapted for synchronous and asynchronous online learning, including general strategies and best practices for adapting case studies into both online learning environments.

Key words: Case study; active learning; problem based learning; online; synchronous; asynchronous

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Case studies are an effective active learning method that use narratives to engage students in higher-level learning objectives within Bloom's Taxonomy (Anderson and Krathwohl, 2001; Handelsman et al., 2004; Herreid et al., 2012; Wiertelak et al., 2016). The Journal of Undergraduate Neuroscience Education (JUNE; https://www.funjournal.org/) and the National Center for Case Study Teaching in Science (NCCSTS; https://www.nsta.org/case-studies) provide two case study repositories with teaching notes that can be adapted and implemented in individual courses. Indeed, case studies have demonstrated efficacy in introductory and advanced undergraduate neuroscience courses with small and large student enrollments across a variety of content and skills learning objectives (Herreid et al., 2012; Brielmaier, 2016; Ogilvie and Ribbens, 2016; Roesch and Frenzel, 2016; Wiertelak et al., 2016; Lemons, 2017; Nagel and Nicholas, 2017; Sawyer and Frenzel, 2018; Mitrano, 2019; Ogilvie, 2019; Watson, 2019; Rollins, 2020). Previous research also suggests that case studies are effective active learning methods for synchronous and asynchronous online and hybrid teaching (Brooke, 2006; Hoffer, 2020), and have been used extensively for business and health professional education (Lee et al., 2009; Rollag, 2010; Schiano and Anderson, 2014; Thistlethwaite et al., 2012). Here, we add to this literature by describing examples of successful strategies for the use of case studies in both synchronous and asynchronous online undergraduate neuroscience courses.

The synchronous and asynchronous courses described here primarily used interrupted, clinically-focused, primary literature-based case studies as cumulative activities. Interrupted case studies use multiple, sequential sections of narrative and questions, and clinically-focused case studies use narratives focused on diseases and disorders (NCCSTS, 2021). Primary literature-based case studies promote student analysis and evaluation of primary literature by incorporating data throughout the case (Prud'homme-Généreux, 2016; Cook-Snyder, 2017; Sawyer and Frenzel, 2018; Rollins, 2020). Cases were administered as cumulative activities after covering relevant content in class, allowing students to apply their knowledge to a novel scenario. The implementation notes included with the majority of published case studies in neuroscience (e.g., JUNE and NCCSTS) are designed for use in in-person courses and can be adapted with only minor updates for synchronous online courses. Adaptation for asynchronous online courses, however, presents several unique challenges. Methods for synchronous and asynchronous courses are described below.

CASE STUDIES IN SYNCHRONOUS ONLINE COURSES

Case studies were used in a synchronous online format for advanced one-semester courses in cellular and molecular neuroscience (Neuroscience 3950; ~30 students) and neuroanatomy and physiology (Neuroscience 4100; ~30 students) with the same instructor at a small liberal arts college (Denise Cook-Snyder, Carthage College). Both courses are designed for junior- and senior-level neuroscience majors. To implement case studies for these courses, minor updates were made to a previously described classroom management strategy for in-person courses (Cook-Snyder, 2017; Figure 1):

