CASE STUDY

Partnering with students to redesign an introductory chemistry laboratory course: An exploration of the process and implications

***Hannah Jardine** and **Gavin Frome**, Center for Teaching, Research and Learning, American University, USA.

Elizabeth Griffith, Department of Chemistry & Biochemistry, University of Maryland College Park, USA.

Contact: hjardine@american.edu

ABSTRACT

The most effective teaching and learning environments are those in which students are involved as active partners with faculty, and the greatest impact occurs when faculty go beyond asking students for feedback and instead involve them in design, production, and implementation. In this paper, we explore the process of student-faculty co-creation by presenting a specific case involving students as partners in the redesign of an introductory chemistry laboratory course to incorporate more group learning, support students' skill development, and increase students' sense of belonging in chemistry. This case study investigates how faculty can set up and structure a successful co-design partnership and attend to potential challenges as well as how educational developers and teaching centers can work in partnership with faculty and students to design or redesign courses.

KEYWORDS

students as partners (SaP), STEM education, course redesign

A growing body of literature argues that the most effective teaching and learning environments are those in which students are involved as active partners with faculty, playing a role in developing and improving the learning experience (Bovill et al., 2011; Cook-Sather et al., 2019; Little, 2011). This vision of partnership dates to John Dewey's (1916) calls for more democratic education, and many scholars since have argued students should share responsibility in curriculum development (Giroux et al., 1981; Rogers & Frieberg, 1969; Shor, 1992). When faculty work with students to co-create courses and curricula, students are more deeply engaged in learning, faculty experience greater motivation for teaching, and curricula better address students' needs (Cook-Sather et al., 2014; Cook-Sather et al., 2019). The greatest

impact occurs when faculty go beyond asking students for feedback and involve them in design, production, and implementation (Bovill et al., 2016; Martens et al., 2019).

The literature on students as partners in co-creation includes a diversity of approaches (e.g., Bovill, 2019; Delpish et al., 2010; Healey et al., 2014; Lubicz-Nawrocka, 2018; Mercer-Mapstone et al., 2017; Mihans et al., 2008). Students may fill various roles, from consultant to co-researcher to pedagogical co-designer (Bovill et al., 2016), and the nature of student involvement may vary as well (Bovill, 2017; Konings et al., 2017). In recent years, literature addressing students as partners in STEM courses has been particularly vibrant, with collaborations yielding benefits in curriculum design (Charkoudian et al., 2015; Rivers et al., 2017). Partnerships with students have led to improvements in equity and inclusivity in STEM (Bunnell et al., 2021; Chukwu & Jones, 2020; Cook-Sather et al., 2021; Latin, 2022; Narayanan & Abbot, 2020), addressing barriers to belonging and thriving in disciplines where White and Asian male students are overrepresented (National Center for Science and Engineering Statistics [NCSES], 2019).

In this paper, we explore the process of student-faculty co-creation by presenting a case involving students as partners in the redesign of an introductory chemistry laboratory course to incorporate more group learning, support students' skill development, and increase students' sense of belonging in chemistry. We hope to contribute to the growing body of literature on students as partners in co-creation and co-design by investigating the following research questions: How can faculty set up and structure a successful co-design partnership and attend to potential challenges? How can educational developers work in partnership with faculty and students to design or redesign courses?

CONTEXT

In late 2018, Elizabeth was accepted to participate in a year-long faculty learning community facilitated by teaching center staff in which participants were awarded a grant to support significant course redesign. The faculty members met during Spring 2019 to learn about course design, worked on their redesign over the summer, and piloted their redesigned course in Fall 2019. Elizabeth proposed a redesign of her introductory 2-credit laboratory course for chemistry majors, with a focus on integrating student-centered pedagogies and creating a more equitable learning environment. She utilized the funding to hire five undergraduate students to work with her as a team on the redesign. The team met regularly throughout the summer of 2019 to review course materials, discuss changes, and develop new activities and laboratory assignments for the weekly 3-hour experimental lab and the weekly 1-hour lecture to supplement the lab.

