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Developing Collaborative Solutions to Teaching Challenges

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Abstract
The Solve My Problem professional development program was built upon evidence-based principles from Scientific Teaching (active learning, inclusivity, and assessment) and faculty learning communities (autonomy, competence-building, and connection). Over a four-week period, faculty worked in groups to collaboratively solve a shared teaching challenge. The virtual summer program was designed for faculty to develop implementable solutions. Participation and engagement were supported by maximum flexibility and minimal cost. At the conclusion of the program, each group shared the solutions, materials, and products they developed. Here, we describe the structure of this professional development experience and reflect on its impact and future.

Keywords
professional development; collaboration; faculty network; science education; workshop; higher education; group work; Scientific Teaching

Introduction

In spring 2021, our faculty colleagues across the country were experiencing a wide variety of concerns as they approached the third academic year since the onset of the COVID-19 pandemic. To support science faculty through this difficult time, we leveraged our experience as active members of the National Institute on Scientific Teaching (NIST; formerly Summer Institutes on Scientific Teaching) to create a forum that would allow colleagues to share their concerns and collaboratively develop solutions to the challenges they were facing.

As faculty prepared for the 2021–22 academic year, they faced a range of problems, some of which were directly related to the impact of the pandemic on higher education and others that were perennial (Flaherty, 2020). After a year and a half of remote learning, students were grappling with mental health difficulties, a loss of learning experiences (e.g., hands-on laboratories), and lack of connection with fellow students and instructors (Ezarik, 2021). At the same time, many faculty felt stressed, overworked (both at home and in their work responsibilities), and isolated (Walsh et al., 2021). Beyond the particular difficulties arising from the pandemic, science faculty faced continuing challenges such as creating assessments for large enrollment courses, improving inclusivity, and managing student group learning in laboratories and lectures (Walsh et al., 2021).

Supports, such as a network of trusted colleagues and access to resources, are three times more important than real or perceived barriers for the implementation of evidence-based student-centered teaching practices (Bathgate, Aragón, Cavanagh, Waterhouse, et al., 2019; Bathgate, Aragón, Cavanagh, Frederick, et al., 2019). We set out to create a summer event to provide support by connecting science faculty from across the country. By creating a forum where faculty could support each other and collectively solve an educational problem, we hoped to capitalize on the power of a faculty network. We drew on the model of a faculty learning community in which a group of faculty meet regularly in an active, collaborative process to enhance teaching and learning, with “activities that provide learning, development, the scholarship of teaching, and community building” (Cox, 2004, p. 8). Successful faculty learning communities involve three elements: 1) faculty members have autonomy to provide direction for their own activities; 2) the learning community helps faculty develop their competence in specific pedagogical areas; and 3) faculty members build relationships with colleagues (Daly, 2011). Therefore, we designed the summer program to emphasize autonomy, competence-building, and connection.

Our experiences with NIST established a foundation for designing an evidence-based summer learning community for faculty. NIST has provided science education professional development workshops for faculty since 2003 (Pfund et al., 2009). Scientific Teaching, which encourages faculty to approach their teaching with the same rigor as they approach their research, is based on three pillars: active learning, assessment, and inclusivity (Handelsman et al., 2004). During week-long intensive summer institutes, educators attend professional development workshops and have opportunities to apply these three pillars in designing course activities. Much of the focus of this model includes group work with a trained facilitator who supports group development, dynamics, process, and product development (Chen et al., 2021). Data demonstrate that participation in a Summer Institute training program supports faculty implementation of evidence-based student-centered pedagogical practices and leads to positive student learning outcomes (Cavanagh et al., 2016; Cavanagh et al., 2018; Reeves et al., 2021; Wang et al., 2021). NIST has also hosted a range of smaller-scale workshops and weekly informal online discussions, and many alumni have gone on to teach pedagogy courses and lead other types of professional development. Over 5,000 faculty from over 200 institutions have participated in NIST programming since 2003.

