Higher Education Faculty Collaboration With K–12 Teachers as a Professional Development Experience for Faculty

By Sarah Knowlton, Jay Fogleman, Frieda Reichsman, and Glênisson de Oliveira

We report on the potential of higher education science faculty involvement in a K–12 scientist–teacher partnership as a source of faculty professional development (PD). Participating higher education science faculty members were paired with middle or high school science teachers to create online, technology-enhanced curricular materials in a range of disciplines for middle and high school science classes using innovative, open-source software created for the project. The same pairs designed and taught associated PD workshops to participating in-service teachers during a summer institute. The activities and professional development cover Earth and space science, physical science, and life science. Survey results on higher education faculty involvement, and attitudes indicate that this process represents a valuable form of faculty PD. It also provides a foundation for future collaboration and network building.

There is a growing concern about how best to support students entering college to pursue and succeed in coursework in science, engineering, and mathematics (STEM). This need has also drawn attention to how science professors are developed as educators as well as researchers. Faculty members are engaged in many different kinds of professional development (PD) related to teaching, such as faculty center workshops and courses that range from several hours to several days in length (e.g., Ebert-May et al., 2011; Erickson, Brandes, Mitchell, & Mitchell, 2005; Henry, 2010; Sunal et al., 2001). Studies have described factors that enable or impede faculty involvement in PD and represent barriers to change (Caffarella & Zinn, 1999; Sunal et al., 2001). In this article, we report on a scientist–teacher partnership that serves as a PD opportunity for participating higher education faculty members.

There has been a significant amount of research and theorizing regarding effective strategies for professional development of teachers and professors. Many have recognized the situated nature of most adult learning and have called for learners to engage in meaningful tasks within a supportive discourse community where individually held meanings can be shared and refined (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Putnam & Borko, 1997). Community- and partnership-based PD opportunities have also been recognized as effective sources of faculty dialog and growth (Bianchini, Hilton-Brown, & Breton, 2002; Wineburg & Grossman, 1998). The collaborations between scientists and teachers have long been recognized as excellent sources of teacher PD (Briscoe & Peters, 1997; Loucks-Horsley, Stiles, & Hewson, 1996; Tanner, Chatman, & Allen, 2003; Willcuts, 2009); however, the learning opportunities within these partnerships for higher education faculty have not received the same attention.

The higher education science faculty–teacher collaboration presented here was part of the Rhode Island Technology Enhanced Science (RITES) project, a 5-year, National Science Foundation (NSF) Math and Science Partnership project, which includes most of the state's school districts. RITES assembled Resource Teams (RTs) to develop materials for middle and high school students featuring technology-rich activities incorporating strong science inquiry practices to help achieve the goal of improving the quality of science teaching and learning across the state.

RTs consisted of a community of higher education faculty/scientists, a subset of the middle and high school (referred to as G5–12) teachers involved with the project, and project staff. The RT structure included a community leader, three RT subgroups (Earth and space science [ESS], life science [LS], and physical science [PS]) parallel to the state grade-span expectation categories, and project staff and faculty (Figure 1). The community leader and ESS, LS, and PS RT leaders were higher education faculty who were contributing members of the project leadership or project staff. Within the three RT subgroups, a higher education faculty member and G5–12 teacher were recruited and paired (RT pairs), each member bringing unique content and pedagogical knowledge to the team. The separate RT pairs developed a curriculum supplement for middle and/or high school students called an investigation and cotaught the associated summer two-and-a-half-day short-course workshop to in-service teachers. The support environment for the RTs included examination of K–12 standards and background educational research, online supports (e.g., screencasts, descriptions, timelines, examples) and templates (e.g., structure of the investigation and short course), and technology support.

Investigations consist of a sequence of inquiry-rich activities for middle and high school students on a particular topic, designed and delivered using the RITES investigation software created by the Concord Consortium. Students collect data through simulations, a variety of Vernier or PASCO probes, and by visiting websites that compile or release data. Data analysis is conducted within the investigation software, and student work is saved and stored in the cloud (Figure 2). The short-course workshops were two and a half days in length (15 contact hours) and focused on a particular investigation. In addition to details about the investigation, short courses included relevant background science content and activities for middle and high school students not included in the investigation. The RT pairs used aspects of research-based design for teacher PD to strengthen teacher mastery of content and standards (e.g., Birman, Desimone, Porter, & Garet, 2000), such as active learning, collegial discussion, and opportunities for reflection.

