The Undergraduate Teacher-Scholar Program: Comparing Near-Peer and Non Near-Peer Instructors in Laboratory Courses

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Peer learning programs have been developed to support many introductory science courses by providing additional instruction and engagement. These programs are beneficial to both learners and instructors, providing content learning and confidence and attitudinal gains. There is evidence that the benefits of peer learning are higher when students are taught by a near-peer instructor who is close to the learner in age and experience. Building on this existing evidence, a peer learning program, the Undergraduate Teacher-Scholar (UGTS) Program, was created, involving both graduate student and near-peer instructors teaching in the same discussion or laboratory section. This format creates a vertical learning community within the course structure. The Teacher-Scholar program provides the opportunity to compare the roles of graduate student and near-peer instructors teaching the same students the same instructional material. We report differences and similarities in the perceived roles of the graduate student and near-peer instructors by all of the stakeholders involved in the program. Both graduate student and near-peer instructors are valued by students; however, the near-peer instructors provide mentorship and role model qualities that are not replaced by a graduate student instructor.

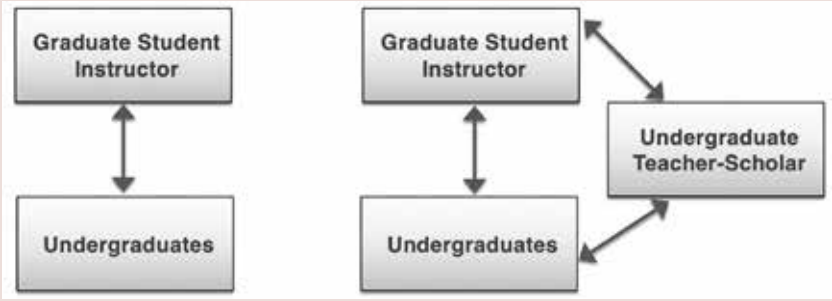
At large undergraduate institutions, many introductory science courses are taught in a large lecture format. The addition of a peer instructor into the learning environment can provide a more personalized learning experience for the student (Bene & Bergus, 2014; Eberlein et al., 2008; Topping, 2005). Peer learning has been studied through many different models and programs (Adams & Lisy, 2007; Bene & Bergus, 2014; Campbell et al., 2019; Duncan & Dick, 2000; Gosser et al., 2010; POGIL, 2019; Otero et al., 2010; Weaver et al., 2008; Wilson & Varma-Nelson, 2016; Yew & Goh, 2016). When the peer instructor is closer to the learner in education, experience, and knowledge, the learner's zone of proximal development has more overlap with the peer instructor (Topping, 2005). When peer learning models are implemented, students report higher levels of willingness to ask questions, higher comfort levels learning from the peer instructor, greater satisfaction with their course experience, and improved content learning (Bulte et al., 2007; Duncan & Dick, 2000; Hall et al., 2014; Sawyer et al., 2013; Singh, 2010; Smith, 2008; Ten Cate & Durning, 2007; Topping, 2005; Weaver et al., 2008). Benefits extend beyond content learning to affective benefits such as increased motivation to ask questions, greater comfort being wrong and working through confusion, and improved motivation to learn subject matter (Bulte et al., 2007; Hall et al., 2014; Singh, 2010; Smith, 2008; Ten Cate & Durning, 2007; Topping, 2005).

The Undergraduate Teacher-Scholar (UGTS) Program was designed to build on the known benefits of peer learning programs. The Teacher-Scholar Program places approximately 100 undergraduate students as Teacher-Scholars each semester in eight different general and organic chemistry courses for both chemistry majors and nonmajors, serving nearly all laboratory and discussion sections for each course. Each UGTS is assigned to work with a graduate student instructor (GSI) throughout the semester to co-teach a laboratory or discussion section, enabling undergraduate students to learn how to teach in a mentored setting. Students enrolled in the course, the UGTS, and a GSI engage with each other at the same time and in the same environment. We call this environment a vertical community of scholars. Traditionally, laboratory and discussion sections are taught only by a GSI. Inserting an undergraduate student instructor (the UGTS) into the vertical learning community bridges the gap in label and experience between the students enrolled in the course and the GSI (Figure 1).