In Summer 2021, we offered members of the NIST community an opportunity to work virtually with colleagues from across the country to address pedagogical challenges. We built on participants' shared knowledge of Scientific Teaching, a shared commitment to improving their teaching, and past experiences working collaboratively at NIST events. For the summer "Solve My Problem" (SMP), faculty were invited to submit problems they were experiencing in their own teaching. In small groups, participants collaborated over four weeks to tackle challenges of interest to them. Each group determined their own goals and created materials to share with the other participants. Overall, SMP represents a valuable model for educational professional development because it allowed faculty to work on problems of the greatest concern to them, build community, and prepare for the upcoming academic year.

Event Structure

As the organizers of the Solve My Problem (SMP) program, since 2003 we have collectively organized and facilitated over 50 Summer Institutes on Scientific Teaching, have taught pedagogy courses, led professional development programs, and implemented Scientific Teaching principles in our own courses. In developing SMP, we applied the principles of Scientific Teaching in a new context that was accessible to a diversity of faculty. The overall structure comprised:

1. an opening workshop,
2. a framework for small group work across four weeks,
3. a closing workshop in which groups could share their products, and
4. a follow-up meeting six months after the final workshop (Figure 1).

Each group was assigned a coordinator to help guide the process. The NIST evaluation committee collected participant post-event data to provide insights into future programming. All of these elements parallel the structure of the Summer Institutes on Scientific Teaching.

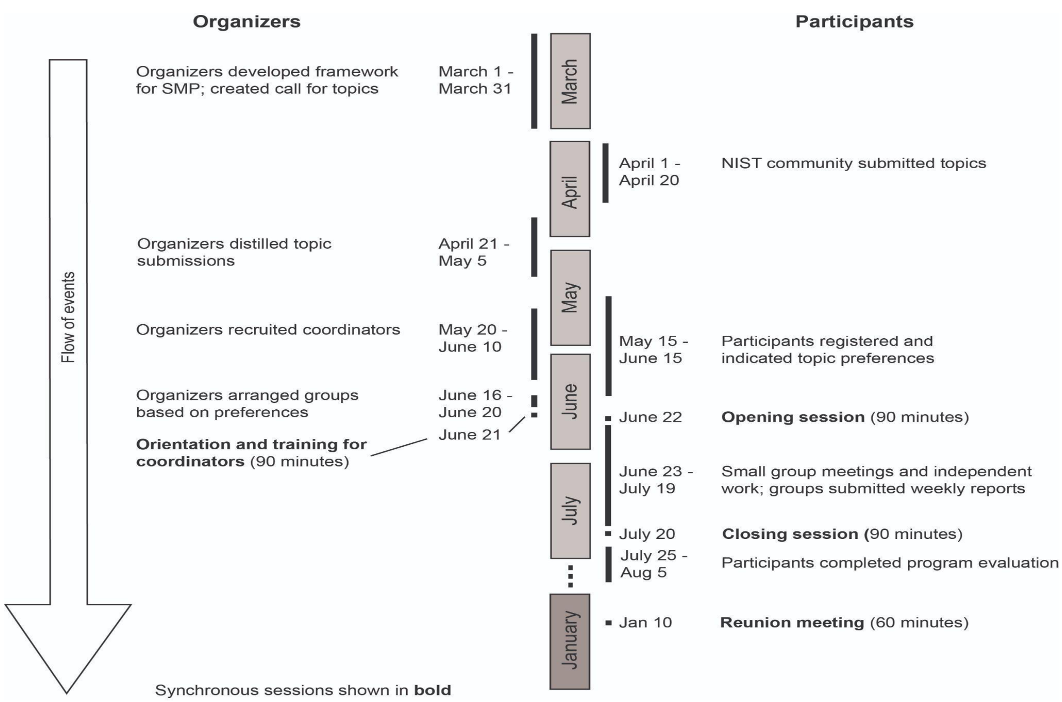

Figure 1. Timeline of organizers' (left) and participants' (right) activities for Solve My Problem.

