Course-Based Support for Peer-Led Study Group Facilitators in a Large Instructional Team

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An institutionalized program of peer-led study groups (PLSG) adds instructional power to our large-enrollment introductory organic chemistry courses. Concomitantly, there is a challenge to keep the instructional philosophy and subject matter coherent with the faculty expectations and goals across this diverse group of undergraduate instructors. Thus, to improve communication within the instructional workforce of our large organic chemistry course, we have installed a required course for all undergraduate PLSG facilitators and peer tutors hired by the Science Learning Center at the University of Michigan. This liaison course, taught by a graduate student instructor under the direction of the faculty course coordinator, focuses on enhancing subject matter clarity and stemming the flow of misinformation that has sometimes been reported in the PLSG sessions. We examined the perceived value of the liaison course, self-assessment of course content knowledge by the facilitators, and how enrollment in the course has shaped the experience of those leading a PLSG.

Formal programs involving peer-led instruction are long-standing, prevalent, and well-studied in higher education. Peer instruction sits at the core of many of the "high-impact teaching practices" advocated for their positive effects on student learning (Brownell & Swaner, 2009, 2010; Kuh, 2008) and has consistently been shown to contribute to improved student learning (Wilson & Varma-Nelson, 2016, and references therein). One variable in these shared and distributed forms of teaching is the degree to which the peer instructor's work is directly connected with the core course (Miller, Groccia, & Miller, 2001; Peterson, Wilkinson, & Hallinan, 1984; Smith, 2013; Strain, 1981; Topping & Ehly, 1998; Wilson & Varma-Nelson, 2016). As described in Sandler and Salvatore (2013), the peer-led study group (PLSG) program—run by the Science Learning Center (SLC) at the University of Michigan—provides out-of-the-classroom programming and support for students enrolled in introductory natural science courses, particularly those in chemistry. The SLC programs, including PLSG, are voluntary and free for any students enrolled in a relevant course. Historically, peer-led study groups have been fully managed by the SLC staff. Each group is facilitated by a student who is recruited, trained in collaborative group instructional strategies, and paid by the SLC; the facilitators are explicitly directed away from using didactic "telling" strategies during group sessions. PLSGs have evolved to sit alongside our courses as a service provided by the college and enjoy voluntary participation by over 60% of organic chemistry lecture students as one of many available resources (Table 1). Although the details of the intervention we are reporting here are as idiosyncratic to our setting as any description of an institutional or departmental program, peer-led methods are as widespread as they are diverse, ranging from informal in-class discussions to out-of-class institutional structures.

The question of instructional coherence cuts across all learning resources. When students are part of a given learning environment, are they getting the same or conflicting messages from the different instructional sources to which they have access (e.g., textbook, internet, classmates, worksheets, professors, formal and informal peer leaders)? Although we identified one of these resources (PLSGs) as a particularly important target because of the scale and significance of the intervention in our setting, the principle of attending to instructional coherence is a universal issue.

Intervention

Responding to a baseline level of reports from faculty and graduate student instructors about inconsistencies in the messages our students were getting in their study groups about the course content, we installed a companion course for

study group peer facilitators to bring greater coherence to the lecture students' educational experience. The PLSG program was an outgrowth of a course-specific project in the organic chemistry teaching program in the early 1990s (Coppola, Ege, & Lawton, 1997). The successful adoption, institutionalization, and expansion of the program by the SLC, although quite positive for providing a peer-led instruction option for the campus, was also accompanied by its relative dissociation from the direct "pulse" of the courses being served. We have recently sought to recapture the greater sense of coherence across the instructional team that was present when the PLSG was a departmental program (Table 1 and Figure 1).