Research in medical school education proposes that there is an important distinction to be made between non-near peer and near-peer instructors (Akinla et al., 2018; Bulte

FIGURE 1

Traditional lab and discussion model (left). Undergraduate Teacher-Scholar Program model (right). There is a vertical community of scholars with a smaller gap in experience and label between tiers than in the traditional model.



et al., 2007; Hall et al., 2014; Singh, 2010; Ten Cate & Durning, 2007). A near-peer instructor is someone who shares the same label with the learner and who is the closest to the learner in age and experience. There are measurable differences in student comfort, motivation, and learning from a near-peer instructor compared to a non near-peer instructor (Hall et al., 2014). When the instructor shares the same label as learners (medical student as opposed to doctor), learners report higher levels of comfort admitting they are confused, higher levels of motivation to learn because they see a successful version of their future in the near-peer instructor, and more successful learning (Bulte et al., 2007; Hall et al., 2014; Singh, 2010; Ten Cate & Durning, 2007).

If near-peer instructors yield improved outcomes then a distinction should be made between undergraduate (near-peer) and graduate (non near-peer) student instructors. Most reported undergraduate chemistry peer learning programs use undergraduate and graduate student instructors in different, disintegrated components of the course structure, such as supplemental office hours or study sessions (Duncan & Dick, 2000; Otero et al., 2010; Weaver et al., 2008; Wilson & Varma-Nelson, 2016). The Teacher-Scholar program provides an opportunity to explore near peer and non-near peer instructors in similar roles in the same classroom. Here we report on the perceived benefits of the Teacher-Scholar program and the similarities and differences of the perceived roles of the UGTS and GSIs from the perspectives of the students, UGTSs, and GSIs.

Methods

Course and study populations

The primary data collection semester was the fall of 2015 after the program was fully developed. In the fall of 2015, 109 UGTSs, 87 GSIs, 3,700 students, and nine faculty participated in the Teacher-Scholar program in eight courses: General Chemistry for majors and nonmajors (two semesters each) and Organic Chemistry for majors and nonmajors (two semesters each). Table 1 shows the data collection methods used during the fall 2015 semester.

The racial demographics of the UGTSs were similar to those of the students in the courses; the largest groups represented were white (26%) and Chinese/Chinese American (28%). There were a variety of other Asian groups (30%) and a small number of African Americans (2%) and Mexican or Latino students (4%). The population was approximately 50% women.

Surveys

Surveys were designed to investigate satisfaction with the Teacher-Scholar Program, the impact of the Teacher-Scholar program on the UGTSs, the different interactions of students with GSIs and UGTSs, and perceived differences between the roles of the GSI and UGTS. Presurveys were administered to the UGTSs to probe their goals and motivation for participating in the program. Survey questions were developed iteratively over several years, and therefore, the survey given in fall 2015 was developed responsively to GSI, UGTS, and student responses in previous semesters. Short answers were coded for emergent themes. All surveys were approved by the campus Committee for Protection of Human Subjects. Survey response rates were 34% for GSIs, 84% for UGTSs presurvey and 56% postsurvey, and 86% for undergraduate students. The GSIs were mostly first-year graduate stu-

TABLE 1

Data collected during the fall 2015 semester.

	Presemester survey	Postsemester survey	Postsemester interview	Postsemester focus group
Student		X	X	
UGTS	X	X		X
GSI		X	X	

UGTS = Undergraduate Teacher Scholar
GSI = Graduate student instructor

TABLE 2

Program involvement by semester.

	Undergraduates	UGTSs	GSIs	Faculty members
Fall	~3,900	~100	~110	6
Spring[a]	~2,800	~90	~85	6

[a] The spring semester has fewer participants because course sizes are smaller in the spring.
UGTS = Undergraduate Teacher Scholar
GSI = Graduate student instructor

dents each fall semester; 72% of the GSIs who consented to participate in this study were first-year graduate students. The remainder were second- and third-year graduate students.

Interviews and focus groups were used to qualitatively probe UGTS, student, and GSI perceptions of the Teacher-Scholar Program. Interviews and focus groups were conducted at the end of the fall 2015 semester. There were two focus groups involving 25 UGTSs from both general and organic chemistry courses. Interviews with six students and three GSIs from the general chemistry laboratory course were conducted. These interviews focused on general chemistry because near-peer role modeling may be more helpful to students when students are new to their environment. All focus groups and interviews were audio recorded, and emergent themes were coded.