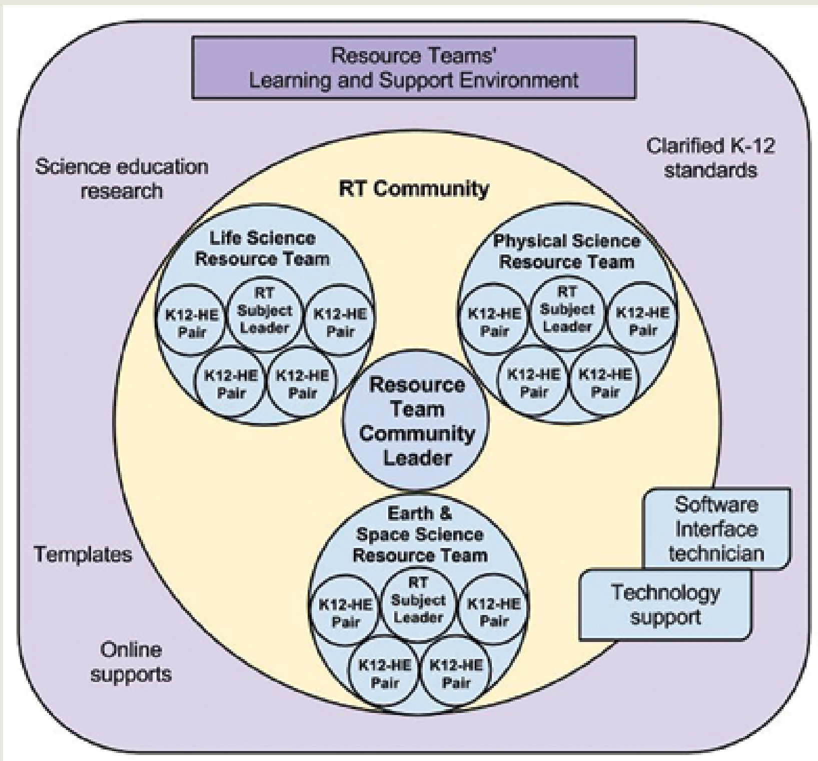
The RT pairs worked together over approximately 6 months. These teams were formed between February and March each year, and the work was completed in August of the same year when the short courses ended. Each RT pair decided on a standard to address, researched the relevant literature and existing online interactive activities, designed curricular materials, and prepared and taught the associated short course. This design allowed the RT pairs an extended period of time to work on a well-defined task. A representative example of one team's collaborative process is shown in Figure 3. In addition, pairs were supported by all-RT community meetings to discuss specifics of investigation and short course design. These meetings focused on connecting K–12 standards and assessments (e.g., the New England Common Assessment Program) with particular investigation topics, exploring and demonstrating effective research-based pedagogy, and supporting such teaching using the interactive features of the RITES activity software. In between the all-RT meetings, the ESS, LS, and PS RT leaders periodically met with their teams to focus on content and setup of investigations designed by the pairs within the group.

Over a 3-year period, 28 higher education faculty and/or researchers representing five Rhode Island institutions of higher education, including both 2- and 4-year schools, and 22 middle and high school teachers representing 12 school districts in the state participated in the RT process to develop materials in 24 different content areas. RT members were paid by the project for their participation.