Elizabeth initiated the co-creation with encouragement from Hannah, who had studied and facilitated student-faculty partnerships previously (Jardine, 2020). The aim was to co-create the curriculum before the course took place (Bovill & Woolmer, 2018). The role of the students was to act as consultants and pedagogical co-designers (Bovill et al., 2016) by both providing feedback on the course as it existed and developing new instructional materials. The purpose of working with students on the redesign was to incorporate the student perspective to improve the course and enhance student engagement and a sense of belonging.

To select and recruit students, Elizabeth identified students who had taken the course in one of the previous 2 years with whom she had developed a relationship through office hours and in-class interactions and whom she knew to be conscientious, hard-working, open to both giving and receiving constructive criticism, and enthusiastic about the subject material and helping others. This list was edited with an aim toward diversity in the potential participants' gender, race/ethnicity, and academic year. Elizabeth then reached out directly through email to the identified students, describing the project and the students' proposed involvement to gauge their interest, resulting in the recruitment of two second-year and two third-year students. The fifth student, a fourth-year and a transfer, never took the course being redesigned but had taken an upper-level chemistry course with Elizabeth and had expressed interest in course development. Elizabeth believed the inclusion of this fifth student would provide an additional unique perspective. Table 1 includes the pseudonyms and a summary of the demographic information for the five students.

Table 1. The student partners on the co-design team

PSEUDONYM	GENDER	RACE/ETHNICITY	YEAR	NOTES
Anita	Female	South Asian-American	Second	
Cara*	Female	White	Fourth	Transfer student
Dan	Male	White	Third	
Emma*	Female	White	Third	Left the chemistry major
Patrick*	Male	Asian-American	Second	

The asterisks (*) indicate consent to be interviewed for this case study.

QUALITATIVE CASE STUDY APPROACH

The data and conclusions presented come from an International Review Board approved qualitative case study that drew on multiple sources of evidence "to gain an in-depth understanding of the situation and meaning for those involved" (Merriam, 1998, p. 19). Hannah acted as a participant-observer during the redesign team meetings, where she collected field notes to document the meeting structure and topics of conversation. At the start of the co-design partnership, she held a semi-structured group interview with the students and asked questions such as "How did you all feel about your experience in [the course]?" and "Why are you interested in supporting this course redesign?" At the end of the summer, Hannah held one-on-one interviews with the student partners (the asterisks in Table 1 indicate consent to be interviewed) to discuss questions such as "Tell me a bit about the work you did this summer" and "What are you most proud of regarding the changes you made to the course?" Elizabeth kept a record of personal reflections during the course redesign process. Elizabeth and Hannah compiled notes and documents that the redesign team produced throughout the summer, which included the students' reflections after reviewing the course materials from the previous semester as well as the new worksheets, activities, labs, and resources that the team produced.

Following recommendations from Merriam (1998), Hannah analyzed the data during and after data collection. Each week after collecting field notes, she summarized inferences,

reactions, and follow-up considerations that influenced subsequent data collection, such as potential final interview questions. After, she analyzed the field notes and interview transcripts by applying an inductive open constant comparative coding method (Miles & Huberman, 2019; Strauss & Corbin, 1990) to develop themes around the research questions. This analysis was not meant to develop generalizable claims but was designed to summarize lessons that might be applied to similar future endeavors.

STRUCTURING A SUCCESSFUL CO-DESIGN PARTNERSHIP

We present several considerations for structuring a successful co-design partnership aimed to increase student engagement and sense of belonging, particularly in STEM.

Recruit a team of students with a variety of experiences and diverse backgrounds

The way Elizabeth set up the co-design partnership over the summer was very intentional, starting from recruiting the team of students. She purposefully built a team with a variety of experiences and diverse backgrounds, drawing from a pool of students with whom she already had relationships. Emma, who had done well in the course but still decided to leave the chemistry major, was able to share insights that could help mitigate and address some of the negative experiences and anxieties that had led to her decision. Cara, a transfer student, was able to provide a perspective from someone who had taken the course equivalent at another institution and had struggled with feeling a sense of belonging after transferring to the institution. The students recognized the value of this diversity, as Patrick shared: “the people I worked with had their own experiences with the class and that definitely was a big factor in helping us all collaborate.” By recruiting a diverse team of students from those she had already built rapport with, Elizabeth encouraged collaboration, open communication, and sharing of broader perspectives, leading to a more inclusive and representative course redesign. However, the prerequisite of having a prior relationship limited participation in the project to students comfortable interacting one-on-one with the instructor. This approach, while beneficial in this instance, may exclude some students who, due to background or personality, do not feel comfortable interacting with their instructor.

