Learning Partnerships Between Undergraduate Biology Students and Younger Learners

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In two upper-level elective biology courses and one beginning-level general biology course, college students participated in Learning Partnerships with middle or high school classes to study some aspect of biology. The goals were to enhance learning by providing resources to middle and high school students and teachers and by encouraging college students to consider teaching as a learning tool and a possible career goal. The college students designed lessons, activities, and laboratories that were done at the schools and at Bates College. Feedback and data suggest that the partnerships have helped teachers enrich their curricula, enhanced student learning, encouraged additional high school students to consider applying to college, and encouraged college students to consider teaching science.

The idea for partnering college students with younger students as a pedagogical strategy builds on the notion that you learn something best when you have to teach it. Including a science education outreach component in undergraduate science courses gives college students an opportunity to teach what they are actively learning, as well as what they have learned in the past. It encourages them to integrate what they have learned into larger contexts and helps them better understand different perspectives and learning styles including their own (3, 4, 5). This kind of experience also allows them to experience teaching, in the hope that they will consider staying involved with science education at some level.

High school and middle school science teachers are more often being expected to use technology in their classrooms, teach new content and concepts, and cross disciplinary lines that are not familiar to them. Partnering teachers and their classes with college students brings help and fresh energy that can be used in many different ways. Connecting college students with middle school or high school classes also provides opportunities for intellectual, social, and interpersonal interactions between groups of students who might not otherwise cross paths. This in turn supports the social nature of learning that we have come to realize is so important to its success (4). This type of partnership can also offer high school teachers help with meeting requirements to align their curricula with state-mandated learning standards (17, 18).

These "Learning Partnerships" inherently include some of the models that are beginning to transform science education, which are based on how individuals actually learn about science and come to understand the content, skills, and processes necessary to "do" science (7, 12, 15, 16, 19). These models include student-active teaching (15), cooperative and collaborative learning (2, 13), team-based learning (9, 14), active learning (10), experiential learning (6, 7) and service learning (1, 8, 11).

Bacteriology and Virology are junior- and senior-level

electives that count toward the Biology major. Learning and Teaching Biology is a beginning-level course that includes majors and nonmajors. Virology does not include a formal laboratory, and for several years I have given students the option of proposing and doing a project of their own design, which can be laboratory-based or not (L. Abrahamsen, Abstr. 16th Annu. Meet. Am. Soc. Virol., abstr. P13-1, p. 214, 1997). I designed Learning and Teaching Biology around required partnerships to focus on teaching as a learning strategy. With experience, it became evident that the partnerships were most successful when college students met with school teachers ahead of time to brainstorm, further develop their ideas, and plan any activities. This allowed careful tuning of the program so that it could be integrated into the teacher's curriculum.

METHODS

These Learning Partnerships included 11 teachers in 12 partnerships (one teacher participated in two consecutive years), 43 college students, and 146 high school and middle school students, 106 of whom provided responses to evaluations. Participating schools were Bates College, Martel School, Lewiston Middle School, Longley School, and Lewiston High School in Lewiston, Maine, and Edward Little High School in Auburn, Maine. All of the middle and high schools are public schools. There were eight middle school and four high school partnerships.

Logistics of the partnerships. The partnerships in Learning and Teaching Biology were required, while those in Virology and Bacteriology were optional. Many of the partnerships were arranged through the Bates College Center for Service Learning. Some of the participating school teachers had attended a science education outreach workshop and expressed an interest in having their classes learn about particular aspects of biology or microbiology.

In one case, students had worked with a teacher in another context and proposed the new partnership, and in another case, a teacher heard about the partnerships and asked to be included. Their college partners contacted all of the teachers at the beginning of the semester and arranged to meet to talk about how the partnership would progress.

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In the college classrooms. In Learning and Teaching Biology, the Partnerships counted as 40% of each student's grade. In Virology and Bacteriology, students were allowed to decide individually whether their participation would count as 0 to 40% of their grade. In all classes, college students worked in teams of two to five. In the upper-level courses, all participating students were required to present their work at the annual Bates College student research symposium in the form of a talk or poster. Assessment of each Partnership was based on a proposal and bi-weekly progress reports, a written presentation of the entire project with accompanying lesson plan, overall participation, a self-assessment of learning, a peer assessment of each group member's contribution to the Partnership, a teacher assessment of the group's work, and (in the case of the upper-level classes) the quality of their final symposium presentation. Not all of the college students participated in classroom visits. Some prepared labs or other materials, participated in assessment, or ran labs when young students came to the College. I met with student teams weekly and on an as-needed basis. Often these meetings were brief and I kept track of what was going on via the progress reports. I attended all of the laboratory sessions that took place at the College. I also attended several classroom sessions when I was invited and available.