After the third year of the 5-year project, the RT process was evaluated

FIGURE 1

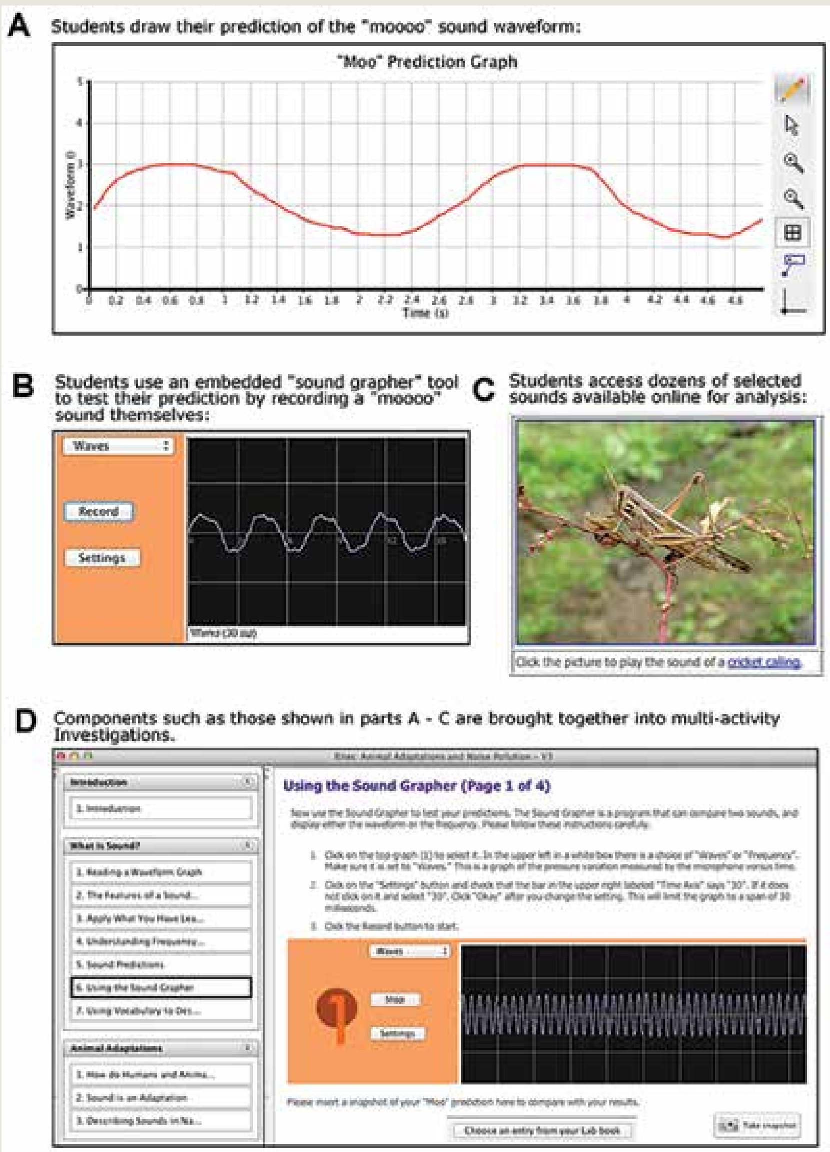
Structure of the Rhode Island Technology Enhanced Science Resource Team (RT). HE = higher education.



from the perspective of RT members, with particular attention to higher education faculty–teacher collaborations and the attitudes held by the university faculty population. We used two online surveys to determine the participants' experiences within their RTs, one directly after the experience (Survey 1) and one a year later (Survey 2). Survey 1 included approximately 25 items with some variation depending on the respondent's role, and Survey 2 included 8 items. Survey questions relevant to this article are presented in tables and figures where the results are reported (Survey 1: Tables 1–4 and Figures 4, 5, 6a, and 7; Survey 2: Table 5 and Figure 6b). Survey questions were vetted by the researchers to minimize response bias. We sent the survey to all 25 RT team members who were involved in development of investigations and short courses between February and August 2011. We distributed Survey 1 via a website link within an e-mail message in October 2011. Responses were anonymous, though we asked respondents to identify themselves as higher education faculty or G5–12 teachers. We received 21 responses (84% response rate), including 11 higher education faculty members and 10 G5–12 teachers, during a 2-week period. Some respondents did not answer all survey questions, resulting in fewer than 21 responses for some of the questions. Survey 2 was also anonymous and sent out to the same 25 people through an e-mail link one year later, in October 2012, to investigate sustainability of the partnership and impact of the experience after some time had passed. We received 15 responses, including five higher education faculty members and 10 G5–12 teachers.

FIGURE 2

Example of Rhode Island Technology Enhanced Science investigation created by scientist–teacher Resource Team pairs. Online investigations software includes interactive elements where students can make and test predictions, including (A) tables, drawing tools, prediction graphs; (B) interactive models and multiple-choice and open-response questions; (C) access to other online resources; and (D) access to multiple activities on a particular topic.



Results and discussion

Impacts on higher education faculty

Because the investigations and short courses involved development of materials in addition to dissemination of science content knowledge by higher education faculty, learning opportunities were available for faculty at many different points in the project and in a number of different areas (e.g., Figure 1, Figure 3). For example, faculty were exposed to new pedagogy and learning strategies for students, examined middle and high school science standards, and gained an understanding of the realities involved with teaching at the middle and high school levels.