Allow for both individual and collaborative work

Another consideration was allowing for both individual and collaborative work. The weekly meetings with the full team “brought everybody on the same page,” as Emma mentioned. Outside of the weekly meetings, the students managed their own time to achieve the deliverables set by the team. The work—up to 10 hours a week in total—was flexible. Depending on the task, students worked on their own, in pairs, or groups of three and decided on what to do synchronously or asynchronously. Typically, students reported that they spent about 4 hours together each week and that these periods of collaboration were better for ideas and brainstorming. Overall, students seemed satisfied with this model of work structure and reported it as being “a good idea.”

Set up organized systems for communication and collaboration

Working on a course redesign as a team requires significant coordination. For this project, the instructor gathered students' input to establish systems for communication and collaboration. At the start of the redesign, Elizabeth gave students a binder containing the course materials for the semester and a packet of guiding questions to start the conversation. Throughout the summer all documents were stored on Google Drive, and Google Docs served as the medium of collaborative document development, especially using comments. The decision to utilize Google Docs came from the students themselves, as did the decision to organize everything into a larger system of files in Google Drive. The students also set up a group chat in GroupMe to keep in touch between meetings. These systems of collaboration and communication were understood by students as being essential to the success of the co-design.

Provide opportunities for freedom, flexibility, and creativity

Other important considerations for structuring the co-design partnership included providing opportunities for freedom, flexibility, and creativity. All process decisions, including how work would be distributed, how information would be shared, and what deadlines would be set, were made with students' input. As Emma noted, "we have all these ideas and Dr G was kind of like you can change it; you can do whatever you want." Patrick recognized that they were encouraged to "think outside the box." Emma also praised the inclusivity of these initial planning meetings, commenting that "it was actually really fun just being able to talk about everything; like, everybody was sharing what their ideas were and stuff." The agency Elizabeth encouraged in students to develop their own structure for the project empowered them to take ownership of the creative process. This authority resulted in greater innovation in students' development of materials.

CHALLENGES OF THE CO-DESIGN PROCESS

Even in a thoughtfully structured partnership, challenges are likely to arise. In our case study, these challenges manifested as a persistent effort to achieve balance, especially in managing the tension between the breadth and depth of creative output, divergent opinions, levels of expertise, and motivations among students, as well as the proper degree of guidance and structure versus freedom and flexibility the instructor should provide. The emergence of such complications is not indicative of a failure of preparation but rather a probable byproduct of student-faculty co-design partnerships. Being aware of the likelihood of these difficulties may help instructors manage them when they occur.

Balance depth versus breadth

The primary challenge of balancing depth versus breadth lies in the limitations of time. Both the students and Elizabeth recognized that they were not able to accomplish as much as they had hoped, even with a full summer of work. As Emma put it, "I was kind of expecting at the beginning that we were going to go through every experiment, but then like seeing how long experiment one took I was like, ok that's definitely not happening." Echoing that sentiment, Cara remarked that it "took a lot of time to figure out everyone's comments and kind of work through that." These quotes reveal that students' expectations did not match the

reality of the work and that only after beginning the project did they realize how much time it takes to consider everyone's feedback. However, all parties recognized the work they did accomplish was thoughtful and detailed. While an instructor cannot predict the rate at which students will complete tasks, facilitating a discussion of expectations early may alleviate some anxiety for students who may be concerned about failing to meet the goals they envisioned.