Results and discussion

Development of the Teacher-Scholar Program

The Teacher-Scholar program was developed over four semesters beginning in the fall of 2013 using an iterative approach that was inspired by educational design research methods (Cobb et al., 2003; van Akker & Nieveen, 2017) and was responsive to feedback from students, GSIs, and UGTSs. A weekly pedagogy course was designed to introduce UGTSs to evidence-based pedagogical methods and provide support for laboratory or discussion sections. An introduction to the program was included in GSI and UGTS training to clarify the roles and obligations of the GSIs and UGTSs. In the fall of 2015 the final structure of the program was in place (Tables 2 and 3). The UGTS was expected to co-teach one laboratory or two discussion sections each week and attend a weekly pedagogy course (Table 3). The great majority of UGTSs were placed in laboratory sections. The weekly pedagogy sessions began with active group reflection on the previous lab or discussion and preparation for the upcoming laboratory or discussion. The last half of the pedagogy session was focused on a discussion of a larger pedagogical topic (Table 4). UGTSs often applied to return for one or more semesters after their first experience as a UGTS (Table 5).

Characteristics of Undergraduate Teacher-Scholars

The Teacher-Scholar program is one of the earliest leadership opportunities available to a large range of STEM majors on campus. Students may apply to be a UGTS after they have performed well in their general or organic chemistry courses, as early as the second semester of their freshman year. The UGTS's role as apprentice teachers with an expert GSI enables them to contribute to student learning without being experts in chemistry content. As a result, the Teacher-Scholar program recruits students from a variety of fields. Approximately 15–20% of UGTSs reported that they planned to major in chemistry or chemical biology, while the remaining planned to major in biology, engineering, psychology, math, and humanities. The

TABLE 3

Expectation for Undergraduate Teacher Scholar for each component of the Teacher-Scholar Program.

	Laboratory/discussion section	Pedagogy course
Description	• placed in specific lab or discussion section (one time per week)	• 90-minute course session once per week • content preparation for the week's laboratory or discussion assignment • introduction to pedagogical theory and practice
UGTS expectations	• prepare for upcoming lab/discussion section • attend each weekly lab or discussion session	• work in small groups to prepare for upcoming lab/discussion • work in whole cohort to complete weekly pedagogical methods workshop

UGTS = Undergraduate Teacher Scholar

TABLE 4

Activities for weekly pedagogy session.

20 minutes	Complete worksheet for the upcoming lab/discussion in small groups
15 minutes	Discuss previous and upcoming lab or discussion session
5 minutes	Introduction of special topic
40 minutes	Special topic: • Role play • Conversations in the classroom • Misconceptions • Implicit bias and stereotype threat • Fixed versus growth mindsets • Imposter syndrome • Worksheets: Planning/writing • Worksheets: Peer review and revision • Course evaluations and surveys • Curriculum design: Propose new lab experiment or discussion topic • Presentation on lab experiment proposal or discussion topic

TABLE 5

Percentage of new and returning Undergraduate Teacher Scholars.

	New	Returning one time	Returning two or more times
Fall 2015 (n = 124)	79%	15%	6%
Spring 2016 (n = 68)	53%	43%	4%
Fall 2016 (n = 123)	71%	13%	16%
Spring 2017 (n = 107)	44%	39%	17%

TABLE 6

Student and Undergraduate Teacher Scholar survey responses in laboratory courses to the question "Which of the following did your UGTS do this semester? (Please select all that apply.)."

	Students	UGTSs
Provided information*	94%	100%
Acted as a role model*	61%	90%
Graded student work	13%	5%
Facilitated discussion	45%	70%
Created course resources	8%	35%
Planned lab activities	16%	10%
Monitored safety procedures*	86%	75%
Supervised the use of class instruments*	89%	70%

*indicates the roles we expected for the UGTS
UGTS = Undergraduate Teacher Scholar

majority were biology majors (60%). These numbers have remained consistent in subsequent years. When asked to indicate their career goals, 67% indicated prehealth, but other career goals included education, law, engineering, and research.

UGTSs were surveyed presemester to probe their goals for participation in the program. The most common goals were to become a better teacher (70%), to solidify their chemistry knowledge (49%), and to improve communication skills (13%). UGTSs were asked postsemester to indicate which factor they felt improved the most from participating in the program. The most common answers to this question were "ability to design good chemistry questions for students" (23%), "ability to guide students through a question without giving away the answer" (27%), "ability to explain chemistry concepts and techniques" (27%), "increased chemistry content understanding" (10%), and "feelings of belonging at the university" (12%). Thus, their presemester goals were consistent with their perceived outcomes.