Higher education faculty reported via survey that their RT work was a valuable professional experience (Figure 4), especially with regard to an enhanced awareness of K–12 education (Table 1). Although more than half of the higher education faculty had participated in outreach activities before working on a RT (Figure 5a), almost all of the faculty participants expressed an interest in further outreach activities following their RT experience (Figure 5b). Additionally, a number of higher education faculty indicated that aspects of their research were incorporated into the investigations and short courses, a valuable outreach opportunity (Table 2). Professors were also able to convey directly to teachers what is expected of students at the college level.

The impacts of RT participation on higher education faculty's teaching were also positive. Fifty percent reported positive changes in use of technology and inquiry in their college classes (Table 1), and 90% felt that the approaches to science learning used in investigations could be adapted for use at the college level (Figure 6a). A year after participation on a RT, four out of five faculty members reported that they had developed new material for their college classes *as a result of work on a RT* (Figure 6b). These results demonstrate the impact of this experience. Previous research on science teaching at the university level has indicated that faculty methodology changes primarily when they are dissatisfied with their existing conception of science teaching (Sunal et al., 2001).

We recognize that our study group is small, and we acknowledge limitations associated with self-reporting (e.g., Ebert-May et al., 2011). The nature of an anonymous survey also makes it susceptible to response bias (i.e., the possibility that the survey respondents were not representative). However, the fairly high response rate for Survey 1 (84%) and the high level of involvement by higher education faculty in project events, such as NSF site visits and community roundtable discussions, support the generally positive outcomes found by our survey.

FIGURE 3

Example of workflow design by Resource Team (RT) pair on radioactivity, demonstrating important elements of the 6-month partnership. RITES = Rhode Island Technology Enhanced Science.

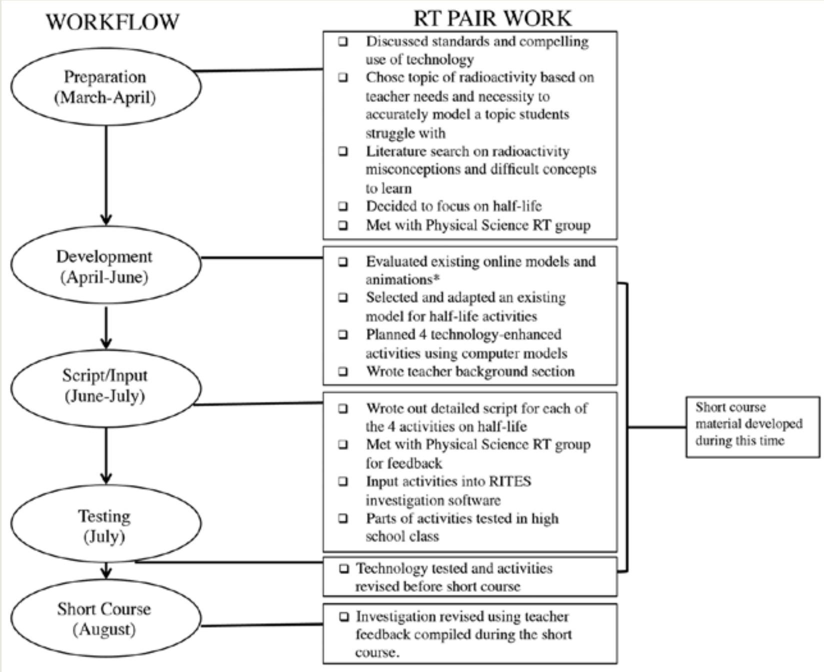


FIGURE 4

Percentage of survey respondents who felt that "Working on a Resource Team was a worthwhile professional experience," from Survey 1.

