Students as Partners in the Scholarship of Teaching and Learning

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This essay reflects upon lessons learned from engaging students as partners in the scholarship of teaching and learning (SoTL). The pedagogical research question addressed by this project was: Does the case study teaching method promote student engagement and learning in an introductory biology course? Student partners were actively involved in synthesis of course materials, discussion of research methods, and the peer review and publication process. Although largely successful, a number of challenges involving communication issues, time constraints, and project management were encountered. Based on the lessons learned from working through these challenges, tips are provided here that may be useful for in a variety of educational and research scenarios.

INTRODUCTION

Engaging students in scholarly research can benefit both faculty and students by promoting development of important skills and providing opportunities to make our work public. The project described here aimed to engage undergraduate students in the scholarship of teaching and learning (SoTL), which includes contextually grounded inquiry focused on student learning, methodologically sound research conducted in partnership with students, and sharing of findings and insight about teaching (Franzese & Felten, 2017). The case study teaching method, which uses narrative to present content and engage students in inquiry-based learning, formed the basis for our SoTL project. The four main objectives of our project were to (i) synthesize original case studies for use in teaching, (ii) publish and present our work publicly, (iii) engage students in SoTL research study design, and (iv) promote inquiry-based learning by involving students in collection and analysis of data about the effectiveness of case study teaching at promoting learning. Much was learned from the aspects of this project that were completed as planned. More importantly, after reflecting on challenges and shortcomings encountered during this project, we now offer tips and advice to enhance future SoTL projects.

SoTL and other research-based learning projects provide myriad opportunities for developing useful skills, such as the ability to pose well constructed research questions and present findings effectively, while also learning the importance of organization and integrity in research (Wagner, 2014). Students have reported high levels of intellectual and personal empowerment, and an emergent feeling of participation in the building of knowledge, after completing independent inquirybased activities (Levy and Petrulis, 2011). Conceptually oriented tasks and collaborative learning activities that provide opportunities for creative problem solving and group discussion of reasoning help optimize the effectiveness of such projects, as does the use of technology and a focus on inquiry-based activities Ruiz-Primo, *et al*, 2011).

Although this entire project could be thought of as a case study in pedagogical research, the case studies referred to here are those used for teaching scientific concepts. To engage learners, case studies present information using a narrative interspersed with active learning exercises such as role-playing, debates, hands-on activities, and laboratory simulations. Case studies are often accompanied by formative assessments to guide content and skill mastery. This pedagogy is based on the case study teaching method first popularized in medical and legal education, but differs from these paradigms by focusing on broad concepts and theoretical scenarios in addition to realworld events. Case study teaching has already been shown to promote development of analytical skills, enhance student motivation to participate in learning activities, and increase assessment scores in a variety of secondary and post-secondary science courses (Flynn and Klein, 2001, Herreid *et al*., 2011, Murray-Nseula, 2011, Olgun *et al*., 2008, Tomey, 2003, Yalçınkaya *et al*., 2012). Instructors have also reported that case study teaching allows them to cover more content in class, and that this method of teaching is beneficial to students even though many of them find the unfamiliar format challenging (Yadav, 2007).

ENGAGING STUDENTS IN THE DESIGN AND IMPLEMENTATION OF A SOTL PROJECT

Student researchers were selected from a pool of students who recently completed the introductory biology course for which the case studies would be written. Students who demonstrated a high level of content mastery and skill in writing were interviewed to gauge their interest in and potential ability to complete the project. The rationale for this approach was that strong writing skills and knowledge of biology seemed the most likely indicators of success in a project that would rely heavily on these qualifications. Other attributes, such as creativity, perseverance, and diversity of perspective may have also been relevant selection criteria, but there was no available method to accurately assess these qualities for this project. Selected students committed for one academic year (nine months), during which time the goal for each student was to write one and publish case study, present work at an undergraduate research symposium, participate in research study design, and, if time permitted, engage in data collection and analysis to determine the effectiveness of the newly published case studies at promoting mastery of relevant learning objectives. Funding was provided by an institutional grant to support innovative teaching practices and offer student partners remuneration as incentive to complete the project and cover travel expenses to attend a local academic meeting.