Clearly, the mere existence of peer leaders, or facilitators as we will call them here, does not guarantee their understanding of, or instructional alignment with, the learning goals and pedagogical approaches related to the subject matter designed by the faculty instructors. To address the goal of improving coherence across the distributed team of instructors in our introductory organic chemistry courses, we recently created a companion class for all the facilitators and tutors associated with the organic chemistry courses. Herein, we report our experience in implementing a new collaborative model—providing direct support for the PLSG program—between what was, prior to 2013, a set of relatively independent instructional activities.

Organic chemistry course

CHEM 210, or Structure and Reactivity I, is the first-term organic chemistry course offered by the University of Michigan. This large course is composed primarily of lecture and discussion sessions (Table 1). Other structured resources for this course include open faculty discussions (ca. 6 hours/week), PLSGs, and drop-in tutoring sessions offered through the Science Learning Center. Although students do not use resources with the same level of effectiveness (Chen, Chavez, Ong, & Gunderson, 2017), our students have consistently listed the SLC study groups in their top four resources (Table 1), and as such these study groups warrant attention. Thus, these PLSG sessions are the focus of this report.

Course-based content review

In thinking of the ca. 100 members of the instructional team for these courses as a single body, we also started thinking differently about the steady undercurrent of hearsay reports of disagreement between how the faculty, the graduate student instructors, and the study group facilitators were communicating about the instructional program. We strive for

TABLE 1

On-cycle organic chemistry (Structure & Reactivity I, fall term) at the University of Michigan (2005–2016).

Logistical information	***N***	**Common learning resources reported by students**	**Percentage of students reporting general use**
Number of enrolled students	1,300–1,600	Attending lecture	93%–98%
Number of faculty-led lecture sections	4	Self-study	93%–98%
Number of discussion sections led by 10–11 GSIs	55–60	Coursepack (old exams)	92%–96%
Number of PLSG sessions led by 50–70 facilitators	65–75	PLSGs	55%–75%
Number of laboratory sections led by 25–28 GSIs	50–56	Textbook (reading)	45%–85%
		Informal peer groups	60%–65%
Possible student contact	**hours**	GSI-led discussion	48%–67%
Lecture periods (per week)	3 × 1 hour	Textbook (problems)	45%–55%
GSI discussion (per week)	1 × 1 hour	Informal discussion in lab	40%–43%
Open faculty hours (per week)	6 hours	Faculty-led discussion	25%–40%
GSI office hours (per week)	20 hours	GSI-led office hours	12%–15%
GSI-led laboratory (per week)	3 hours	Course-specific podcasts	12%–20%
		General internet resources	5%–20%

Note: Self-reported, aggregated data from three preexam surveys taken during each fall term, 2005–2011, 2015–2016; although most of these are relatively steady, over this time period, the use of PLSG groups and general internet resources has inclined, whereas the use of the textbook (reading) has declined. GSI = graduate student instructor; PLSG = peer-led study group.

as much coherence as possible (course coordinator, single syllabus, common exams, and a single gradebook) while leaving room for instructor interests on the day-to-day planning. The organic chemistry faculty members, as a group, have an internally generated, living document that captures a faculty-for-faculty agreement about scope, depth, and sequence in the organic courses. Graduate student instructors (GSIs)usually attend one of the class meetings, receive written overview summaries from the faculty, and attend a faculty-led 1–1.5 hour weekly staff meeting.

Until recently, the undergraduate facilitators were only moderately linked to the course, with their own experiences and their access to the learning management system to draw from, as well as their own pedagogical training sessions alongside a couple of peer leaders who served as content resource specialists. To help improve instructional coherence in a teaching system that includes this substantial number of undergraduate facilitators, the Department of Chemistry and the SLC collaborated to add more direct communication into the design of the instructional infrastructure (Figure 1). Our strategy was to add a new GSI position to the team, as a liaison between the course instructors and study group facilitators. Although the SLC handled the direct pedagogical training in facilitating group work, the CHEM 210 SLC facilitators and tutors were now required (with limited exceptions, e.g., being at the credit limit for the term) to enroll in a content-based course (CHEM 220: Teaching Experience for Undergraduates) for those facilitating study groups in CHEM 210.