The structure of Solve My Problem was designed to accommodate the following needs:

- *Substantive outcome:* SMP design ensured faculty would have a substantive outcome upon completion, such as materials, strategies, or activities that they could implement in their own courses or that could be adopted by other attendees.
- *Timing*: Faculty represented institutions with a variety of schedules and from geographically diverse regions across North America. Many faculty would be returning to in-person teaching in the fall semester of 2021, after an extended period of remote teaching. We scheduled SMP early enough in the summer so faculty would have time to revise plans for fall term and implement ideas that they developed during SMP; consequently, we chose four weeks from late June to late July 2021.
- *Flexible time commitment:* There was a specific start and end date, but all groups created their own schedules over the four-week period to produce the desired end product.
- *Cost:* We were able to offer the workshop at no cost to participants due to the technical and financial support from NIST. Although SMP was free to participants, we plan to collect a small registration fee in the future to fund honoraria for coordinators.

Our primary programmatic goal was for faculty to tackle challenges that were of personal interest; therefore, we wanted participants themselves to generate the topics. We solicited topics from the broader NIST community, providing three examples to model the types of questions and information that might be relevant. After receiving submissions from the community, we clustered similar topics and identified themes of interest to faculty from a variety of scientific disciplines.

Once themes were established, we considered how to best form groups for productive collaboration. We aimed for groups of five or six participants, which was large enough to have a diversity of ideas but small enough for participants to work together effectively (Wilson et al., 2018). When registering, participants indicated their topic preferences. We created groups based on these responses. For topics of high interest, we created multiple groups per topic, dividing faculty either geographically (for time zone purposes) or by discipline, when possible. Among the 82 participants, who represented 72 institutions (see Table 1 for demographics), we formed 15 groups covering eight topics: active learning (3 groups), assessment (1 group), grading (2 groups), group learning (2 groups), inclusivity in departments (2 groups), metacognition (2 groups), project-based learning (2 groups), and return to in-person learning (1 group).

Table 1

Solve My Problem Summer 2021 Participants' Campus Role

Position	Number of Participants	Percent
Adjunct Faculty	4	5%
Assistant Professor	8	10%
Associate Professor	5	6%
Professor	10	12%

Instructor/Lecturer/Assistant Teaching Prof.	21	26%
Senior Instructor/Senior Lecturer/Associate Teaching Prof.	16	20%
Senior II Instructor/Clinical Professor/Teaching Prof.	7	9%
Educational Developer/Center for Teaching and Learning	4	5%
Other	7	9%
Total	**82**	**100%***

*Adds to more than 100 percent because of rounding.

Participants were welcomed to the summer program at an introductory 90-minute virtual session. Organizers provided introductory remarks, including an overview of Scientific Teaching principles, guidance about the structure of SMP, and an example of a final project. Participants then met in their small groups for team-building activities and to define specific goals for their topic.

A coordinator was assigned to each group to support group progress and communicate with the organizing committee. Coordinators were individuals who had been actively involved with NIST, often as facilitators at previous professional development workshops. Coordinators were trained at a pre-event meeting that explored group dynamics (Brunt, 1993), case studies, and information about logistics and expectations. Additionally, organizers met with the coordinators at the midway point and shared feedback from participant weekly progress reports to help inform efforts for each subsequent week of SMP.

Solve My Problem group work was self-directed. Each group determined its own meeting frequency and schedule. This flexibility was important for participation, given the many demands on participants' time. We recommended that groups meet once per week and encouraged participants to work on their projects independently between group meetings. Groups were asked to complete weekly progress reports, which provided accountability for collaborative work, ensured that groups were meeting milestones, and provided organizers and coordinators with information to support groups as needed.

Each group refined the focus of their inquiry, developed a strategy to address the problem, and determined what product would be meaningful to them. As organizers, we developed a template for a final presentation and a model product; however, groups had flexibility in defining their goals and output. This flexibility allowed groups to consider how best to address their defined problem. At the same time, groups benefited from the creative and varied contributions of diverse individuals who were working towards a common goal (Wilson et al., 2018).

The final workshop served as a culmination of group efforts and an additional opportunity to build community among participants. All 15 groups presented the results of their four weeks of group work; the fact that 100% of groups completed the program was indicative of overall engagement. Sixty-four participants (78%) attended the final session; several people were unable to attend due to previous commitments. At the final session, participants were divided into breakout rooms with individuals from different topics; each person had three minutes to showcase the work their group accomplished by presenting a poster or slide show. The breakout rooms featured animated conversation and further discussion about how to implement changes. Additionally, materials were archived online so that participants could access and adopt them.