1)   *Flipped lectures cover background material relevant to the case.* In flipped lectures, students gain familiarity with content before class, and class time is used to assess and build upon student understanding using active learning (Brame, 2013). To gain familiarity with background material in the synchronous online course, students completed assigned textbook readings (Kandel et al., 2013) and watched recorded lectures from the instructor before class. Lectures were recorded using Screencast-o-matic (https://screencast-o-matic.com/) and posted on the course's learning management system (LMS; Schoology; https://www.schoology.com/). Comprehension quizzes were administered before class using Google Forms to incentivize students to complete the readings and Zoom lectures **(Brame, 2013). In-class meetings were conducted over**
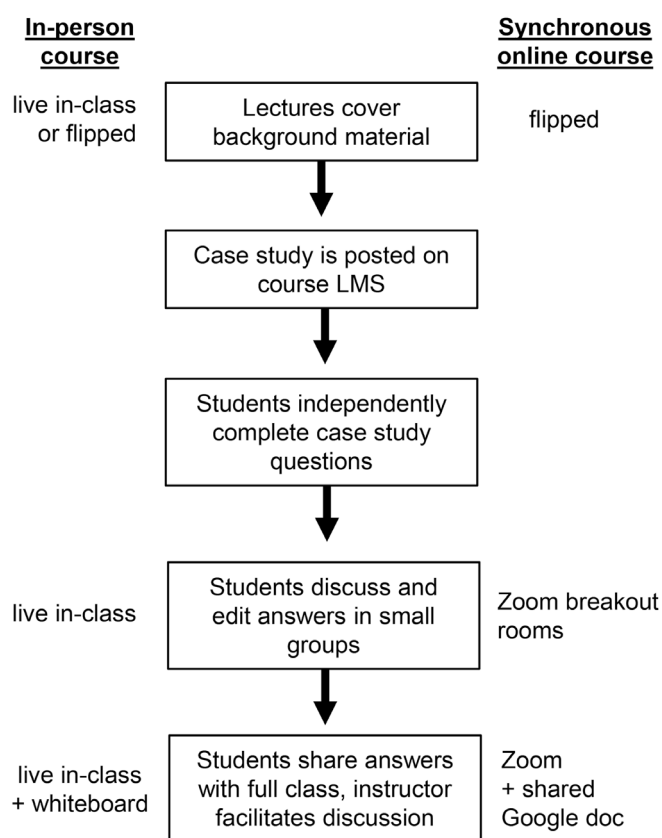
In-person course

live in-class or flipped

Synchronous online course

flipped

live in-class

Zoom breakout rooms

live in-class + whiteboard

Zoom + shared Google doc

| Lectures cover background material |
| Case study is posted on course LMS |
| Students independently complete case study questions |
| Students discuss and edit answers in small groups |
| Students share answers with full class, instructor facilitates discussion |

Figure 1. Comparison of case study implementation strategy for in-person versus synchronous online courses.

(https://zoom.us/) during one to two 65 minute class periods per week. Students received instruction in using Zoom at the beginning of the course, including joining a Zoom class, providing verbal and non-verbal feedback to the instructor, and joining breakout rooms to work with peers. In-class active learning included peer instruction in Zoom breakout rooms to discuss and expand on course content (Mazur, 2009;). These methods for student preparedness before class and active learning in class follow the key elements of the flipped classroom (Brame, 2013), which have demonstrated efficacy for synchronous online courses (McLaughlin et al., 2013; Carrick et al., 2017; Tang et al., 2020). These methods are also a minor update from in-person classroom management for case studies, which also used before-class readings and quizzes, and in-class active learning, but where lectures were delivered live during class time (Cook-Snyder, 2017).

2)   *An electronic copy of the case is posted on the course LMS.* In the synchronous online course, cases were used as cumulative activities after covering background material in class. Cases were posted approximately one week before their due date, but LMS analytics suggest that most students downloaded the case 48 hours or less before the due date. Cases were adapted from published cases (Bolognese et al., 2005; Timson and Zimmerman, 2006;

Madern et al., 2012; Millas et al., 2014; Brielmaier, 2016; Ogilvie and Ribbens, 2016; Roesch and Frenzel, 2016; Sawyer and Frenzel, 2018), or written by the instructor following a framework for converting primary articles into cases (Prud'homme-Généreux, 2016; Cook-Snyder, 2017). Briefly, this framework adds narrative to the typical structure of a primary research article (Introduction, Materials and Methods, etc). The use of narrative engages students in analysis and evaluation of primary literature data. The same cases and methods were used in the in-person courses.

3)   *Students complete short answer questions embedded in the case.* In the synchronous online course, students completed the case's questions and submitted their answers to the course LMS before class started. The same methods were used in the in-person courses.

4)   *Students discuss and edit their answers in small groups in class.* In the synchronous online course, students were provided 10-15 minutes per case section to discuss their answers in randomly assigned Zoom breakout rooms of 3-4 students. Breakout rooms can help re-establish in-class norms for online learning, like participating in small-group discussion, which has been shown to promote equitable participation in synchronous online courses (Reinholz et al., 2020). These methods mirror the discussion methods used in the in-person course, where students were provided 5-10 minutes per case section to discuss their answers in self-selected groups of 3-4 students.