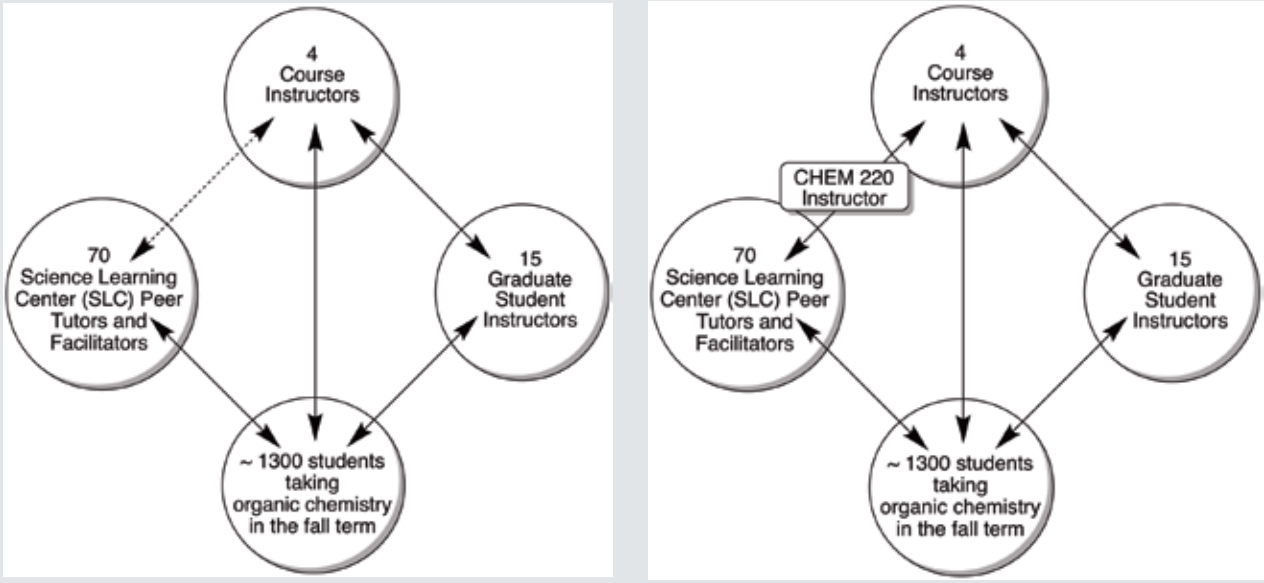
The new liaison GSI offers a set of five to seven low-enrollment sections into which the facilitators enroll (1 hour/week). The agenda for each week's session is developed cooperatively between the GSI and the faculty member serving as the course coordinator, with the subject matter staying about 1 week ahead of the syllabus for the lecture course. Through the liaison's work with the facilitators, the SLC and the department hoped to reduce the flow of misinformation, or add clarity to some of the subtle differences that do exist from term to term, ultimately seeking to better unite the message from the entire instructional team.

In fall 2013 (F13), the CHEM 220 class was initially structured to be a review of material covered in CHEM 210, with approximately one third of class time spent on lecture-style review, and two thirds of class time spent on problem review. This format was altered the following year to evenly split the time in discussion between problem generation and content review. In fall of 2015 (F15), the course reverted to content review. This report focuses on these first three semesters (F13, F14, and F15) of implementing CHEM 220 as support for CHEM 210 undergraduate PLSG facilitators and tutors.

We were interested in the following questions regarding our implementation:

FIGURE 1

(a) Arrows indicate conversational flow between parties involved in Structure and Reactivity I. Dashed arrow indicates low frequency of interaction. (b) Through the introduction of the course to support study group facilitators, the liaison of CHEM 220 acts as a formal link between facilitators/tutors and the course instructors.