In the school classrooms. After meeting with their teachers and planning their programs, students visited their classes on a mutually acceptable schedule that averaged about five times during the semester. Various programs included mini-lectures, investigational labs at the school or the College, small group discussions of the scientific method and experimental design, guided inquiry-based lab experiences, and multi-media presentations such as films. The younger students were required to participate in the Partnerships. They often worked in groups of three or four for laboratory-type experiences, and groups were required to make posters in scientific format to present their work. The college students and their partner teachers assessed the learning of the younger students with tests, quizzes, homework assignments, informal question and answer sessions, journal entries, surveys, and evaluation of the quality of the posters.

An Example from Bacteriology, "Bacteria in Your Environment," which includes a sample lesson plan is presented in Fig. 1. The general outline for the lesson plans was developed with the help of colleagues in the Bates College Education Department. It is an example of an outcomes-based curriculum format in which the goals are stated first and are used as a focus for the design of the lesson. Students were provided with the headings of the lesson plan (lesson title, outcomes, concepts to be learned, etc.) and were required to complete the plan with their specific information. An example from Learning and Teaching Biology, "An Introduction to Cells and How We See Them," is presented in Fig. 2.

Evaluations—college and younger students. Participating college students were asked to respond to four questions that were included in an instructor-administered evaluation of the course (Tables 1 and 2). Younger students were given the same questions on an evaluation form that they

were asked to fill out at the end of the Partnership (Table 3). Students were asked to respond "yes" or "no" and to provide comments. College students were also asked to assess the contributions of their group members compared to their own contributions by stating whether their peers had contributed "as much," "less," or "more" than themselves.

Evaluations—teachers. Teachers were asked to score Bates student preparation, Bates student professionalism, the scientific accuracy of any student presentations, and their own students' interest in the program as "poor," "fair," "average," "good," or "great" (Fig. 3). They were also asked to answer "yes" or "no" to three questions (Table 4).

Presentation of the partnerships. Every year Bates has a college-wide research symposium in which students from all disciplines present their research. In Bacteriology and Virology, students who participated in the Learning Partnerships were required to present their work at this symposium. This encouraged students to gather and analyze data of various kinds, to think about their own work in light of other scientific and/or educational research, and to plan and accomplish assessment of their work. Often the "results" section of the college student presentations included the work of their younger Learning Partners, who were also invited to the symposium with their parents and teachers.

RESULTS

College students. The results of the college student evaluations of the Learning Partnerships are shown in Table 1 for Bacteriology and Virology in which the partnerships were optional, and in Table 2 for Learning and Teaching Biology which had required partnerships. An average of 98% of all students reported that the experience of working in a group was a good one. An average of 96.5% learned a significant amount of biology from participating in the Partnership, and an average of 91% said that they would remember the content of the lesson they taught better than had they only studied the material for an exam. Overall, the students in both groups responded very favorably to the Learning Partnership experience, and 98% of them considered the experience valuable.

In all three courses, students were asked to evaluate the work of their group members by comparing the contributions of each group member to their own. Overall, in 80% of cases, students thought that the work of group members was equal to their own; in 8% of cases, students thought that peers contributed less than themselves; and in 12% of cases, students rated the contributions of their group members as greater than their own.

I was interested in finding out whether participation in a Learning Partnership encouraged students to consider teaching science. Before participating, 18% of all students said they would consider teaching science as a career. After participating in a Learning Partnership, this number rose to 36%.

Younger students. The results of responses from 106 middle school and high school students who were asked to evaluate their participation in the Learning Partnerships are shown in Table 3. The responses suggest that these stu-

Format: College students met with a tenth grade class four times. In the first session at the high school, four college students gave mini-presentations (see below). Groups of four high school students led by a college student mentor used the scientific method to propose a hypothesis about what bacteria they would find in a particular environment, and designed an experiment using agar plates and swabs to test it. The second session was devoted to the collection of bacterial samples in the environments the groups had chosen (the classroom, the art room, the cafeteria, the principal's office, the bathroom and a student (his normal flora). For the third session, the students met at the bacteriology lab at the college to use stains and microscopes to morphologically analyze the bacteria they isolated. They took pictures of their stains and plates, and counted and categorized the bacterial types they found in each environment. The mentors helped the younger students analyze their data and explained how to present their work in scientific poster format. The students made posters in class with the help of their teacher, and presented them to the college mentors, their teachers and peers at the fourth session at the high school.