Six months after the summer event, we hosted a follow-up meeting. We scheduled this after the fall term so that faculty could have an opportunity to reflect on their learning from the summer SMP and implement some of the strategies. Twenty-nine participants (35%) were able to attend the follow-up meeting. Attendees reconnected with their group members and discussed successes and challenges with other past participants.

Materials and Process

Groups had freedom to develop the types of materials best suited to solving their problems.
Groups stored all of their working documents and final products in a common Google Drive folder, so other participants could access all materials. Materials included articles from science education literature, annotated bibliographies, meeting notes, teaching products, and final presentation materials.
Examples of final products included detailed approaches and strategies for teaching, and plans for inclusion of new curricular ideas. For example, one group explored ungrading; they explored the rationale, developed tips for implementation, and compiled an extensive literature review and list of resources related to different ungrading approaches, such as specifications grading, standards-based grading, and contract grading. Another group was interested in developing meaningful lab assignments that promote deep learning. This group created a blueprint that could be applied broadly to project-based learning with specific resources so that others could implement the approach.
Among the groups who reported that they developed a concrete solution to solve their problem, we identified a number of commonalities. These groups:

1. Articulated a specific problem.
2. Took detailed notes at each meeting that tracked the group evolution and discussions over time.
3. Organized science education literature relevant to the problem, with a few groups producing an annotated bibliography.
4. Provided examples of how the literature could be applied to a real-world scenario, such as the creation of a student assignment or activity.
5. Included contributions from all members, as evidenced by notes, literature submissions, and final presentation development.
6. Created a final product (slides or poster) that presented the ways in which the problem was addressed and provided specific examples and strategies for implementation.

Discussion

Solve My Problem attracted a group of dedicated faculty who developed collaborative solutions to their teaching challenges. This program filled a niche to help participants address their specific teaching needs, especially in light of new pandemic-imposed teaching paradigms. Participants spanned a broad range of professional categories (Table 1). Of note, half of the participants identified as career instructional faculty (with titles ranging from Instructor to Associate Teaching Professor to Clinical Professor) whose primary responsibility is likely undergraduate instruction. Anecdotally, participants shared with the organizers how nice it was to know that they were not alone in tackling shared teaching problems, and how much they appreciated participating in a program with low barriers to entry, including minimal cost and flexible scheduling.

Most SMP participants had prior experience with NIST programming. As self-reported during the opening session, 89% of participants had participated in intensive week-long workshops, pedagogy courses, or other structured programs offered by NIST, and many reported that they had multiple experiences with the organization. Consequently, the majority of the participants had previously participated in professional development that includes significant group work, had experience with implementing evidence-based student-centered teaching principles, and shared an understanding of the principles and pillars of Scientific Teaching (active learning, assessment, and inclusivity). With such a large portion of self-selected repeat NIST participants, the organizers and coordinators did not have to convince participants of the validity of collaborative group work or the value of exploring literature on evidence-based teaching practices. The small portion of participants who were new to Scientific Teaching were surrounded by alumni who shared the value of the professional development model and teaching framework.

Faculty Learning Community

The structure for SMP emphasized autonomy, competence-building, and connection. These attributes have been identified as essential components of faculty learning communities (Daly, 2011), and furthermore are key factors that lead to individual motivation, as described by self-determination theory (Deci & Ryan, 2000).

Autonomy

Each group operated with a large degree of independence, including topic selection, approach, final product, and time commitment. While the organizers provided an overall framework, individuals collaborated to direct the trajectory of their group work, with the goal of solving a teaching problem in a way that would be helpful to members of the group. This autonomy meant that each group could invest their time in creating materials that would be meaningful to them.

Competence-building

Through participating in SMP, faculty learned from colleagues' experiences, spent time reading literature about evidence-based educational practices, and discussed strategies they might apply to their own teaching. Altogether, participants emerged from the workshop with new or refined ideas.