5)   *Students share their answers with the full class and the instructor facilitates discussion.* While in their breakout rooms in the synchronous online course, student groups were assigned to answer case study questions in a Google Doc shared with the whole class and visible on the instructor's shared screen in Zoom. Google Docs allowed for collaborative note taking and group work, which are strategies to increase student engagement and participation in whole-class discussion in online and hybrid learning (Bruff, 2020; Reinholz et al. 2020; Zhu et al., 2020). The instructor could also monitor student progress in real time, and join breakout rooms if students needed additional help. This is an update from in-person methods, where the instructor asked for volunteers to report their group's answers, and the instructor recorded these answers on the whiteboard at the front of the class. In both synchronous online and in-person courses, whole-class discussion emphasized that there can be multiple "correct" answers, and the best answers are accurate and well-supported by the case study itself, previous course content, and/or additional primary literature as needed. Students were expected to edit their own original answers based on class discussion. This provided students with immediate feedback on the instructor's expectations of "correct" answers, while allowing for student reflection on improving their answers. This discussion structure also reinforced core competencies of independent/self-motivated learning and
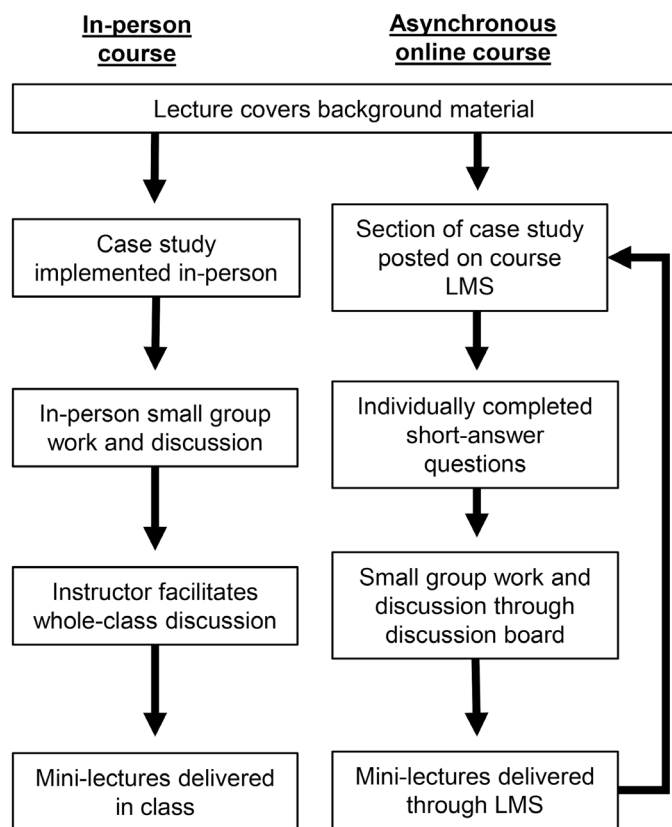
In-person course

Lecture covers background material

Case study implemented in-person

In-person small group work and discussion

Instructor facilitates whole-class discussion

Mini-lectures delivered in class

Asynchronous online course

Section of case study posted on course LMS

Individually completed short-answer questions

Small group work and discussion through discussion board

Mini-lectures delivered through LMS

Figure 2. Comparison of case study implementation strategy for in-person versus asynchronous online courses.

scientific communication (Kerchner et al., 2012).

Cases were completed in one to two 65-minute class periods per week, and students re-submitted their edited answers to the course LMS after class for pass/fail grading for completion.

Taken together, this classroom management strategy demonstrates that only minor updates were needed to convert in-person case studies to synchronous online courses. Given the efficacy of case studies for online active learning (Brooke, 2006; Hoffer, 2020), we encourage instructors to further modify these methods to use case studies in their own online classroom.

CASE STUDIES IN ASYNCHRONOUS ONLINE COURSES

The implementation strategy outlined here (Figure 2) has been used to successfully adapt both published and novel case studies for an asynchronous online course structure in both majors and non-majors section of introductory neuroscience (NSCI 111; 20 mostly freshman/sophomore students in each section), as well as upper level courses of Sensation and Perception (PSYC 350; 35 junior/senior students) and Neurodevelopment (NSCI 358; 35 junior/senior students) with the same instructor at a small public regional university (Daniel Ehlinger, University of Wisconsin-River Falls). These courses contained a relatively even split of psychology and neuroscience majors.