Lesson Plan Outline

Lesson Title: *Bacteria in Your Environment*

Outcomes: What will your students know and/or be able to do at the end of your lesson?

- *Define what bacteria are, where are they found, and what they require to reproduce.*
- *Design a simple experiment using the scientific method.*
- *Perform a Gram stain and use a microscope to observe bacteria.*

Concepts to be learned: What concepts do you want your students to understand?

Growth by binary fission. What constitutes a cell, and what is the difference between a prokaryotic and eukaryotic cell?

What is a control? What is microscopic magnification? How do we calculate magnification? Which bacteria make you sick, and which ones keep you healthy?

Curriculum Reference: How do these concepts/skills connect with the curriculum currently being used?

The students are learning about cells and organelles. This will give them an example of another kind of cell. They are also learning about health and disease next term, so the idea that bacteria can cause infectious diseases will introduce them to that unit. They are learning about size and scale in math class, so the microscope lab will tie in as well. We will teach them about magnification and how to calculate total magnification for the lenses of a light microscope.

Maine Learning Results Reference: Which science/technology/health learning results include these concepts?

Science and Technology: Standard A: Classifying Life Forms

Standard B: Ecology – finite resources and populations

Standard C: Cells and Organelle – preparation and examination of microscope slides, identification of causes and effects of disease, structure and function of cells

Exploring what students know: How will you find out what your students already know about your topic? Is there an activity you can use to find out? Can you establish why your concept is relevant to their lives?

Students will be divided into groups of four. Students will be asked what they know about cells and bacteria. Each group will work together to draw and label an animal cell, and a bacterial cell. The concepts of normal flora, infectious diseases and how bacteria are beneficial in the environment will be introduced.

Presenting new information: How will you present your lesson? Is there a way to appeal to different learning backgrounds and styles?

We will use 4 mini-lectures (bacterial anatomy, replication, growth parameters and cell wall structure) with appropriate overheads and pictures. We will discuss all concepts that are presented in our small groups. We will also talk about the scientific method, and help students to design experiments by proposing a hypothesis and finding ways to test it. We will use experiential learning in lab to teach students microscopy skills and how to make Gram stains. We will ask students to draw what they see, explain what they have learned to their parents (see homework) and explain what they have learned to the people who come to see their posters to facilitate visual, experiential and auditory learning.

Practicing, applying and/or processing learning: Once you have presented the new information, how will your students use it?

Students will use what we have taught them as they design their experiments, collect their samples and do staining and microscopy in the lab. They will use their new knowledge to explain their work to their teachers and peers.

Assessment/Closure: How will you know that your students have understood the concepts? How will you test whether they have learned the skills? Can your students understand/do what you set out to teach them?

We will have students do 2 homework assignments. One will be to write a journal entry explaining how they asked a friend or relative what they already know about bacteria, and describing how they taught them something new. The other homework assignment will be to write the materials and methods section for their poster individually so they can see whether their group mates could reproduce their work by reading the section (they will be able to share and combine their homework for the real posters).

We will ask students to do Gram stains and focus the microscopes in lab so we know that they can do it. Our material will be included in their next mid-term exam, and we will ask for the results. We will also assess how much our students have learned by observing and listening to their poster presentations.

Attachments (not included here – college students were required to provide references, a resource list, a glossary, and examples of student work as part of their final lesson plan.)

FIG. 1. An example of a Learning Partnership in Bacteriology entitled “Bacteria in Your Environment.” Bacteriology is a junior-senior level biology major elective course.

Format: College students planned this Partnership as a 5-session unit on cell biology. Each class session was 80 minutes long. They collaborated with a sixth grade teacher to determine the content. They brought microscopes to the middle school, and later helped the teacher write a successful grant to obtain a microscope for her classroom. The college students handed in detailed lesson plans for each of the five days. The teacher still uses the unit as part of her curriculum, and has shared it with colleagues at another middle school.