Connection

Some instructors may have limited opportunities to collaborate with faculty familiar with Scientific Teaching practices. Isolation of faculty was heightened during the pandemic, when many faculty taught virtually from home rather than in classrooms with students, which further reduced collaboration. Therefore, faculty were particularly grateful for the opportunity to collaborate with colleagues during SMP. We know from the literature that supports are three times more important for implementation of evidence-based student-centered teaching practices than real or perceived barriers, and the program filled in a niche of support by connecting faculty with other faculty (Bathgate, Aragón, Cavanagh, Waterhouse, et al., 2019; Bathgate, Aragón, Cavanagh, Frederick, et al., 2019).

Topics and Group Work

In preparing for SMP, the organizers assumed that many faculty would want to discuss emerging issues from the pandemic or the upcoming Fall 2021 scheduled return to in-person learning. However, most of the 15 groups focused on topics that were not directly related to the pandemic-induced teaching crisis, changing modalities again, or challenges sparked specifically by the pandemic. Only one group focused on the return to in-person teaching, while the other 14 groups examined core teaching issues such as engaging students as active participants in their learning, creating formative assessments that are also effective learning activities, and improving discussions of inclusivity across a department. The majority of the topics fit within the core pillars of Scientific Teaching. These evidence-based elements continue to be critically important for improving student learning environments (Cavanagh et al., 2016; Cavanagh et al., 2018; Reeves et al., 2021; Wang et al., 2021). Furthermore, this indicates that interest in Solve My Problem was not an artifact of the pandemic, although the need for support and interactions might have been amplified. Professional development in which faculty collaboratively work on a specific pedagogical issue will continue to be valuable in the future.

As participants engaged in their group work, we observed that some problems were easier to solve than others. A few groups focused on targeted problems for which they could more readily generate a solution. For example, groups that discussed opportunities to try a new model of ungrading or to build more active learning into their courses produced content with specific recommendations that individual faculty implemented in Fall 2021. Some topics, such as metacognition, proved to be more amorphous and harder for participants to determine exactly what problem needed to be solved. Nonetheless, even when topics were not amenable to a discrete solution, participants read the science education literature and collected resources to help better frame and address their problems.

We were initially surprised that the products some groups developed included a list of resources that could be used to address problems rather than concrete, implementable teaching activities. It could be that participants recognized that they could begin future planning but that the next concrete steps would require buy-in and discussion from institutional colleagues. Or it could be that faculty valued having the dedicated time to explore the literature for possible solutions adaptable to a specific teaching environment.

While faculty were not specifically focused on ways the pandemic has shaped their classrooms, many faculty reported they had not had time to stop, reflect, and attend to their own professional development (Vandegrift, 2022). SMP gave participants the time and space to dedicate to this important work. Additionally, all of these types of problems, no matter the time scale for implementation, benefit from having more people to discuss the problem, identify resources, and examine possible solutions.

Revisions for the Next Iteration

Based on our experiences, as well as post-evaluation feedback from coordinators and participants, we have identified areas that would benefit from further refinement. In future iterations, we will more clearly explain elements that may lead to productive SMP outcomes: 1) identify a specific problem, 2) review the literature, 3) take collaborative notes, 4) encourage everyone to participate, and 5) share previous experiences and knowledge. Participants may also benefit from more guidance regarding expectations for final presentations and products. We plan to share examples of products as a guide. Additionally, we plan to increase the time allotted to final presentations at the closing session, which will allow more substantive interactions among participants.

Final Thoughts

We used the level of participant engagement as a metric of program success. Engagement included consistent participation for the duration of the SMP within the working groups, creation of robust final products, and attendance at the final workshop and January follow-up meeting. In addition, positive feedback from participants and coordinators motivated us to offer SMP the following summer.

SMP provided a low-barrier opportunity for faculty from a wide variety of institutions to engage in professional development through extensive flexibility, minimal cost, and online programming. Data from the Summer Institutes on Scientific Teaching have shown a positive relationship between faculty participation in professional development workshops and increased implementation of evidence-based practices in their courses (Durham et al., 2020). Thus, more opportunities for educational development programming should be created to meet the diverse needs of faculty, to make space for new innovation, to build community among educators, to share creative solutions to common challenges, and ultimately to improve student learning experiences and outcomes

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