1)   *Flipped lectures and class activities cover background material relevant to the case.* Delivery of background material involved completing readings of assigned textbook chapters and watching lecture material recorded using Voicethread (https://voicethread.com) that are posted to the course LMS (Canvas; https://instructure.com/canvas). Voicethread allows for asynchronous peer and instructor interactions with recorded lecture content and is an ideal tool for delivery of lecture content in an asynchronous online course. A significant amount of background material is delivered through active learning activities, including online lab assignments and problem-based learning activities (including case studies). Specifically, on a given week of course content students are often asked to breakdown primary research figures/data, reflect on additional video sources, and compare/contrast primary research with popular news reporting. Offering a variety of classroom activities such as these, with both lower and higher cognitive demand, follows evidence based best practices for asynchronous online courses (Dunlap et al, 2007; Dykman and Davis, 2008). These methods are a minor update from in-person classroom management for case studies, and are consistent with flipped classroom course structures.

2)   *The case is delivered in separate pages embedded within a module of the course LMS.* In the asynchronous online course, individual sections of the interrupted case narrative are embedded into separate pages contained within a case-study specific module on the LMS. Therefore, students read the case narrative independently rather than in small groups as typically occurs in an in-person classroom. At the end of each separate page of the case, students must complete a required activity utilizing a text submission box, and completion of the activity is required in order to gain access to the subsequent part of the case. The modularization of the case study and maintaining a logical, sequential organization of the case content is critical to learning in an asynchronous online format (Zsohar and Smith, 2008), and represents a major update from in-person classroom management for case studies. Required activities take two general forms: short answer questions and discussion board posts/replies.

3)   *Students complete short answer questions.* In this asynchronous online course, questions contained within the published case implementation notes that assess lower levels of Bloom's taxonomy (e.g., remembering and understanding; Anderson and Krathwohl, 2001) were converted into short answer questions/reflection exercises that were answered independently. That is, questions that are geared towards remembering and understanding core course content that is delivered directly through the written case study narrative, or that requires students to compare the case study content back to previously presented class material, were answered independently rather than in small groups, representing a major modification to in-person classroom management for case studies. Short answer

Synchronous Online Course		Asynchronous online course
large	Delivery of content in ___ "chunks".	small
individual reflection and live discussion	Student learning is promoted through ___.	individual reflection & discussion boards
the class	Students are able to work on ____ schedule.	their own
Does not address	___ internet accessibility issues.	Helps alleviate
comparable to in-person	Instructor preparation & modification to published implementation strategy is ___.	increased from in-person

Figure 3. Several important issues to consider in synchronous versus asynchronous case study implementation.

questions were graded for completion using pass/fail grading.

4)   *Students complete discussion board posts and replies.* In this asynchronous online course, questions contained within the published case implementation notes that assess higher levels of Bloom's taxonomy (e.g., applying, analyzing, evaluating, creating; Anderson and Krathwohl, 2001) were modified to create small group discussion boards of 8-10 students. Breaking large class sizes into smaller discussion groups of smaller size helps focus the discussion and ensures that back and forth dialogue takes place (Baker, 2011). Thompson et al (2016) suggest that the most effective discussion board prompts are well-structured and allow for open-ended responses such that students have an opportunity to openly engage with each other around the course content. Winning strategies for creating effective discussion prompts include directly attempting to evoke personal experiences, creating hypothetical scenarios for students to interact with, providing substantiated opinions on a topic, or creating new content that other students can assess or directly interact with (Thompson et al., 2016).

In this course, discussion board posts and replies utilized a two-stage format. First, an initial discussion board post in response to the discussion prompt was due on a specific date and time. Students were graded with a rubric (provided to students ahead of time) that assessed minimum word count, whether the discussion post answered all questions or completed the required activity described in the

discussion prompt, and whether the student made an explicit attempt to advance the discussion beyond their own post by asking follow-up questions or expressing a substantiated opinion for others to interact with. Following the initial discussion post, students were given 48 hours to make at least 3 replies within the discussion board. Replies could be made to either their peers' original post or to threaded replies made on their own original post. Students were again graded with a rubric (given to students ahead of time) that assessed a minimum word count, minimum number of required replies, and whether the student added a unique thought, opinion, question, or reference to prior course content or outside sources within their reply. In order to provide a consistent weekly schedule for students, weekly due dates for discussion posts and replies were maintained throughout the semester. The instructor periodically acknowledged critical points raised by students and contributed questions to further each discussion as needed. Maintaining instructor presence in asynchronous online courses is a major contributor to positive student performance and experiences (Fish and Wickersham, 2009). Again, this classroom discussion strategy represents a major modification to in-person classroom management for case studies.