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The first goal of this project was for student partners to write original case studies that could be used to teach introductory biology and be submitted for publication, then later be used to assess the effectiveness of the case study teaching method. The driving motivation for this process was to extend learning outside of the classroom and allow the instructor's passion and excitement for the subject to captivate, motivate, and encourage students in their own exploration (Derounian, 2017). The aim was also to empower student partners with as much agency and creative control as possible. We started by collaborating to identify which topics were best to write case studies about for use in our introductory biology course. Chemical bonds, macromolecules, and photosynthesis were chosen because they are concepts student partners reported to be particularly confusing, and they were not sufficiently covered by existing case studies. The input of student partners who had previously taken the course provided a valuable perspective. For example, some topics identified by student partners as most challenging differed from the topics the primary investigator thought were most challenging based on test scores. One topic students identified as unexpectedly challenging was photosynthesis. Even though assessments suggested students develop a relatively high level of proficiency in this area prior to testing, test scores do not necessarily reflect how challenging material was for students to learn, and may conceal the effect of confounding variables such as unintentional differences in the difficulty of questions about different topics, differences in student motivation to learn about specific topics, and variations in the amount of work students have to complete for other classes at the same time various topics are taught. This experience echoes that reported by Green and Scoles (2016) who stated students "come in with open eyes, and because they don't have any background knowledge of a subject necessarily, or on what the rights and wrongs of teaching are, they're able to give you a much clearer perspective...a much more honest, unbiased perspective."

We modeled our case studies on the format promoted by the National Center for Case Study Teaching in Science (NCCSTS) (http://sciencecases.lib.buffalo.edu/cs/collection/) at the University of Buffalo. One student chose to write about chemical bonds using an interactive slide presentation of highly creative dialogue between a fictional student and his chemistry tutor. Discussion of chemical bonds was interrupted by formative assessment questions to promote engagement and facilitate use of clickers, as well as informative diagrams illustrating molecules and chemical bonds. This case study was completed in time to submit for peer review, receive and respond to feedback, and be accepted for publication. A second student worked throughout the project to synthesize a case study about macromolecules. This work has not been completed, but already demonstrates an amazing level of creativity and a unique approach to content delivery an instructor may never have thought to use. The narrative of this case study focuses on fictional superheroes and villains to convey fundamental concepts about macromolecules. The text is complemented by equally creative comic-book style illustrations. Bimonthly meetings between the faculty mentor and student researchers focused on discussing questions and comments about writing, the peer-review process, and pedagogy. This experience helped students learn the importance of revision and incorporating external feedback in academic writing, while providing a sense of accomplishment and feeling of belonging to the academic community.

The second goal of this project was to engage students in making our work public. We planned to share our work by publishing case studies in a peer-reviewed publication and by presenting student work at an undergraduate research symposium. This part of the project was highly rewarding as one student co-authored case study has been successfully published in a peer-reviewed publication, and a second case study is currently in preparation. One student also presented work at a college-wide research symposium.

The third goal of this project was to engage student partners in research study design to develop a follow-up study on the effectiveness of case study teaching at promoting fulfillment of relevant learning objectives in our introductory biology course. We started by generating the hypothesis that teaching with case studies promotes learning of scientific topics and development of written and oral communication skills. Next, we chose which case studies to use in our research study, and selected textbook reading, class discussions, and lectures as controls for comparing the effectiveness of case study teaching to other methods of content delivery. We then discussed relevant methods of data collection and analysis, as well as the necessity and procedure for obtaining institutional review board (IRB) approval to collect data on student learning and engagement. Student researchers were provided short tutorials on how to write surveys, research papers, and IRB applications, and guided through opportunities to analyze mock data using appropriate statistical tools.

The final goal of this project was to engage student case study authors in inquiry-based learning through the collection and analysis of data about the effectiveness of our newly published case studies at promoting mastery of relevant course learning objectives, and to ultimately include student partners in the authorship of a research manuscript. Unfortunately, student partners could not be involved in data collection and analysis as planned due to a combination of miscommunication and logistical challenges that are discussed later in this essay. Our initial timeline included three months of project planning and case study writing, followed by six months of case study teaching as well as collection and analysis of data to form the basis of a research manuscript investigating the effectiveness of the newly written case studies at promoting mastery of relevant learning objectives (Figure 1A).