Program satisfaction

All participants (GSIs, UGTSs, and students) expressed a high level of satisfaction with the program. Over the course of four semesters (spring 2015–fall 2016), 100% of UGTSs, 97% of students, and 100% of GSIs reported on surveys that they would like the program to continue. Students expressed appreciation that their UGTS understood the difficulties they were facing and could give specific advice about their academic futures. UGTSs were overwhelmingly positive because the program gave them a sense of mastery of the material and purpose in helping their fellow peers. Many explained on surveys that the program provided a sense of belonging at a highly competitive university. GSIs for laboratory sections commented on surveys

that the UGTSs' past experiences in the course prepared them to be the expert in troubleshooting experiments.

Do program goals match perceived goals of participants?

To assess whether the program was functioning as intended, the perceived goals of the participants were compared to the goals of the program. It was expected that the UGTSs would contribute to the learning goals of the laboratory by providing information, facilitating the use of equipment, and monitoring safety, while also acting as a role model. There remained certain roles only for the GSI, including grading and leading the section. Both UGTSs and students were asked on surveys to select what their UGTS did in their section (Table 6). Almost all students and UGTSs answered consistent with the roles listed above. Importantly, the four roles that we hoped that the UGTSs would fulfill matched the four categories the students and UGTSs chose at the highest percentages. In answers to open-ended questions, the GSIs were consistent with the student and UGTS survey results in Table 6.

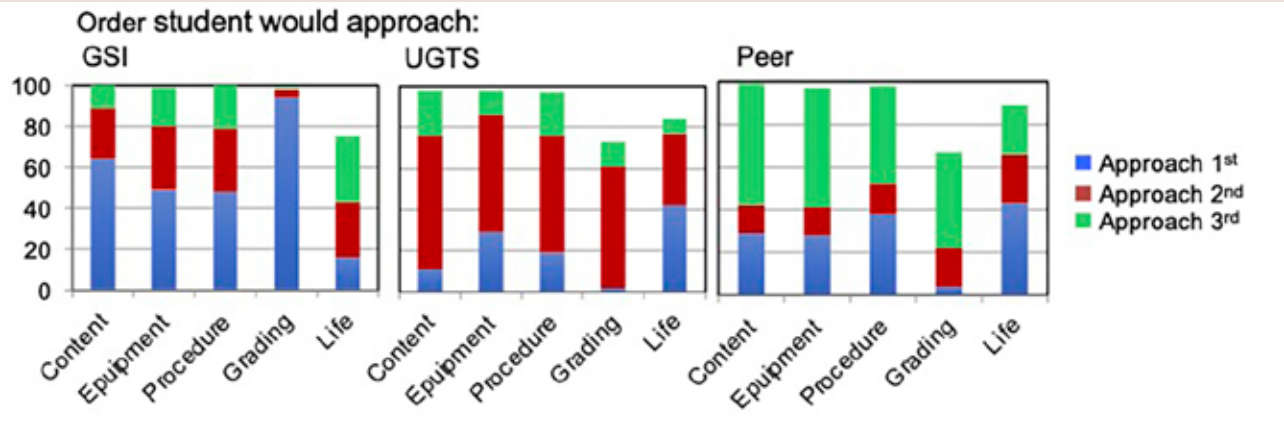
Perceived role of Undergraduate Teacher Scholar compared to graduate student instructor

To probe whether there are distinctions between near-peer (UGTS) and non near-peer (GSI) instructors, the perceived roles of GSIs and UGTSs were compared. The UGTS were asked in focus groups how their role differed from the GSI. The majority of UGTSs (80%) stated that their role was similar to that of a GSI with the exception of grading and prelab lecture, and 48% of UGTSs elaborated further that their role focused on equipment and helping students troubleshoot, while the GSIs focused on course policy, grading, and conceptual questions. When GSIs were asked in open-ended questions on the survey about their role compared to their UGTS's role, 54% of the GSIs expressed that they believed students chose to ask them conceptual questions and the UGTSs more practical questions. An additional 20% mentioned that students asked the UGTSs about equipment and instrumentation, while students asked the GSIs about grading and course policy. Thus, the perceptions of the GSIs and the UGTSs were similar, with both groups recognizing the leadership role of the GSI in course policy and chemistry concepts and the familiarity of the UGTSs with the equipment and the specific experiments being performed.