Balance differing levels of expertise, motivation, and opinion

Another challenge was managing students' different opinions and varying levels of expertise and motivation. As in any team project, there was a need to balance different working styles, expectations for quality, and interests. Navigating these characteristics was a difficult process, and students sometimes struggled to come to an agreement when creating assignments. As Cara said, "it was good to have everyone's input, but I think it took more time than if we were to do it at home individually." There were also concerns that the workload was not distributed evenly. "I felt myself doing stuff where I probably could have asked for help," Cara commented, adding, "I just felt like I was taking the lead and they were kind of like following me a little bit." To alleviate some of these challenges, faculty should be purposeful about pairing students with varying levels of expertise and leadership skills from the beginning and facilitating the setting of collaborative norms to support a productive team dynamic.

Balance the level of guidance and structure versus freedom and flexibility

A third challenge we encountered was the balancing of guidance and structure with freedom and flexibility. Elizabeth intended to give students authority over creating new instructional materials, but at times this freedom left students a bit unsure where to start. As Patrick lamented, "sometimes we'd be confused about what she meant." Cara expressed appreciation for the autonomy granted, but also felt Elizabeth "had specific ideas in mind that, like, she wanted, so if we would have had more of like an outline from her, I feel like that would have been more time efficient." Patrick made similar suggestions, such as requesting the instructor provide them with a list of goals at the outset, incorporate more check-ins throughout, and "be more direct with us." Students maintained that emphasizing the iterative nature of the process at the outset, particularly acknowledging that trial and error does not equate to time wasted, would have been beneficial in helping them frame their work throughout. These comments illustrate the benefits of granting students flexibility in the creative elements of a project, but only when accompanied by clear goals and supportive oversight during the process. By not providing such support, an instructor risks the enterprise shifting away from a partnership toward student labor or a student-led project.

EDUCATIONAL DEVELOPERS SUPPORTING CO-DESIGN PARTNERSHIPS

In the case presented here, the teaching and learning center played a critical role in supporting the student-faculty co-design process. This assistance took many forms, including pairing the instructor with a faculty learning community, providing training on course design, and furnishing financial resources so that students could be paid for their work. The structured professional development and cohort of supportive peers provided the foundation for Elizabeth's redesign decisions. The financial assistance made possible the recruitment of a

diverse group of students, many of whom stated they would not have been able to participate, especially during the summer, without financial compensation. Although there are benefits in terms of learning and professional development for students, it would be unfair and unethical to ask students to contribute their time and insights in this way without financial compensation. Lastly, having someone on staff who is familiar with the literature on students as partners and other models that have worked at other institutions was key. Hannah's experience with and knowledge of students-as-partners frameworks provided critical inspiration, insight, and guidance throughout this project.

CONCLUSION

This case study demonstrates impact and lessons learned from faculty-student co-design, especially in chemistry where "intentional effort to allow students to define and work towards a more inclusive STEM community" (Bunnell et al., 2021) is critical. Students mentioned how eye-opening this experience was in terms of understanding the "behind the scenes of a class," as Emma described it. Patrick noted how this experience helped him to recognize all that goes into teaching and designing a course:

> This is one of the few opportunities you have to see the inner workings of what a professor does and how some students might think "oh why doesn't the professor just do this," you can see why that's not necessarily like . . . there's no easy solution.

Cara described how valuable the student perspective is when designing instruction: "I feel like there's things that we thought of that she didn't think of at all. . . . We're still going through this major, we still have opinions, and we've seen how other professors do things too." Elizabeth agreed that the lessons learned from working with students were invaluable and not only enhanced this specific course, but her teaching overall.

The following key takeaways summarize our findings in response to the questions explored in this case study. First, considerations for structuring a successful co-design partnership include recruiting a diverse team of students, allowing for both individual and collaborative work, providing flexibility, and setting up organized communication systems. Challenges to consider include balancing breadth versus depth, attending to differences in expertise and motivation, and balancing freedom and structure. Lastly, teaching center resources, especially financial, and staff with knowledge of students as partners may play a critical role in the success of faculty-student co-design partnerships. We hope that the ideas and insights shared here inspire others to pursue co-design with students with greater confidence, especially in courses like introductory chemistry that benefit from the enhanced student engagement and sense of belonging that the student perspective can provide.