LESSONS LEARNED FROM WORKING THROUGH CHALLENGES, AND TIPS FOR FUTURE SOTL

We successfully completed three of our four project goals, which included writing original case studies, making our work public, and engaging students in research study design. However, due to the amount of time required to write and revise the case studies, combined with obstacles such as obtaining IRB approval for students to work with data, we were unable to pursue our fourth goal of involving students in data analysis to promote inquiry-based learning. Prior to starting the project, we anticipated that completion of the fourth goal would be most fulfilling to students, and thus considered it most important. In fact, one of the main motivators for choosing a SoTL project over laboratory research or fieldwork for this project was the increased likeli-

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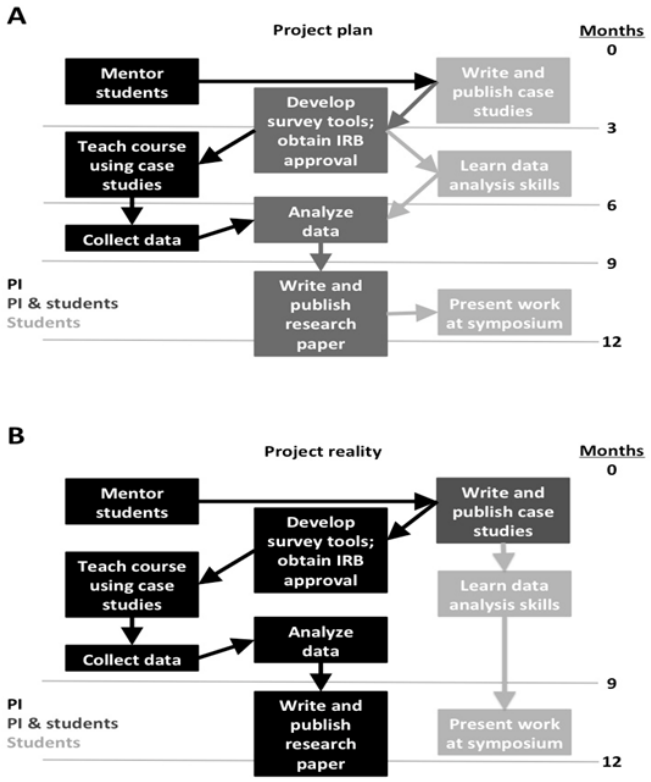
Figure 1. *Proposed project timeline revised due to challenges and obstacles.*



Legend: *Black boxes represent work completed by the instructor/primary investigator (PI) only; dark gray boxes represent worked completed by the PI and students; light gray boxes represent work completed by mentored student partners only. The final three months of our initial timeline was allotted to making our work public and producing a follow-up manuscript to report the findings of follow-up research study investigating the effectiveness of our case studies at promoting learning. Because more time than anticipated was required to complete the case study writing, and because approval could not be obtained for student partners to collect or analyze data, the initial timeline was revised and many aspects of the project were completed without directly engaging student partners. (Figure 1B)..*

hood student partners would progress far enough to be involved in the critically important processes of peer review, manuscript revision, and publication.

Unexpectedly, this did not result in reports of dissatisfaction or disappointment from the students involved. This was, in part, because one student was able to complete the experience of publishing a peer-reviewed case study, and another student made substantial progress on this path. Additionally, this student stated that writing the case study was much more engaging and rewarding than data analysis and learning about the IRB process. It was also clear that writing and revising their case studies deepened the level of content mastery of the students, as evidenced by increasingly clear and thorough explanations and self-reported evaluations of content mastery. Therefore, perhaps the most important lesson learned from this project is to not underestimate the value of the creative process in promoting scholarly teaching and engaging students in SoTL.

A number of other important lessons were learned by working through challenges encountered throughout the planning and implementation of our project. Some notable challenges are identified in Table 1, along with the outcome of working through each challenge, a summary of lessons learned, and tips for future projects. One of the first challenges encountered was the need for funding and approval to support the work of students on an extracurricular project that was intended to involve collection and analysis of data from other students. We learned that institutional grant offices are a helpful resource for identifying sources of funding, and that many internal grants are awarded to support small-scale research projects at teaching focused institutions. This realization was quickly followed by an institutional challenge related to research study approval. We knew that in order to collect or analyze data from students taking a course, researchers would be required to complete training and receive IRB approval. What we learned was that some IRBs will not permit undergraduate students to work with data collected from other undergraduate students. Our IRB objected to undergraduate students working with data collected from students who may theoretically be their past or future classmates, even if identifying information was removed. Additionally, the amount of time required for student partners to complete the training course and certification test required to receive IRB approval was prohibitive. However, it should be noted that IRB approval was only required for working with data collected from students; no approval was necessary for students to write and publish case studies.