Student perception of the role of the UGTS compared to the GSI was probed to gain insight into the contribution of the program to student experiences. Students were not informed explicitly of differences between UGTSs and GSIs, and therefore, the perceived similarities and differences in roles emerged from student interactions with both. Students viewed the UGTS and GSI roles as similar, with the majority of students (78%) selecting the choice: "My Undergraduate Teacher-Scholar did everything that the GSI did with the exception of prelab lectures and grading" and 6% of students selected the choice: "My Undergraduate Teacher-Scholar's role did not differ from my GSI's role." Consistent with these choices, the majority of students in laboratory courses indicated that UGTSs helped improve their understanding of laboratory equipment and procedures (> 90%) and the chemistry concepts necessary to accomplish the labora-

FIGURE 2

Student responses for the order they would approach GSI (left chart), UGTS (middle chart), or peer (right chart) with certain types of questions. The data represents responses from 1906 students who completed the survey from all courses with UGTSs.



tory experiments (> 75%).

To provide a more detailed portrayal of the relative roles of the GSIs and UGTSs, students in laboratory sections were asked on surveys whom they would approach (GSI, UGTS, peer, or no one), and in what order, to ask specific types of questions (Figure 2). Students indicated that for content, equipment, procedure, and grading questions they would approach the GSI first, the UGTS second, and a peer third. These responses are logical because GSIs are the content experts and complete all the grading. However, there was not a strong preference for content, equipment, and procedure questions and students commented that often they would choose whoever was closer between the UGTS and GSI to answer these questions. Students do not approach GSIs first with questions related to life at the university, such as which classes to take or how to get involved in research. Students were equally likely to state that they would approach their UGTS or a peer first to ask life questions.

Students who did not have a UGTS in their section shifted some of the focus of their questions on content and procedure to the peer categories (Table 7). The frequent answer to whom they would approach was "never" for the UGTS because these students did not have a UGTS. Interestingly, the percentage of students indicating they would ask the GSI first for content and grading questions decreased, while for equipment, questions increased significantly (Table 7). Comments on student surveys suggest that GSIs without a UGTS simply do not have enough time to answer all student questions. This supports the important role of the UGTS to provide greater access to knowledgeable instruction during the laboratory section. Students without a UGTS indicated that they would primarily approach a peer to ask life questions, suggesting that UGTSs possess qualities that are not replaced by a GSI in the sections without a UGTS.

When students were asked on surveys to describe the unique benefits that the UGTS brings to the laboratory, only 3% did not mention any benefits. The remaining students mentioned the extra assistance the UGTS gave answering questions and providing a different perspective. A portion (20%) commented that the UGTS had taken the class previously and could provide practical advice about the experiments and the course. Many students (26%) mentioned that the UGTS was more approachable than the GSI. Students also commented that their UGTS was easier to understand because they used familiar language. In addition, students appreciated that their UGTS understood their difficulties as undergraduates both in and beyond the course. About 10% of the students explicitly mentioned the UGTS giving advice about undergraduate life. In interviews, students from general chemistry reported feeling more comfortable being wrong in front of the UGTS because the UGTS did not assign grades. Selected student responses from surveys illustrating unique benefits of the UGTS are in Table 8.

UGTS and GSI responses to open-ended question on surveys were consistent with the student responses previously described. UGTSs commented that students tended to approach them with 'life' questions. The UGTSs sensed that students felt more comfortable when interacting with them because they were not assigning grades. GSIs indicated that they felt

TABLE 7

Survey results indicating whether students report they would approach a graduate student instructor or peer first in laboratory sections given the following categories of questions.[a] Note that the Undergraduate Teacher Scholar category was removed from this table to show a comparison between peer and graduate student instructor.

With UGTS	**GSI**	**Peer**
Content	64%	29%
Equipment	49%	28%
Procedure	48%	38%
Grading	93%	4%
Life	16%	43%
Without UGTS	**GSI**	**Peer**
Content	51%	49%
Equipment	67%	32%*
Procedure	49% *	50%
Grading	88%	10%
Life	19%*	61%

[a] The data represent responses from 1,860 students who completed the survey from all courses with UGTSs. Students without UGTS: $N = 379$; students with UGTS: $N = 1481$. A two-sample test of proportions was used to compare the proportion of students who first asked their GSI or peer each type of question between students who did not have and did have teacher-scholars in their laboratory sections. All comparisons were significant, except those indicated with an *.