This research was successfully reviewed according to the university's Institutional Review Board.

NOTE ON CONTRIBUTORS

Hannah Jardine *is a teaching & learning specialist at American University's Center for Teaching, Research and Learning. She previously worked for the University of Maryland Teaching and Learning Transformation Center, where she led the course redesign faculty learning community that Elizabeth participated in. Her research focuses on the process and outcomes of positioning students as instructional partners, particularly in undergraduate STEM programs.*

Elizabeth Griffith *is a senior lecturer at the University of Maryland. She has received several awards and fellowships for teaching excellence and innovation and is deeply invested in improving retention in STEM.*

Gavin Frome *is a graduate assistant for teaching & learning at American University's Center for Teaching, Research and Learning. They are dedicated to promoting inclusive teaching, with interests in accessibility and student feedback.*

REFERENCES

Bovill, C. (2017). A framework to explore roles within student-staff partnerships in higher education: Which students are partners, when, and in what ways? *International Journal for Students as Partners, 1*(1). https://doi.org/10.15173/ijsap.v1i1.3062

Bovill, C. (2019). A co-creation of learning and teaching typology: What kind of co-creation are you planning or doing? *International Journal for Students as Partners, 3*(2), 91–98. https://doi.org/10.15173/ijsap.v3i2.3953

Bovill, C., Cook-Sather, A., Felten, P. (2011). Students as co-creators of teaching approaches, course design, and curricula: Implications for academic developers. *International Journal for Academic Development*, *16*(2), 133–145. https://doi.org/10.1080/1360144X.2011.568690

Bovill, C., Cook-Sather, A., Felten, P., Millard, L., & Moore-Cherry, N. (2016). Addressing potential challenges in co-creating learning and teaching: Overcoming resistance, navigating institutional norms and ensuring inclusivity in student–staff partnerships. *Higher Education, 71*, 195–208. https://doi.org/10.1007/s10734-015-9896-4

Bovill, C., & Woolmer, C. (2019). How conceptualisations of curriculum in higher education influence student-staff co-creation in and of the curriculum. *Higher Education, 78*(3), 407–422. https://doi.org/10.1007/s10734-018-0349-8

Bunnell, S., Lyster, M., Greenland, K., Mayer, G., Gardner, K., Leise, T., Kristensen, T., Ryan, E. D., Ampiah-Bonney, R., & Jaswal, S. S. (2021). From protest to progress through partnership with students: Being human in STEM (HSTEM). *International Journal for Students as Partners*, *5*(1), 26–56. https://doi.org/10.15173/ijsap.v5i1.4243

Charkoudian, L. K., Bitners, A.C., Bloch, N. B., & Nawal, S. (2015). Dynamic discussion and informed improvements: Student-led revision of first-semester organic chemistry. *Teaching and Learning Together in Higher Education, 1*(15). https://repository.brynmawr.edu/tlthe/vol1/iss15/5

Chukwu, A., &, Jones, K. (2020). Feminist interventions in engineering: Co-creating across disciplines and identities. In A. Cook-Sather & C. Wilson (Eds.), *Building courage, confidence, and capacity in learning and teaching through pedagogical partnership: Stories from across contexts and arenas of practice*. Lexington Books.

Cook-Sather, A., Bahti, M., & Ntem, A. (2019). *Pedagogical partnerships*. Elon University Center for Engaged Learning. https://doi.org/10.36284/celelon.oa1

Cook-Sather, A., Bovill, C., Felten, P., & Cook, M. (2014). *Engaging students as partners in learning and teaching: A guide for faculty*. Jossey-Bass.

Cook-Sather, A., White, H., Aramburu, T., Samuels, C., & Wynkoop, P. (2021). Moving toward greater equity and inclusion in STEM through pedagogical partnership. In A. Beach, C. Henderson, N. Finkelstein, S. Simkins, G. Weaver, & K. White (Eds.), *Transforming institutions: Accelerating systemic change in higher education*. ASCN.