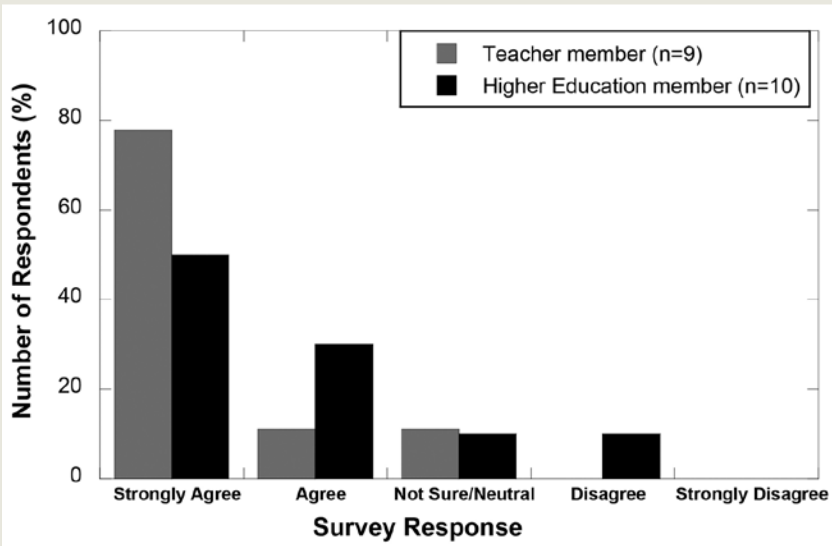


FIGURE 5

Percentage of higher education faculty involved in K–12 educational outreach projects (a) *before* and (b) *after* (anticipated) participation on a Resource Team (RT; *n* = 10, Survey 1).

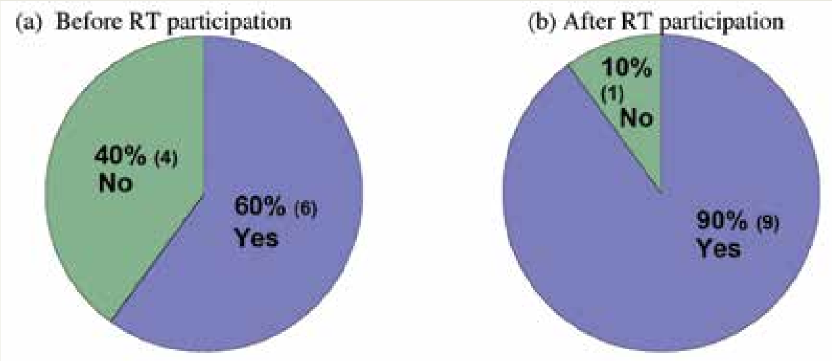


TABLE 1

Higher education faculty survey responses regarding changes in views and opinions resulting from work on a RITES Resource Team (*n* = 10*).

Response	Positive/ favorable change	No change	Negative/ unfavorable change
Use of technology in my classes	5 (50%)	5 (50%)	0 (0%)
Use of inquiry methodology in my classes	5 (50%)	5 (50%)	0 (0%)
Understanding of incoming college student background	4 (40%)	5 (50%)	1 (10%)
Understanding where I can contribute to K–12 education	7 (70%)	2 (20%)	1 (10%)

Note: RITES = Rhode Island Technology Enhanced Science.
*Questions are from Survey 1.

TABLE 2

Higher education faculty survey responses on sharing their research (*n* = 10*).

Response	Extensively	Somewhat	Very little	Not at all
Were you able to bring aspects of your research (or other "hot" topics in your field) to G5–12 classrooms through your [project] investigation?	2 (20%)	7 (70%)	0%	1 (10%)
Were you able to share your research (or other "hot" topics in your field) to the teacher participants in your short course?	2 (20%)	7 (70%)	1 (10%)	0%

*Questions are from Survey 1.

Partnership

For scientist–teacher partnerships to be successful, participants must make a significant investment, the capabilities of each participant must be valued, and there must be a mutual benefit (Loucks-Horsley et al., 1996). Scientist–teacher partnership was one goal of the RT experience, and both faculty and teachers expressed the value of a situation in which both members of the pair shared important and unique contributions. Though both groups contributed significantly to all parts of the investigation and short-course design, in general teachers saw their role as designing the investigations to be grade appropriate, and higher education faculty saw their role as ensuring that the content was accurate and current (Table 3). Nevertheless, by recognizing and valuing each other's expertise, the teams appeared to avoid the pitfalls of a top-down model of communication.

To support their joint work, RT pairs used a variety of communication and collaboration methods. They reported that they communicated most often in face-to-face meetings and e-mail exchanges. Phone meetings were used less often, and electronic conferencing and collaborative word processing (e.g., Google docs) were used sporadically. They reported that they worked with their partner about half the time and worked independently half the time. Only two of 21 RT members reported working primarily independently. RT pair collaboration was noteworthy, considering that investigation development time over the 6-month development period was significant: 50% reported spending 40–80 hours and 30% spent 80+ hours. Short-course development time was less, though still substantial, especially considering the development time reported did not include the time for teaching the course: 67% spent 20–60 hours, and 19% spent 60+ hours.