UGTS = Undergraduate Teacher Scholar
GSI = Graduate student instructor

that the UGTSs were instrumental to helping the lab run smoothly and valued the contribution of their prior experience in the course. UGTS and GSI responses in focus groups and interviews were consistent with their responses on surveys.

Conclusion

The Teacher-Scholar program provides an opportunity to examine the roles of non near-peer and near-peer instructors in the same classrooms teaching the same material to the same students in the same physical space. All participants agreed that the GSI and UGTS were assigned similar roles in the laboratory supervision. There is an advantage to having two instructors in the classroom to provide more instruction to students. This is evident in students' statements that they would approach the instructor who was closer with questions about content, equipment, and procedures.

Although the perceived classroom roles of UGTSs and GSIs were similar, the UGTSs provide additional benefits to students. Students reported feeling more comfortable with the UGTS and appreciated the prior experience of the UGTS in the same courses. Students turned to the UGTS for questions beyond those focused on the course. Hall et al.'s (2014) research on near-peer instruction suggests that shared experiences, closeness in age, and a shared label (undergraduate) are large factors in students' willingness to ask these types of questions and may help students to view the UGTSs as more approachable (Hall et al., 2014).

The collaboration between the GSI and UGTS is a clear strength of the program for the UGTSs. The Teacher-Scholar program offers students a leadership, teaching experience early in their time in college that they can use to qualify for future positions. This early teaching opportunity is available to students pursuing a variety of majors because the GSI can provide expert content knowledge and experience to the classroom. The GSI acts as a teacher, mentor, and role model for the UGTS. In return, the GSIs value the UGTS for their previous experience in the courses.

Overall, there was near unanimous support from UGTSs, GSIs, and students for the Teacher-Scholar program. The program provides integrated near-peer academic and mentoring support for STEM students in the first two years of university studies, which is a key time to influence student experiences and retention (Damkaci et al., 2017; Akinla et al., 2018). At the same time, the program provides considerable leadership and content knowledge benefits for the broad range of undergraduate students who join the program as UGTSs. This general program design should have broad applicability in introductory courses of most STEM disciplines, which are typically taken by both nonmajors and majors. In the future, it will be interesting to probe the relationship between the perceptions reported here and real-time teaching practice by the UGTS and GSI instructors. ■

Online Supplemental Materials

Pre- and postUGTS surveys, GSI survey, student surveys, and focus group and interview questions—https://bit.ly/3eVzMNb

References

Adams, G. M., & Lisy, J. M. (2007). The chemistry merit program: Reaching, teaching, and retaining students in the chemical sciences. *Journal of Chemical Education*, *84*(4), 721–726. https://doi.org/10.1021/ed084p721

Akinla, O., Hagan, P., & Atiomo, W. (2018). A systematic review of the

TABLE 8

Sample quotes from students on surveys in response to the question, "What unique contributions does the Undergraduate Teacher-Scholar Program bring to the laboratory?

Student	Student response
Student 1	I found having so many people to turn to when I have questions a very useful and almost luxurious resource. The fact that Teacher-Scholars are more equal in age to me also helped me talk with less inhibition.
Student 2	He provided someone who was a bit more relatable than the GSI, but also served as an authority in the class.
Student 3	Also having an instructor who is not grading you is conducive to honest questions.
Student 4	It brings a person who can guide the lab through personal experience. It is sometimes harder to understand things solely from a gsi because they are far more advanced and can't relate to the students.
Student 5	She is also willing to answer any questions we have that are unrelated to the lab, such as questions about this program or questions about being an undergraduate.
Student 6	Familiarity with (the university)
Student 7	I not only learned about chemistry, but also about my teacher-scholar's experiences with chemistry—what he found hard, what he found easy, and strategies he found helpful in learning chemistry.

literature describing the outcomes of near-peer mentoring programs for first year medical students. *BMC Medical Education*, *18*(1), 98. https://doi.org/10.1186/s12909-018-1195-1

Bene, K. L., & Bergus, G. (2014). When learners become teachers: A review of peer teaching in medical student education. *Family Medicine*, *46*(10), 783–787.

