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Value of the Array of Returner Roles within the Professional Development Program

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Abstract

In addition to educating participants about inquiry instruction, equity and inclusion in STEM, and assessment, the Institute for Scientist and Engineer Educators' (ISEE's) Professional Development Program (PDP) is intentionally designed to provide opportunities for participants to return in subsequent years to observe (shadow), practice, and train in a variety of roles (e.g., design team leader, discussion group leader, apprentice facilitator, apprentice instructor). Returning participants not only receive instruction to guide them in these roles, but also receive feedback from core team designers and experienced facilitators and instructors while conducting and after performing these roles. Panelists will discuss one or more roles they engaged in as a PDP participant and how these experiences shaped their approaches to learning, teaching, and working with others as part of their professional careers. Topics to be covered will include leadership, facilitating dialogues and group discussions, the process of active listening, and the intentional design of ideas around diversity, equity, and inclusion.

Keywords: equity & inclusion, facilitation, leadership, professional development

1. Introduction

A primary goal of the Institute for Scientist and Engineer Educators' (ISEE's) Professional Development Program (PDP) was to prepare future scientists and engineers to be leaders in effective and inclusive education. PDP participants engaged in sev-

eral workshops designed to enhance their understanding of evidence-based pedagogical techniques that promote inclusive learning environments, with an emphasis on inquiry instruction. In addition, participants engaged in the design, facilitation, and assessment of an instructional activity with a team. As part of this process, all participants also received

professional development training in areas including leadership and communication, how to effectively work with teams, and how to design equitable and inclusive activities.

An unique aspect of the PDP is that it allowed participants to return for a second year (or more) to lead teaching teams or assume leadership roles in the community. This feature was intentionally designed into the program to provide an opportunity for returning participants to shadow and view PDP instructors through a lens that critically examined how instructors facilitated discussions or activities. Returning participants were also afforded with the opportunity to talk with instructors to discuss why facilitation moves were made. In addition, returning participants gained experience in performing a variety of roles (such as leading a design team or facilitating a small group discussion or activity), while also receiving feedback on their experience from veteran instructors. Through this mechanism, returning participants were able to gain valuable practice in a somewhat controlled environment while also establishing themselves as leaders in the PDP community.

A primary purpose of this panel and manuscript is to highlight the variety of roles that were assumed by PDP participants. In addition, panelists will discuss how these roles impacted their teaching practices, leadership skills, educational and professional values, and careers.

2. Impact on enduring understanding, equity, and inclusion

While a graduate student at University of Texas (UT) Austin, Dr. Raquel Martinez participated in the ISEE PDP Program for three years (2017–2019) as a participant, Design Team Leader (DTL), and Shadower. In her first two years, she designed inquiry activities for the Texas Astronomy Undergraduate Research experience for Underrepresented Students (TAURUS) program, a Research

Experiences for Undergraduates (REU)-like research experience for highly motivated undergraduates from underserved and traditionally marginalized groups. She also co-created a mentoring workshop for the undergraduate research advisors in TAURUS and led the one-on-one graduate student mentoring component for TAURUS, which matched scholars with one or two UT astronomy graduate students for near-peer mentoring throughout the duration of the research program. In her third year of PDP participation, Raquel was a Shadower and DTL, and led the design of an inquiry activity for UT's research methods course, a class aimed at early astronomy majors with a goal of acquainting them with basic research skills (e.g., facility with the command line, introductory Python programming, literature reviews).

The UT Austin Ph.D. program in Astronomy does not require its students to hold teaching assistantships to obtain the degree. Thus, depending on an individual student's funding situation, one may not obtain relevant, up-to-date pedagogical instruction or even step foot into an undergraduate classroom. Given Raquel's career goals, she was drawn to the opportunity to create an intensive, hands-on educational experience for undergraduate STEM majors through the PDP that was thoroughly crafted with research-based principles in mind to not only promote lasting understanding, but also incorporate equity and inclusion intentionally into the design process. This latter point is of particular importance to Raquel since she is highly motivated to use her teaching and mentoring to mitigate the barriers that are encountered by underrepresented students in STEM that might discourage them from continuing to pursue their passion.

In Fall 2022, Raquel will begin an NSF Mathematical & Physical Sciences Ascend Postdoctoral Fellowship and will apply the moves and techniques learned from the PDP to the broadening participation portion of her proposal. She is looking forward to the re-emergence of an updated PDP and how she might be able to contribute to and incorporate its

lessons into her future activities within an academic setting. Raquel plans on continuing to be a part of the wider PDP leadership community as her career progresses.