1. Do PLSG facilitators find this course a valuable support to their work? If so, what aspects do they find valuable?
2. For those students who have experienced being a group facilitator pre- and post-CHEM 220, has this course changed their experience of facilitating a study group?
3. Does enrollment in this course influence the facilitators' perceptions about their course content knowledge and/or confidence about their understanding?

Methods

To understand the effect of introducing CHEM 220, we investigated three sources of data (Table 2): (a) end-of-semester evaluations conducted by the SLC as a condition of enrollment in study groups comprising two fall semesters before CHEM 220 was implemented (F11 and F12), and the subsequent three fall semesters where facilitators were enrolled in CHEM 220 (F13, F14, and F15); (b) end-of-semester evaluations of the CHEM 220 sessions were administered F13–15 voluntarily, with free- response questions; and (c) quantitative and qualitative information was solicited via e-mail from nine students who had facilitated an organic chemistry SLC study group prior to the existence of CHEM 220 (F13) and had continued to facilitate with the support of CHEM 220.

After collection, all qualitative data were coded for emergent themes (Maxwell, 2013) related to our questions. Subsequently, coding frequencies across data sets were analyzed, and the results are reported herein. Surveys were coded independently by the first two authors and then discussed until agreement for each code and response was found. Table 2 summarizes which data set was used to help answer each of our three questions.

Results and discussion

Course value?

Overall, facilitators affirm that CHEM 220 is a valuable support to their work. The worksheets with sample problems and the opportunity to interact with the instructional liaison are reported as the most valuable aspects of the class. As shown in Table 3, the majority of students who completed the end-of-semester course evaluation found the course useful, especially when the focus was content review (F13 and F15).

When given the free-response question "In what ways did attending CHEM 220 help you as a tutor or as a facilitator?" students wrote that they found the most useful parts of the course to be content review,

TABLE 2

Summary of which data source was used to answer each of our questions about our implementation of the CHEM 220 course and the GSI liaison.

Data sources	(1) Course value?	(2) Experienced perspective?	(3) Content knowledge and/or confidence?
(a) SLC evaluations			Tables 6 & 7
(b) CHEM 220 course evaluations	Tables 3 & 4		
(c) Survey of experienced facilitators		Table 5	Table 5

Note: GSI = graduate student instructor; SLC = Science Learning Center.

TABLE 3

Summary of quantitative responses by facilitators about CHEM 220 from their evaluations of CHEM 220 (A/SA: *agree/strongly agree*; N: *neutral*; D/SD: *disagree/strongly disagree*).

	Fall 2013			Fall 2014			Fall 2015		
# of study groups/ # enrolled in CHEM 220 / # of responses	*69/73/41*			*71/80/29*			*66/64/42*		
	A/SA	N	D/SD	A/SA	N	D/SD	A/SA	N	D/SD
Overall, 220 was a useful class	41	0	0	22	4	3	40	1	1
Attending 220 sessions helped me prepare for my position in the SLC	40	1	0	17	7	5	40	1	1
Attending 220 for every term I facilitate/ tutor would be useful	28	6	7	11	5	13	33	3	6

lecture pacing, human, and physical resources (Table 4). Content review was provided by the liaison each week to refresh students on the material presented in the lecture, so it was gratifying to see that their open responses reflected this topic. Students noted that seeing problems, either presented (F13 and F15) or generated during discussion (F14), became a helpful resource because they could then use those with their study group members. From the liaison's perspective, having these problems helped to encourage an open discussion of the lecture content among the facilitators.

The additional weekly contact with the liaison and their peers was noted as valuable to the study group facilitators. When asked about how attending CHEM 220 helped as a tutor or facilitator in the end-of-semester CHEM 220 course evaluations, respondents mentioned that the course "provided a source of example problems and concept clarification" and that "if I had a random question, or if a student asked something that I wasn't sure about, it was helpful to be able to ask [the liaison] and get a direct answer." CHEM 220 provided a space where they could go with their own content questions, helped them to know what important concepts to review in their study groups, and connected them with the "party line" from the faculty instructors who were teaching that term (particularly when and if there were different emphases from the term when a facilitator took the course as a student).