5)   *Mini-lectures are embedded throughout the case study to expand on key concepts and recap important class discussions.* Most published case studies provide basic content within the case narrative that the instructor would typically highlight, define, or expand upon when delivered in an in-person course. Further, the instructor typically highlights important small-group discussions for the entire class to experience. To meet specific learning objectives and create a whole-class community in an asynchronous online course, several modifications were made to the in-person classroom management strategy. First, relevant additional content was provided throughout the case by embedding short (5 to 10 minutes in length) lecture videos, written definitions, or outside resources. Second, the instructor created video recaps to highlight sticking points from independently submitted short answer questions and particularly relevant discussion board posts and replies. Video recaps were posted within 48 hours of the final case study activity. Students were also strongly encouraged to post questions related to the case study in the general class-wide discussion board in the main navigation menu of the LMS.

DISCUSSION

There are many benefits to incorporating case studies into online learning. One frequent concern of online learning is the high cognitive load that is placed on students, and pedagogical techniques such as scaffolding the lesson material, priming the learner to exert effort when making sense of the material, and breaking the lesson into several user-paced parts may help reduce extraneous cognitive processing (Mayer, 2019). Importantly, the modular and sequential nature of content delivery of the case study

method incorporates all of these techniques, and is likely to reduce cognitive load that often exists in online courses. Second, building community through student-student and student-instructor discussions is just as important online as it is in-person, as it contributes to positive student performance and experiences (Fish and Wickersham, 2009; Tucker, 2020). As demonstrated in the above implementation strategies, using case studies in online courses not only provides interesting and applicable course content, but also provides an excellent mechanism for keeping students engaged with the course material, each other, and the instructor in an online learning environment.

There are several important benefits and weaknesses when comparing synchronous to asynchronous case studies in online courses (Figure 3). For example, benefits of an asynchronous online model include a greater ability to deliver case content in smaller units, allowing students to work on their own schedule, and alleviation of internet accessibility issues. The asynchronous model, however, requires substantial knowledge of optimal use of discussion boards for student interaction (for review, see Thompson, 2006; Baker, 2011) and a careful consideration of which specific discussion questions to turn into discussion board prompts. Our experience suggests that too many discussion board prompts result in substantial student fatigue, and that the alignment of the discussion board prompts to course learning objectives is more important than the total number of prompts. In contrast, synchronous online courses do not require knowledge of optimal discussion board prompts, as live discussion methods can be largely recreated online. Asynchronous courses, however, do not allow students to fully work on their own schedules, or alleviate internet accessibility issues.

The presented case study management strategies, for both synchronous and asynchronous online courses, have been successfully implemented for small to medium class sizes between 20 and 45 students. A key concern of implementing case studies in larger classes is the increased classroom management and grading time required. In case studies in synchronous online courses, these concerns were mitigated by allowing students to complete their original responses at home followed by peer-editing and submission of final responses as a small group activity with pass/fail grading. For larger classes, the number or size of the small-group breakout rooms can be increased while maintaining peer editing for efficient classroom management, and pass/fail grading. The asynchronous online courses also used pass/fail grading of short answer questions to minimize grading time, and used weekly follow-up videos from the instructor to address common misconceptions more efficiently for the whole class. We believe these strategies, plus increasing the size of discussion board groups to accommodate more students, would be effective in larger asynchronous classes. Importantly, cases have been used successfully in large classes (150-350 students; Nagel and Nicholas, 2017), and we believe the classroom management and grading structure for online courses described here can build upon previously established models for large class case-based instruction.

In summary, case studies are an effective active learning method to engage students in undergraduate neuroscience courses delivered in-person or through synchronous and asynchronous online formats. Case studies can be adapted for online delivery while still achieving the same learning outcomes expected through in-person course delivery, while also leveraging potential benefits that exist in online learning. We strongly encourage instructors to explore and adapt published case studies found in JUNE, NCCSTS, and other educational sources for online course structures in undergraduate neuroscience.

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Address correspondence to: Dr. Denise Cook-Snyder, Carthage College, Neuroscience Department, 2001 Alford Park Dr., Kenosha, WI 53140. Email: dcooksnyder@carthage.edu;

Dr. Daniel Ehlinger, Department of Psychological Sciences, 410 S 3rd St, River Falls, WI 54016. Email:daniel.ehlinger@uwrf.edu