Session 1

Introduction to Microscopes: Using light and dissecting microscopes we will give each student an opportunity to become comfortable and enjoy using the microscopes. We will give a brief introduction on what microscopes do and how to use them (and how not to). We will then break into 4 groups of 6 students and spend the rest of the class period using the scopes. Each scope will have something different to look at (single celled organisms, blood cells, bread mold, etc.), and each student will be asked to draw what they see. We will spend 15 minutes at the end of class reassembled as a large group, and will ask students to share what they saw and what they thought about working with microscopes.

Session 2

Introduction to Cells and Their Parts: We will introduce plant cells and animal cells and their most important organelles. We will talk about cells as small units of life, and the concepts of single versus multicellular organisms. We will talk about what people need to live, and then draw connections between what we need and what single-celled organisms need. We will spend the second half of the class helping our groups make models of cells using beans, noodles, straws, Popsicle sticks, paper, plastic bags, etc.

Session 3

Tissues: We will talk about how there are different kinds of specialized cells that work together to form tissues and organs. We will use Legos to demonstrate this concept. We will spend the second part of the class looking at tissue slides under the microscopes and making cheek cell slides stained with methylene blue. We will have the students draw and describe what they see.

Session 4

Other Types of Cells: We will talk about other kinds of cells (plant and prokaryotic). We will look at pond water and onion cells, under the microscopes, and talk about how these cells are the same and different from each other.

Session 5

Assessment: We will spend the first part of class administering a quiz on what we have taught the students about cells. We will spend the rest of the class helping students put the drawings they have made together into booklets, and helping them complete any unfinished drawings. The book will be counted more heavily than the quiz when the teacher calculates their final grades on this unit.

FIG. 2. An example of a Learning Partnership in Learning and Teaching Biology entitled “Cells and How We Look At Them.” The course is a beginning-level majors and nonmajors course that satisfies a general education requirement. First-year students comprised about half of the class.

dents liked participating in the Learning Partnerships and found their participation an effective way to learn biology.

In the example presented in Fig. 1, high school students were given a pretest at the beginning of the Partnership to assess what they knew about bacteria, microscopes, and the scientific method. Students scored an average of 27% on these tests. When similar questions were asked as part of the next midterm exam after all four sessions of the Partnership, students scored an average of 86% on that portion of the test.

We polled the participating high school students before and after they participated in the Partnerships regarding whether or not they were considering applying to college. Before the Partnerships, 55% said they were considering college. After the Partnerships, 74% reported that they were considering college.

Teachers. After completing the Partnerships, all participating teachers were asked to respond to the questions presented in Table 4. All of the teachers evaluated the Partnership as useful to their students' learning. Ninety-one percent considered the Partnership worth their time and effort, and 100% said they would be willing to participate in a Partnership again.

Teachers were also asked to evaluate the work of the Bates students and the interest of their own students in the Partnerships on a scale of "poor" to "great" (Fig. 3). In gen-

eral the teachers were pleased with the performance of the Bates students and with the quality of the lessons they delivered. The teachers also reported a high interest level among their own students.

DISCUSSION

In order to assess the value of Learning Partnerships between college and younger students in the context of an undergraduate class, it is important to consider whether this type of exchange provides educational or other benefits for students. Is this kind of partnership beneficial enough to warrant the considerable time and energy spent? At this point it is somewhat difficult to assess the outcomes quantitatively. Without control groups of middle and high school students, it is not possible to determine the exact contribution that the Partnerships make to the learning of specific content. To address this issue I have begun to work with one of the high schools to use Learning Partnerships for some units of their integrated curriculum while teaching the same material to parallel groups of students using more conventional methods. Nevertheless, the data gathered so far and our collective observations suggest that Learning Partnerships are valuable to college students, teachers, and younger students.

Most of the participating college students considered the partnerships very valuable to their own learning. On av-

TABLE 1. College student evaluation responses and selected comments from students in Bacteriology and Virology who participated in optional Learning Partnerships

Question	Answer ^a		Comments
	Yes	No	
Was the group learning format a good experience for you?	100	0	<ul style="list-style-type: none"> • Absolutely—it was like a study group. • I don't think there is any other way to learn science. • What one of us didn't think of, another did.
Do you think you learned a significant amount of biology from the Learning Partnership you participated in?	100	0	<ul style="list-style-type: none"> • I learned more about the stuff I already knew. • Yes, because we had to think about questions we might be asked, and know enough to answer them! • We were helping our teacher, so we had to know what we were talking about.
Do you think you will remember the content of the lesson you participated in better than you would have if you had only studied it for an exam?	93	7	<ul style="list-style-type: none"> • Learning for a test you forget material you don't use. We USED this material. • Yes because I studied it more. • I learned it differently—in a more meaningful and connected way. • I'll remember this stuff for a long time!
Overall, was the Learning Partnership a valuable experience for you?	100	0	<ul style="list-style-type: none"> • Yes—I learned how hard it is to teach! • We wished we had met college students when we were in high school, so we felt this was very worthwhile. • We were surprised how hard our students worked to make us proud of them.