Both higher education faculty and teachers reported that working with their partner was a highlight of the experience, even when considering the challenges faced by doing much of the work during the busy academic year (Table 4, Figure 3). Additionally, it is important to note that one year after working on a RT, over half of the respondents continued to communicate with their partner at least every 3 months (Table 5). The continued communication suggests these partnerships may be a foundation for lasting professional relationships and represent a sustainable aspect of the project.

Implementation of the collaborative model

Because of the multifaceted nature of the RT process, we found that there was a strong need for supports for the teacher–higher education partners. These supports required considerable staff resources to manage activities, such as organizing groups, developing templates for investigation elements, evaluating and providing feedback on products developed by teams, and coaching on use of technology. Our survey indicated that many forms of support were used: the project website, information sheets, face-to-face supports (e.g., large and small group meetings and discussion with group leader), and task-specific (e.g., templates) supports. However, survey responses indicated that the face-to-face and task-specific supports were deemed most helpful.

Conclusions

Authentic faculty development efforts often revolve around fostering collegial relationships that provide participants with access to new perspectives and expertise. The teacher–higher education partnership described here provided opportunities for the higher education faculty to develop in several ways. Overall, faculty reported that they were able to (a) use their knowledge and passion about science to contribute to teachers' knowledge and science content in the classroom, (b) build a relationship with a teacher in which both partners contribute unique and valuable strengths, (c) learn about issues faced by their G5–12 colleagues, (d) appreciate the background of students entering college, (e) share aspects of their research with G5–12 teachers across the state, and (f) use what was learned to create new or revise existing college-level materials. Teachers and higher education faculty reported overwhelmingly that working one-on-one with their partner to complete a common task was a highlight of the experience. These benefits suggest that there are numerous incentives for faculty to be involved in educational outreach opportunities involving partnership with a teacher.

The importance of providing higher education faculty with this type of learning experience is growing. Implementation of more ambitious standards such as the *Common*

TABLE 3

Sample of Resource Team members' comments regarding their key contributions to investigations and short courses and their roles within the partnership from Survey 1.

Higher education faculty comments:

- This was a team effort. I provided more scientific background, whereas my team member provided more high school teaching pedagogy background.
- I provided the scientific expertise on the topic and suggestions for what activities might fit the investigation. I also found and vetted the web animations. In the short course I designed the material to be covered and created most of the [science] content of the course.
- I was the content expert, with some expertise on inquiry-based education.
- My primary role was to highlight key concepts and provide data.
- I thought my role would be primarily as a consultant on the scientific content and that I would rely on my partner to lead the development of the investigation.
- I thought I would mainly be providing content knowledge and doing less of the design of the investigation and short course.

G5–12 teacher comments:

- I brought the perspective of the classroom teacher to the investigation. I felt empowered to write/revise to meet the needs of middle schoolers. I was able to ensure that the investigation was age appropriate and that it would appeal to an array of learners.
- [My role was to] adapt the information to be useful for middle school age kids. In other words, translating college-level information into something that kids could understand.
- My key contribution was looking at the models/questions we developed through the eyes of the teachers and students who would use the investigation to learn a concept in a new way, analyzing words or questions and design of the model with regard to implementation in high school classrooms.
- My role was to work collaboratively with a higher education person as the middle school "voice."
- I feel that the teacher brings a sense of what will work within the confines of the classroom and a sense of age appropriateness to the investigation.

Core State Standards (NGAC and CCSSO, 2010) for mathematics and the *Next Generation Science Standards* (NGSS Lead States, 2013) present a need for K–12/higher education collaboration (e.g., Kumar, 2013). The RT model developed by the project describes a promising collaborative PD model that includes scientist–teacher partnerships, which can allow faculty to contribute to K–12 education, and provides K–12 teachers with a chance to collaborate with and inform practicing scientists. By providing experiences that are mutually beneficial, it is more likely that scientist–teacher partnerships can thus serve as an essential bridge for supporting STEM students and as a foundation for sustained K–12/higher education collaboration. As the pressure increases at each level of our educational system to meet the needs of all students, it is essential to cultivate the capacity of faculty members to better understand and to help address these needs. ■

TABLE 4

Sample of comments regarding the teacher/higher education faculty partnership from the Resource Team member, Survey 1.