3. Impact on career and professional development

Dr. Devin Silvia first joined the PDP community in 2012 as a graduate student while attending the University of Colorado Boulder. In his first year, he was a member of a team (led by Katherine Kretke) that developed an activity for the solar and space physics REU program run by the Laboratory for Atmospheric and Space Physics. Devin returned as a DTL in 2013 and led a team through a redesign of that same activity. By connecting with the PDP community before moving to Michigan State University (MSU) to work as an NSF Astronomy and Astrophysics Postdoctoral Fellow, he had the opportunity to start the MSU ISEE chapter. Devin returned to the PDP again as a DTL to guide the development of a new lab activity for an introductory physics lab course at MSU, while also stepping into the shadow role.

Following his participation in 2014, Devin was invited to return to the program as an apprentice instructor in 2015, and then continued to participate in the program as a staff instructor in 2016 through 2019. In 2019, Devin also became a member of the ISEE Steering Committee to help navigate the continued growth and evolution of the PDP.

Devin's participation in the PDP and connection to the ISEE community had a profound impact on his career goals and success. He believes this program was a big part of why he was able to transition from an NSF postdoctoral fellow to a faculty member at MSU. Through his engagement with the PDP, he developed not only the skills necessary for designing and implementing effective inquiry-based educational activities but also a passion for creating equitable and inclusive STEM classrooms. Devin's

pedagogical knowledge allows him to generate engaging, hands-on activities for his computational flipped classrooms, a skill that was necessary for securing his current position.

Outside the classroom, Devin has leveraged the experiences he gained through his connection to the PDP to design and implement a pre-semester graduate teaching assistant (GTA) and undergraduate learning assistant (ULA) training module for his department. A significant fraction of the training module is dedicated to discussing how the GTAs and ULAs can work to create more equitable and inclusive classroom environments in their roles as facilitators of student learning. This component was inspired by the PDP's Equity and Inclusion focus areas and provides a foundation for the GTAs and ULAs to identify problematic situations in classroom case study examples and think about how they might handle tricky teaching scenarios when they arise.

Further inspired by the PDP's commitment to addressing issues of equity and inclusion in the classroom and from being well-versed in facilitating group discussions (both in his role as a PDP staff instructor as well as when engaging in challenging conversations with his GTAs and ULAs), Devin became heavily involved with some of the diversity, equity, and inclusion (DEI) efforts within the College of Natural Science (NatSci). As vice-chair of the Council on Diversity and Community in NatSci and as a member of the Taskforce on Inclusive Initiatives, Devin helped to secure a Creating Inclusive Excellence grant to fund a "train-the-trainers" program to build capacity for NatSci to host its own series of cultural competency workshops. Building on the skills he had developed through his prior PDP experiences of leading and facilitating group discussions, Devin was trained as one of the facilitators for these workshops and has since co-designed and co-facilitated a collection of workshops that have provided concrete DEI-focused experiences for over 200 members of the MSU NatSci community.

Overall, Devin truly believes that much of the success he has experienced in his career is a direct result of his participation in and engagement with the ISEE Professional Development Program. The skills developed and knowledge acquired have been critical in his endeavors as both as an educator and as an agent for positive change within his college. Devin will continue to build off of the strong foundation provided to him by the PDP and looks forward to future opportunities to apply the lessons he has learned from the PDP community.

4. Impact on networking, identity, & career

Dr. Emily Rice engaged with ISEE and the PDP as a participant, discussion group leader, apprentice facilitator and instructor, chapter lead, and Steering Committee member. As a graduate student in Astronomy & Astrophysics at UCLA, Emily first participated in the PDP in 2006. Later that summer, she had one of her first experiences with direct mentoring of a research student when she hosted an intern from the Akamai Mainland Program in the UCLA Infrared Lab. As a returning participant in 2007 and 2008, Emily took on additional roles leading group discussions and facilitating the “Three Kinds of Learning” Activity, part of the “Comparing Approaches” workshop at the PDP. Each summer after the PDP, she was a member of a team that designed and facilitated a multi-day light and optics inquiry activity for the Akamai Observatory Internship program short course. In addition, the team coordinated activities intended to develop camaraderie, establish expectations for interns and mentors, and strengthen interns’ identities as capable scientists or engineers (self-efficacy) during the first week of the program. Based on these experiences, Emily contributed to two papers in the 2010 ISEE *Learning from Inquiry in Practice* volume (Rice 2010, Rice et al. 2010).

As an early-career faculty member at the City University of New York (CUNY), Emily returned to the PDP in 2014 and 2015, and established an ISEE

chapter in New York City with participants from CUNY, the American Museum of Natural History (AMNH), New York University (NYU), Columbia University, the Center for Computational Astrophysics (CCA), and other institutions. She was the Design Team Leader for the first team to develop and implement a 1–2 day inquiry activity for summer research students (including astrophysics and Earth and planetary science students from CUNY and other institutions) that was based in the Division of Physical Sciences at AMNH and supported via an NSF-funded REU program. After participating in the PDP as an apprentice instructor in 2015, she continued to serve as a chapter liaison through 2020, recruiting PDP participants, coordinating the design team and its teaching venue as an introductory activity for diverse summer research students, and expanding to a second design team assigned to develop an activity for summer research students in astrophysics at Columbia University. Emily has also served on the Inclusive Leaders Steering Committee since 2019.