^a Percentage of students, n = 15.

TABLE 2. College student evaluation responses and selected comments from students in Learning and Teaching Biology who participated in required Learning Partnerships

Question	Answer ^a		Comments
	Yes	No	
Was the group learning format a good experience for you?	96	4	<ul style="list-style-type: none"> • For the most part, yes. It is easier to learn together. • I liked having education majors in my group. • I especially liked that we all did what we were good at.
Do you think you learned a significant amount of biology from the Learning Partnership you participated in?	93	7	<ul style="list-style-type: none"> • I learned the content in AP biology, but I saw it differently for this. • Yes—I hated science and now I like it because I see that it is hard for everyone. • I don't know, but it sure was fun!
Do you think you will remember the content of the lesson you participated in better than you would have if you had only studied it for an exam?	89	11	<ul style="list-style-type: none"> • I'm not sure, but probably. • Yes because as we planned our lab, we thought of many more things that were important to help others understand better. • This is so different from learning for an exam, but I know I will remember it better.
Overall, was the Learning Partnership a valuable experience for you?	96	4	<ul style="list-style-type: none"> • This was valuable in so many ways. • I never thought I would like teaching, but I loved this. • Yes—I used to hate science, and now I almost like it.

^a Percentage of students, n = 28.

erage, more than 90% of all participating students answered “yes” to questions designed to assess student perceptions of the value of their participation (Tables 1 and 2). Not surprisingly, the percentage of “yes” answers to every question was slightly higher in the group who volunteered to participate compared to the group for whom participation was mandatory, but most responses were positive. It is possible that the students who chose to participate in the former case, or chose to take the course in the latter, were also likely to consider the experience valuable.

All the participating students spent a great deal of time on their Partnerships. They reported spending an average of 4 to 5 hours a week planning, preparing, or delivering lessons. This time was all out-of-class time and certainly could have been spent studying material for exams, but all of the participating students felt that they gained as much or more from participating in the partnerships as they would have from only studying course content. Many participants suggested that the opportunity to test their own knowledge, concepts, and skills in a forum that allowed modification and improvement over time ensured that they would retain far more than had they learned the same material in more traditional ways. I wondered whether spending time on the Partnerships actually took away from study time, so in the upper-level courses I compared the grades on the final exams of the

students who participated to the grades of those who did not. Students who participated received the same average grades on the final exams as those who did not.

There were differences between the level of involvement I was required to have in the Partnerships depending on whether the participating college students were junior and senior science majors or less experienced students. The upper-class students with more science experience required help, but not as much help with content. The less scientifically experienced and often younger college students required quite a bit more help with scientific content as well as logistics. I was impressed, however, by the level of engagement and motivation that the younger college students developed, and felt that the time I spent helping them understand the content they were putting into their lessons was valuable in many ways. Our meetings allowed these students to ask questions about any of the course content that they did not understand and created a culture of active questioning in and out of our classroom. I got to know these students and have kept in touch with many even though most did not major in science. I also felt that encouraging the younger students to assume responsibility for their own learning early on in their college years through participation in a Learning Partnership set a good precedent, and gave them time to seriously consider and perhaps take courses to prepare for a

TABLE 3. Evaluations and selected comments of high school and middle school students who participated in required Learning Partnerships

Question	Answer ^a		Comments
	Yes	No	
Was the group learning format a good experience for you?	92	8	<ul style="list-style-type: none"> • I like working with my friends. • When I don't know something, somebody else does. • I liked asking the college students hard questions.
Do you think you learned a significant amount of biology from the Learning Partnership you participated in?	93	7	<ul style="list-style-type: none"> • Yes, the Bates students explained things well. • We learned that bacteria are everywhere but not all of them make you sick. • I learned a lot and it was fun! • More than ever.
Do you think you will remember the content of the lesson you participated in better than you would have if you had only studied it for an exam?	88	12	<ul style="list-style-type: none"> • When we do hands-on things we remember them longer. • Definitely—I hate exams. • I will remember how to design experiments—I would probably not remember that for an exam. • I will remember what those plates looked like for the rest of my life!
Overall, was the Learning Partnership a valuable experience for you?	98	2	<ul style="list-style-type: none"> • I got to see Bates College for the first time. • The Bates kids rock! • We got to use really good microscopes that we don't have in high school • Liked learning about what college classes are like. • Yes, yes, yes, thank you Bates students!!!!!! • Yes, I loved every minute! Even our teacher had a good time!