Higher education faculty comments:

- I found working with a teacher partner particularly rewarding.
- The partnership with the K–12 education specialist was extremely valuable in helping to inspire future outreach collaborations.
- I enjoy working with in-class teachers. I always learn so much watching them.

G5–12 teacher comments:

- I felt that by working with higher ed[ucation faculty] I was able to dramatically increase my background knowledge of the subject matter. My partner shared additional resources with me that helped to broaden/strengthen my knowledge. Not all of the provided materials were necessary to the exact content of the investigation. Some of it was just a strengthening of the general topic.
- Countless conversations with my higher education colleague gave me a much better perspective on the expectations for my students' next level of education (postsecondary).
- It was extremely gratifying to work with a higher education professional who shares very similar beliefs and values about education (as I do).
- The higher education collaboration was especially rewarding, well beyond the design of the investigation itself and development of the short course. I have few opportunities for team teaching and found this opportunity extremely valuable—two heads are better than one!
- The experience of collaborating with a higher education person was invaluable. We have since presented our short course as a two-hour session to science teachers in my district, with positive feedback. Overall developing an investigation and accompanying short course has been a rewarding professional experience for which I am thankful I was afforded the opportunity.

TABLE 5

Communication with Resource Team (RT) partner one year after RT experience (*n* = 15*).

Frequency of communication	Response
Once a month or more	6 (40%)
Every 3 months	3 (20%)
Every 6–9 months	3 (20%)
Once a year	1 (7%)
Do not communicate	2 (13%)

*Question is from Survey 2 (follow-up survey).

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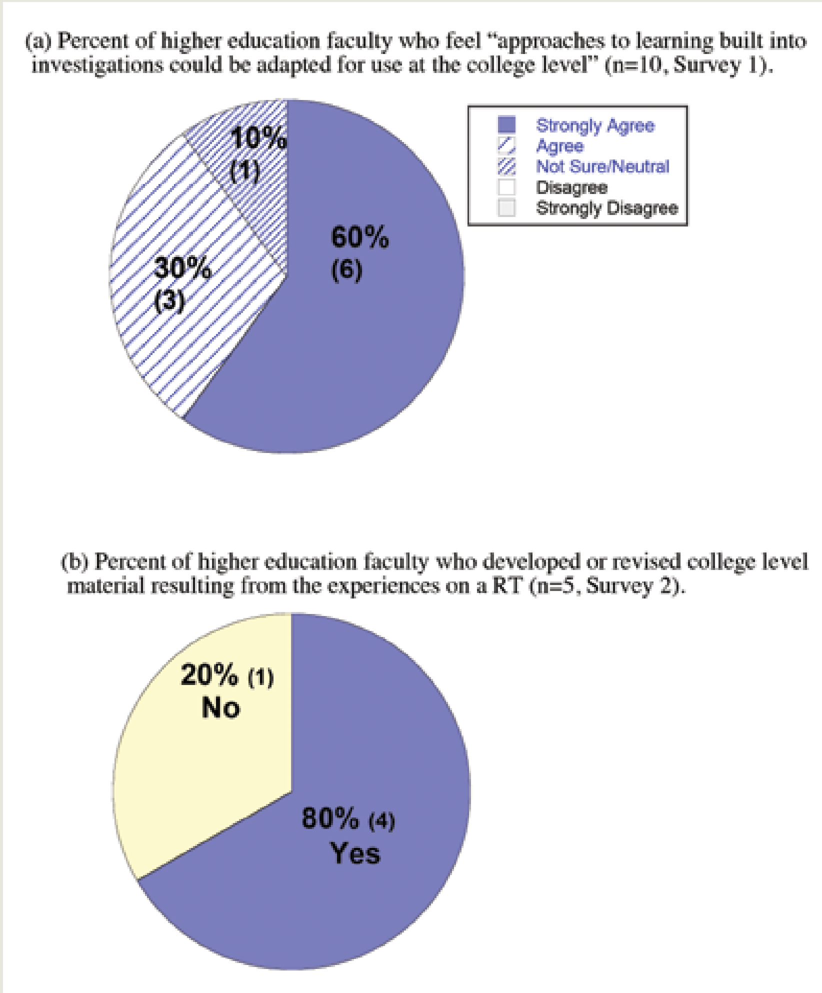
FIGURE 6

Impact of Resource Team (RT) work on higher education material.



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