Delpish, A., Holmes, A., Knight-McKenna, M., Mihans, R., Darby, A., King, K., & Felten, P. (2010). Equalizing voices: Student-faculty partnership in course design. In C. Werder & M. M. Otis (Eds.), *Engaging student voices in the study of teaching and learning* (pp. 96–114). Stylus.

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. MacMillan.

Giroux, H. A., Penna, A. N., & Pinar, W. (1981). *Curriculum & instruction: Alternatives in education*. McCutchan.

Healey, M., Flint, A., & Harrington, K. (2014). *Engagement through partnership: Students as partners in learning and teaching in higher education*. HE Academy.

Jardine, H. E. (2020). Positioning undergraduate teaching and learning assistants as instructional partners. *International Journal for Students as Partners*, *4*(1), 48–65. https://doi.org/10.15173/ijsap.v4i1.4032

Könings, K. D., Bovill, C., & Woolner, P. (2017). Towards an interdisciplinary model of practice for participatory building design in education. *European Journal of Education*, *52*(3), 306–317. https://doi.org/10.1111/ejed.12230

Latin, A. (2022). Belonging in biology: Working through pedagogical partnership for social justice in STEM. *Teaching and Learning Together in Higher Education, 1*(35). https://repository.brynmawr.edu/tlthe/vol1/iss35/3

Little, S. (Ed.). (2011) *Staff-student partnerships in higher education*. Continuum.

Lubicz-Nawrocka, T. M. (2018). Students as partners in learning and teaching: The benefits of co-creation of the curriculum. *International Journal for Students as Partners, 2*(1), 47–63. https://doi.org/10.15173/ijsap.v2i1.3207

Martens, S. E., Meeuwissen, S. N. E., Dolmans, D. H. J. M., Bovill, C., & Könings, K. D. (2019). Student participation in the design of learning and teaching: Disentangling the terminology and approaches. *Medical Teacher, 41*(10), 1203–1205. https://doi.org/10.1080/0142159X.2019.1615610

Mercer-Mapstone, L., Dvorakova, S. L., Matthews, K. E., Abbot, S., Cheng, B., Felten, P., Knorr, K., Marquis, E., Shammas, R., & Swaim, K. (2017). A systematic literature review of students as partners in higher education. *International Journal for Students as Partners, 1*(1). https://doi.org/10.15173/ijsap.v1i1.3119

Merriam, S. B. (1998). *Qualitative research and case study applications in education*. Jossey-Bass Publishers.

Mihans, R. J., Long, D. T., & Felten, P. (2008). Power and expertise: Student-faculty collaboration in course design and the scholarship of teaching and learning. *International Journal for the Scholarship of Teaching and Learning, 2*(2). https://doi.org/10.20429/ijsotl.2008.020216

Miles, M. B., & Huberman, A. M. (2019). Qualitative data analysis (4th ed.). Sage.

Narayanan, D., & Abbot, S. (2020). Increasing the participation of underrepresented minorities in STEM classes through student-instructor partnerships. In L. Mercer-Mapstone & S. Abbot (Eds.), *The power of partnership* (pp. 181–195). Elon University Center for Engaged Learning Open Access Series. https://doi.org/10.36284/celelon.oa2

National Science Foundation, & National Center for Science and Engineering Statistics. (2019). *Women, minorities, and persons with disabilities in science and engineering: 2019*. https://www.nsf.gov/statistics/wmpd

Rivers, J., Smith, A. B., Higgins, D., Mills, R., Maier, A. G., & Howitt, S. M. (2017). Asking and answering questions: Partners, peer learning, and participation. *International Journal for Students as Partners*, *1*(1). https://doi.org/10.15173/ijsap.v1i1.3072

Rogers, C. R., & Freiberg, H. J. (1969). *Freedom to learn: A view of what education might become*. C. E. Merrill.

Shor, I. (1992). *Empowering education: Critical teaching for social change*. University of Chicago Press.

Strauss, A., & Corbin, J. (1990). Basics of qualitative research: Grounded theory procedures and techniques. Sage.