TABLE 4

Summary of free-response answers from facilitator evaluations of CHEM 220 from a question about how the course helped them as a tutor or facilitator.

Code	F13	F14	F15
# of study groups/# enrolled in CHEM 220/# of responses	*69/73/41*	*71/80/27*	*66/64/38*
Review of content	26	11	28
Brought up and addressed tricky or detailed content	8	2	7
Provided physical resources	11	11	8
Provided human resources	6	6	7
Lecture pacing	9	8	4
Increased confidence with subject matter	1	1	1

TABLE 5

Quantitative response from survey of those who facilitated with and without CHEM 220.

Question prompt	Increased	Remained the same	Decreased
How has your *confidence with the subject matter* changed from your time leading a group prior to CHEM 220, and with it?	3	1	0
How has your *confidence in answering questions* changed from your time leading a group prior to CHEM 220, and with it?	3	1	0
How has your ability to learn *what is going on* in the course changed from your time leading a group prior to CHEM 220, and with it?	3	1	0

Experienced perspective?

Yes, experienced facilitators report feeling more confident with the subject matter when supported by CHEM 220. In W15, we e-mailed a survey to the total of nine students who had been facilitators for organic chemistry SLC study groups before and after CHEM 220 existed. We asked these experienced facilitators questions about their subject matter knowledge confidence, confidence in facilitation, and understanding of course pace. Of the four who responded and had experience with CHEM 210 (two respondents had previously worked with Structure and Reactivity II only), three reported (Table 5) that CHEM 220 contributed positively to their confidence about these issues, presumably above and beyond whatever gains might also derive from repeat enrollment.

When asked about how their confidence in the subject matter changed while being enrolled in CHEM 220, one student elaborated in the open text portion of the survey that it "allowed facilitators to be exposed to challenging problems that caused them to dive deeper into the material and better understand the content of CHEM 210. In this way, better questions could then be asked of these facilitators' study group members." Students also expressed appreciation for the content review: "[CHEM 220] has given facilitators a refresh of content they need to know and this allows us to better answer questions." With respect to lecture pace, one facilitator explicitly mentioned that "being

in CHEM 220 helped me keep track of the material covered in lecture on a weekly basis." Such quotes exemplify how the course helped the study group facilitators with their subject matter knowledge, a central goal of the course.

Content knowledge and/or confidence?

On both the targeted survey of experienced facilitators and the semester-by-semester, end-of-term SLC evaluations by study group facilitators, students indicate that having additional exposure to a GSI was helpful in giving them greater confidence in study group.

Targeted survey of experienced facilitators

Although few in number, the responses from the four facilitators who had led CHEM 210 study groups both before and after the implementation of CHEM 220 are revealing. They indicate that contact with the liaison was helpful to their work as facilitators by providing a human resource with whom they could consult; although facilitators have always been encouraged to consult other facilitators for help, the liaison is perceived as a more authoritative content expert. These facilitators also mentioned that the explicit connection to the liaison increased their students' confidence in them as study group facilitators. Two of the four respondents mentioned increases in trust from their study group members. One stated that "having any degree, no matter how small, of official contact with the GSIs/course leader, really increases trust and makes your time and the students [sic] all the more valuable." Gaining study group members' trust is mentioned as a key component for functional study groups by facilitators, and the support of CHEM 220 helps bolster facilitators' resources for factual correctness. Supporting this idea, one student reflected the following: "[CHEM] 220 doesn't really help you answer your students' questions in the sense of giving them answers; rather, it allows facilitators to have a deep understanding of the content so that they can better direct discussion through the use of intelligent questions." Equipping study group facilitators with an understanding of the material that helps them facilitate effective learning through group work is precisely the goal of this design.