^a Percentage of students, n = 106.

career in teaching.

It seems clear that the middle and high school students benefited. The Learning Partnerships enriched their curriculum and offered many opportunities for learning and growth. The younger students visited Bates, had undergraduate role models and mentors, used equipment in the college's labs, had a hand in constructing their own knowledge as they did science in a new context, and presented their work in a public forum. Their level of enthusiasm and academic engagement dramatically increased as the projects went on. The fact that there was an increase in the number of students who said they would consider going to college is certainly a good outcome, and one that can be further assessed as these students progress in their education. Some of the parents who attended the Bates research symposium to see their child's poster had never been on the Bates campus before. All were given the opportunity to sign up to receive the Bates monthly calendar of events, and many said that they would be more likely to take advantage of concerts and other public events in the future.

The teachers who participated in the Learning Partnerships reported that they looked forward to the Bates students' visits as much as their classes did. The extra "adults" in their classrooms offered opportunities for small group dis-

cussions, lab groups, individual help, and special projects that would not otherwise have been possible. Teachers were enthusiastic about bringing their students to Bates and reported that their students gained a better understanding of the "real" process of science and college life. The lesson plans that students produced were evaluated, revised if necessary, and returned to their teachers to be used in future classes and shared with colleagues. The lesson plans have been collected and made available to other teachers as well. Several teachers invited the Bates students to continue their Learning Partnership after the semester ended. Some Bates students have returned to their original teacher's new classes from year to year and have introduced other Bates students to their teachers so that new Partnerships have formed.

The Learning Partnership model seems to lend itself to what DebBurman refers to as "Pedagogical Transferability" (7) in that it can certainly work in any discipline, in a variety of contexts. Even in large classes, offering the option of one or a few Learning Partnerships gives students the opportunity to experience teaching and to contribute to the community without an overwhelming time commitment on the part of the professor. Exposing undergraduates to teaching so that they might consider making it their career is worthwhile, especially in light of the shortage of sciences and mathematics teachers.

FIG. 3. Teacher evaluations of college student performance during Learning Partnerships. Teachers were asked to rank each student group's preparation for class or lab work (white bars), the professionalism of the group members (stippled bars), the scientific accuracy of all presentations (black bars), and the interest level of their own class (striped bars) on a scale of "poor," "fair," "average," "good," or "great." Bars represent the number of teachers giving each response.

TABLE 4. Evaluation responses and selected comments of high school and middle school teachers who participated in Learning Partnerships

Question	Answer ^a		Comments
	Yes	No	
Was this Partnership useful to your students' learning?	100	0	<ul style="list-style-type: none"> • Most definitely—they learned about college, college students, and cells all at the same time! • Yes. I was amazed what they remembered by the time the exam came around. • It was nice to see how my students responded to the Bates students—they were eager to learn! • Yes. They could finally see what a real science lab is like.
Was it worth your time and effort?	91	9	<ul style="list-style-type: none"> • At the beginning it was difficult to connect with the Bates students, but we worked it out. • Absolutely! The Bates students helped me teach something that I would not have otherwise tackled. • Definitely—the break of not having to teach even a few classes gave me some time to think and observe my students in a different way.
Would you do it again?	100	0	<ul style="list-style-type: none"> • In a minute! • Yes, and I hope I can do it again soon! • Yes, we are going to do it again next term with a new class of high school students. • I wish I could do it every year! • Yes. And knowing what we know now, I think it would be even better!

^a Percentage of teachers, n = 11.

When undergraduates interact with younger learners, both groups gain an appreciation for what they really understand and what they do not know. The partnerships allow college students to explore more science in more ways and to cross disciplinary boundaries. They enjoy the satisfaction of sharing their expertise and experiences and of interacting with younger students and teaching professionals. Teachers appreciate help. Younger learners enjoy the mentoring of a group of students not so much older than they and gain some understanding of what a college education offers. Ideal partnerships are mutually beneficial (1), and partnering college students with middle school and high school classes seems to approach the ideal.

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