Our inability to complete all of our projects goals was also due to our reliance on completion of original course materials as one of the first steps in an ordered sequence, which turned out to be a flaw in study design. If we had not attempted to include

Table 1. *Summary of challenges, outcomes, and lessons learned*

Challenges	Outcomes	Lessons & Tips
Obtaining funding	Institutional grant obtained to fund student stipends and travel	Institutional grant offices can be very helpful; may support student partners and SoTL work that is difficult to fund
Producing original student work for publication	One student co-authored case study completed; one in progress	Students contribute valuable perspectives; provide adequate time and feedback to promote creative processes
Engaging students in data collection and analysis	Unable to obtain approval for students to work with data	IRB approval is required to publish data collected from students; IRB may not allow students to work with certain data; consult IRB early on
Maintaining commitment and motivation	Three students withdrew from project; two completed project with high satisfaction	Provide clear objectives and frequent formative feedback; share your enthusiasm for project
Completing project on time	Project required more time than estimated; could not be completed as planned	Divide project into manageable pieces; provide additional buffer time; facilitate collaborations among student partners
Making research findings public	One student co-authored case study published in peer-reviewed publication; research manuscript written after end of student partnership	Plan time and ways to involve student partners in publication process even if they are not approved to analyze data

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students' original case studies in our follow-up research project on case study teaching effectiveness, and instead used only existing case studies, we may have had enough time to figure out a way for the students to be approved to work with data, which may have involved revising our research study to meet our IRB requirements. Furthermore, we needed much more time than planned to complete the case studies.

The project plan initially specified student partners would work ten hours per week for nine months, using the first three months to complete their case studies. To predict the amount of time a student would need to complete this work, the estimated time it would take the instructor to complete the same work was multiplied by three. One student partner completed this work in six months, while a second student worked the entire nine months and still needed many additional months to complete the case study. This suggests undergraduate students should be allotted at least sixfold the amount of time estimated for an experienced faculty member to complete this type of work. Student partners also reported struggling to balance the commitments of an extracurricular research project with obligations to their classwork, outside employment, and family activities. Two additional students joined the project and independently worked on a case study about photosynthesis, but were unable to complete the project due to conflict with other commitments. The lesson learned from this is that protected time for student partners, in the form of a work-study or credit-bearing research project may be useful for alleviating issues imposed by time constraints. Flexibility, alternative pathways of progress, and individualized mentorship may also help overcome these types of challenges.

Maintaining motivation to work diligently on an extracurricular project for an extended period was challenging for both the primary investigator and student partners. Both the student researchers and the primary investigator experienced occasional frustration due to incongruous or unmet expectations in terms of output, feedback, and communication. It was also difficult to determine the optimal amount, depth, and frequency of feedback to provide student partners in order to promote creativity, independence, and project management skills, while offering sufficient guidance, support, and direction. What was made clear is that weekly meetings to discuss ideas and share feedback are crucial to moving a project along at a steady pace, as progress tended to slow when meetings were missed and feedback was not exchanged.

If a similar project were undertaken in the future, several changes should be implemented to improve success. The most important change would be to ensure there is sufficient time and ability for student a partner to become involved in all aspects of the writing and publishing process. One way to accomplish this would be to incorporate case study writing as part of an ongoing class, rather than an extracurricular project. Fostering collaborations between student partners, rather than instructing them to work independently, may help increase motivation, task management, and overall satisfaction during the project. Providing access to outside resources, such as the university writing center, may also help improve student writing. In order to assess the effectiveness of future projects at fulfilling learning objectives, students should be evaluated with a pre- and postknowledge and skills assessment. Finally, separating the production and publication of teaching materials from formal and or informal assessment of those materials would allow students to be engaged in a fulfilling and productive project without being inhibited by restrictions related to conducting pedagogical research.

CONCLUSION

This project adds to the existing field of knowledge about both the effectiveness of case study teaching, and best practices for contemplative pedagogy, SoTL, and faculty-student research partnerships. Student partners helped design, support, and reflect upon research that demonstrated case study teaching promotes learning gains and communication skill development in undergraduate biology. Challenges including miscommunication, time constraints, and inability to include student partners in data analysis prevented engagement of student partners in several key aspects of the academic research process. Despite this, student partners who completed the project reported a high level of satisfaction with the mentorship process, learning about pedagogy and research study design, and especially the progress made on authoring their own manuscripts to submit for peer-review. Future SoTL work should strive to engage student partners in research, guided by the lessons and tips provided here.

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