Facilitators' evaluations of study group experience by the SLC

Facilitators indicate a shift in their experiences in study group comparing before and during the implementation of CHEM 220. Facilitators report many positive experiences interacting with their study group members, including personal and professional aspects (Table 6). Many facilitators' self-reported best experiences involved moments when students personally thanked the facilitators or when the facilitators had a constructive team-building moment. Mentions of feeling more helpful or useful to study group members were more direct after the implementation of CHEM 220. One student expressed this as "feeling like my group members think that coming to group was an important/useful use of time." CHEM 220 seems to have a positive influence on facilitators' feelings of usefulness to their study group members.

Perhaps one of the most striking observations after the implementation of CHEM 220 was the change

TABLE 6

Summary of facilitators reported most satisfying experience(s) about being a study group leader.[a] The course was introduced in the fall 2013 semester.

Code	F11	F12	F13	F14	F15
# of study groups / # enrolled in CHEM 220 / # of responses	*69/n.a./42*	*70/n.a./46*	*69/73/57*	*71/80/61*	*66/64/41*
Student subject-matter knowledge gains	19	11	23	19	12
Student increase in confidence	7	3	1	1	0
Collaborative team building	16	16	17	10	15
Student expression of study group appreciation	12	6	10	7	2
Student expresses personal appreciation to facilitator	6	5	12	14	9
Personal satisfaction / warm fuzzies expressed by facilitator	6	14	9	13	11
Facilitator expresses feelings of usefulness	3	4	8	10	5

[a]Tally of experiences within a semester may exceed the total # of responses (first data row of table) because each response could be coded with more than one code for a satisfying experience.

in facilitators' perceptions of their own subject matter knowledge and difficulty in avoiding giving out answers. After the implementation of CHEM 220 in F13, there is more self-reported concern by the facilitator in their subject matter knowledge and confidence. As one student wrote, "the most challenging part was the fear that I would give my group misinformation." While the experienced facilitators indicate that they did feel that being enrolled in CHEM 220 had increased their confidence in the subject matter when explicitly asked (Table 5), an increase in confidence in the subject matter was not a common response to the free-response question about how CHEM 220 helped them in their role (Table 4). Additionally, in the free-response, end-of-semester surveys after the F13 implementation of CHEM 220 some facilitators (we do not know if individual responses were from new or experienced facilitators) indicate that they struggle with confidence with their own subject matter knowledge (Table 7). One possible interpretation for this is that new and experienced facilitators experience CHEM 220 differently. By providing facilitators a space to review the material and ask questions, CHEM 220 appears to force them to confront the gaps in their own content knowledge, which only the experienced facilitators appreciate in the long run. This observation is consistent with the models of ignorance in metacognition, in which a learner moves from a state of unawareness to one of uncertainty (Egré & Bonnay, 2013). We are unaware of any prior connection to this intriguing concept in the peer-led instruction literature.

In confronting this new awareness of their ignorance, some facilitators capitalized on their direct connection to content experts and contacted the liaison when they found themselves in need of help outside of scheduled course time. "They came up with questions that I didn't know the answer to, so I just relayed the questions to [the liaison] or told them to ask their GSI." This is exactly how we want study group facilitators to handle gaps in their knowledge that they realize during study group.

The facilitators report student pressure for answers and their own increased desire to give students the answer instead of remaining in the role of peer facilitator: "Starting discussions during exam review sessions, students are mostly looking for answers to [practice exam] and review questions quickly . . . so drawing a balance between which questions should just be given an answer to and which ones should be turned into a discussion was difficult at times but usually worked out well." Many of these tensions naturally arise in the transition from "good student" to "novice teacher" (or facilitator).

Limitations

Although providing any version of teacher professional development is not conceptually new, we were nonetheless curious to gather information about whether we could assess effects from introducing this intervention. As a study, we have been careful not to make grand claims because there are significant limitations.

TABLE 7

Summary of facilitators reported most frustrating or challenging experience[a] about being a study group leader. [b]CHEM 220 was introduced in the fall 2013 semester.