Bulte, C., Betts, A., Garner, K., & Durning, S. (2007). Student teaching: Views of student near-peer teachers and learners. *Medical Teacher*, *29*(6), 583–590. https://doi.org/10.1080/01421590701583824

Campbell, J., Malcos, J., & Bortiatynski, J. (2019). Growing a learning assistant program: Using perceptions to inform improvement. *Journal of College Science Teaching*, *48*(3), 66–73.

Cobb, P., Confrey, J., deSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher*, *32*(1), 9–13.

Damkaci, F., Braun, T. F., & Gublo, K. (2017). Peer mentor program for the general chemistry laboratory designed to improve undergraduate STEM retention. *Journal of Chemical Education*, *94*(12), 1873–1880. https://doi.org/10.1021/acs.jchemed.7b00340

Duncan, H., & Dick, T. (2000). Collaborative workshops and student academic performance in introductory college mathematics courses: A study of a Treisman model math Excel program. *School Science and Mathematics*, *100*(7), 365–373. https://doi.org/10.1111/j.1949-8594.2000.tb18178.x

Eberlein, T., Kampmeier, J., Minderhout, V., Moog, R. S., Platt, T., Varma-Nelson, P., & White, H. B. (2008). Pedagogies of engagement in science: A comparison of PBL, POGIL, and PLTL. *Biochemistry and Molecular Biology Education*, *36*(4), 262–273. https://doi.org/10.1002/bmb.20204

Gosser, D. K., Kampmeier, J. A., & Varma-Nelson, P. (2010). Peer-Led Team Learning: 2008 James Flack Norris award address. *Journal of Chemical Education*, *87*(4), 374–380. https://doi.org/10.1021/ed800132w

Hall, S., Stephens, J., Andrade, T., Davids, J., Powell, M., & Border, S. (2014). Perceptions of junior doctors and undergraduate medical students as anatomy teachers: Investigating distance along the near-peer teaching spectrum. *Anatomical Sciences Education*, *7*(3), 242–247. https://doi.org/10.1002/ase.1419

Otero, V., Pollock, S., & Finkelstein, N. (2010). A physics department's role in preparing physics teachers: The Colorado learning assistant model. *American Journal of Physics*, *78*(11), 1218–1224. https://doi.org/10.1119/1.3471291

POGIL. (2019). POGIL. *https://pogil.org*

Sawyer, K., Frey, R., & Brown, P. (2013). Knowledge building discourse in Peer-Led Team Learning (PLTL) groups in first-year general chemistry. In D. D. Suthers, K. Lund, C. P. Rosé, C. Teplovs, & N. Law (Eds.), *Productive multivocality in the analysis of group interactions* (pp. 191–204). Springer. https://doi.org/10.1007/978-1-4614-8960-3_10

Singh, S. (2010). Near-peer role modeling: The fledgling scholars education paradigm. *Anatomical Sciences Education*, *3*(1), 50–51. https://doi.org/10.1002/ase.126

Smith, T. (2008). Integrating undergraduate peer mentors into liberal arts courses: A pilot study. *Innovative Higher Education*, *33*(1), 49–63. https://doi.org/10.1007/s10755-007-9064-6

Ten Cate, O., & Durning, S. (2007). Peer teaching in medical education: Twelve reasons to move from theory to practice. *Medical Teacher*, *29*(6), 591–599. https://doi.org/10.1080/01421590701606799

Topping, K. J. (2005). Trends in peer learning. *Educational Psychology*, *25*(6), 631–645. https://doi.org/10.1080/01443410500345172

van Akker, J., & Nieveen, N. (2017). The role of teachers in design research in education. In S. Doff & R. Komoss (Eds.), *Making change happen* (pp. 75–86). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-14979-6_9

Weaver, G. C., Wink, D. J., Varma-Nelson, P., & Fornes, W. L. (2008). *CASPiE implementation guidebook*. Purdue University.

Wilson, S. B., & Varma-Nelson, P. (2016). Small groups, significant impact: A review of Peer-Led Team Learning research with implications for STEM education researchers and faculty. *Journal of Chemical Education*, *93*(10), 1686–1702. https://doi.org/10.1021/acs.jchemed.5b00862

Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An overview of its process and impact on learning. *Health Professions Education*, *2*(2), 75–79. https://doi.org/10.1016/j.hpe.2016.01.004

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