Code	F11	F12	F13	F14	F15
# of study groups / # enrolled in CHEM 220 / # of responses	*69/n.a./43*	*70/n.a./46*	*69/73/57*	*71/80/61*	*66/64/41*
Students' lack of content knowledge	5	6	0	2	1
Participation	27	29	30	33	26
Students' focus on answers not the process	5	2	2	1	2
Facilitators' lack of content knowledge	3	4	7	7	4
Facilitators' lack of confidence in content knowledge	n/a	n/a	1	4	0
Facilitators' struggle to facilitate and not teach	n/a	n/a	11	1	6
Facilitators' issues with 210 pace	3	3	1	3	1
Other	3	8	7	9	5

[a]Starting with the fall 2013, the survey question addressing the facilitators' most frustrating experience was changed to inquire about their most challenging experience(s) as a study group facilitator. Although these questions are clearly not identical, most students did report negative challenging experiences and as such these two questions were coded using the same set of codes. [b]Percentages for a given semester will not sum to 100% because each response could be coded with more than one code for frustrating experience.

(a) Our instructional setting might be perceived as a limitation of our work, in that nearly 100 facilitators associated with a supplemental institutional resource is not, narrowly defined, the sort of situation that exists broadly at most institutions (including ours). As peer-led instruction has grown as a high-impact practice, in its many varied forms, we are emphasizing here the need for explicit coupling of subject matter with pedagogical topics when thinking about providing guidance for anyone who is going to be taking on an instructional role, even though it is tempting to assume that their expertise is adequate. (b) Because of both turnover of peer facilitators between semesters and the timing of the research project, there were very few peer facilitators that we could poll for their experience leading study groups before and after the added resource of CHEM 220. Although this population was small, they were the few individuals who will ever have experience on both sides of facilitator support and could speak to any changes in their experience. (c) We do not have end-of-semester feedback from every peer facilitator from each semester that the CHEM 220 intervention was implemented. Although there were themes throughout the feedback that we collected, we could have missed additional perspective and experience by not hearing all from peer facilitators.

Conclusions

An explicit link between the college's PLSG program and the course it supports provides some important instructional advantages. The CHEM 220 course, in which the peer facilitators were enrolled, helped deepen the facilitators and tutors' perceived subject matter knowledge, ideally contributing to a better learning environment for our introductory organic chemistry students. Before implementation of CHEM 220, facilitators enjoyed their work and were confident in their ability to answer students' questions and facilitate study groups. Through their enrollment in CHEM 220, they appear to confront their own understanding of the course content and have the resources they need to resolve subject matter issues about which they were less confident.

Extending the usefulness of our experience beyond a large organic chemistry course is easy to imagine. Our work has drawn interest from other courses on campus with existing relationships with the SLC, and efforts are already underway to replicate it across the array of courses served by the PLSG program. Treating the facilitators from any peer-led instruction program as members of the teaching team, regardless of the size of the course or its setting, is our core philosophical message, and cuts across all domains. We are also raising the question about how instructors rely on any instructional resource to support student learning, and the degree to which the message that the students get from that resource is the one intended by the instructor—whether it is the textbook, a website, or the peer that a student turns to when tasked to break into groups for a problem-solving discussion.

The ongoing design challenges of providing support to the SLC PLSG program include mandatory enrollment for tutors, role of repeat facilitators in the course, and scalability for lecture courses that have fewer PLSGs. In the organic teaching program, we wanted a stronger connection between the undergraduate facilitators and the rest of the instructional team to proactively and reactively ensure coherence in the overall instructional effort. Acknowledging the limitations inherent in the current emphasis of focusing on the facilitators' perspective, future work will include investigating an analogous program in our general chemistry course and audiovisual analysis (Boothe, Barnard, Peterson, & Coppola, 2018) from both PLSG sessions and CHEM 220 classes to see how we may be able to best scaffold the development of our peer facilitators and tutors. ■

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