Emily’s participation in the PDP via multiple roles solidified her identity as a scientist-educator and provided an invaluable network for continued professional development. Given the close proximity to ISEE headquarters at UC Santa Cruz, many UCLA graduate students have participated annually in the PDP since its inception, cultivating a community of like-minded astronomers across several UC campuses. Emily credits the PDP, as well as this community of scientist-educators, with (1) her interest in teaching, pedagogy, and curriculum development, (2) her commitment to equity and inclusion as an instructor and mentor, and (3) her achievement of several significant career milestones, specifically developing a suite of 40 introductory astronomy lab activities (<http://www.mccradyricelabs.com>) and obtaining a faculty position at CUNY after two years as a postdoctoral scientist at AMNH.

Even though Emily’s participation and returning roles in the PDP have been somewhat sporadic and

haphazard, they have had a significant impact on her perception of career success and satisfaction. Upon reflection for this panel paper, she recognized a causal connection between her various roles in the PDP and the importance of the PDP philosophy in her career. She realized that a PDP philosophy of “learning by doing” has especially resonated with her as a learner, teacher, mentor, and curriculum designer. This idea, and the related concept of metacognition, was exemplified throughout the PDP in the core content of learning about science, how to do scientific research, how to do engineering design, and how to design inquiry-based education. Importantly, it was also extended to implementing the program as a whole, including learning to teach and facilitate professional development by *actively practicing* both of those things, with opportunities for reflection and feedback from more experienced practitioners. As an example, Emily remembered being surprised to learn about the significant social engineering that instructors employed behind the scenes to help participants get the most out of their PDP experience. In hindsight, that intentional consideration for *all* aspects of the program, not just the instructional content, is intrinsically part of the PDP and what makes it valuable and enduring.

Emily participated in the PDP over multiple years as the program expanded to include engineering and other scientific disciplines beyond astronomy, providing her significant experience with scientists from a variety of research areas and careers beyond astronomy and academia. She credits this experience, along with the learner-focused and backwards design aspects of the PDP, with her interest in teaching an assortment of science courses for majors and non-majors alike, and in designing her astronomy courses to have benefits for learners that extend beyond the content to include critical and quantitative reasoning skills, collaboration and communication skills, and awareness of the nature and culture of scientific research. She also continues to utilize backwards design principles in almost every curriculum development or instructional design task she approaches, and attempts to provide students with

multiple opportunities and formats for assessment in order to facilitate an equitable learning environment.

Many of these pedagogical tools — backward design, metacognition, and growth mindset, to name a few — are not unique to the PDP. However, the PDP was unique in presenting them as intertwined with the process of doing science, as well as the self-efficacy of being a scientist, which Emily credits in no small part to her retention in astronomy and academia.

5. Conclusions

In addition to the aforementioned themes discussed by the panelists, several addition topics were discussed in the question-and-answer period. One predominant theme that emerged revolved around the culture of the PDP. The PDP supported participants’ identities as scientist-educators; it was a place where participants felt free to develop into “the type of scientist [they] want to be.” The PDP culture also enticed and encouraged participants to return. Many participants felt a sense of belonging, community, and respect when engaging in the PDP that contributed to their desire to return in subsequent years. Furthermore, participants were able to see and hear from returners, such as working with a team leader (which helped participants envision that role for themselves) and hearing report-outs from shadowers about the topic they were shadowing and their observations. These intentionally designed opportunities to highlight returning participants helped instill a belief that all participants were trusted to become future leaders in the PDP and within their local communities.

Another important topic that emerged was the idea that coming back as a returning participant provided a valuable way to gain additional practice with the main PDP task (i.e., designing and teaching an inquiry). Participants often valued the opportunity to practice and improve on their facilitation techniques and abilities, with many reporting that

this additional training was useful not only for their inquiry teaching, but also more broadly for facilitating any group of people. Some participants also noted that facilitation provided useful training in how to effectively provide feedback to others (as the facilitation process can be considered as a form of providing feedback). The ability to give effective feedback is an important skill in any discipline. Therefore, many participants found this facilitation training to be incredibly valuable.

A third main area of discussion was that participants were entrusted to take on returning roles that were commensurate with their level of experience and number of years in the program. Returning participants reported being instilled with a sense of confidence that they could take on a given role given the core team's belief that any returner could be up to the task, as well as the fact that any returner was allowed to assume a returning role. In addition, the PDP provided a wide range of returning roles that required different levels of experience and expertise. It was important to have this range of roles so that first-time returning participants did not feel overwhelmed with a role that might be too involved and require more experience. Conversely, it was also important to provide a role that pushed boundaries and supported continued growth for those who had participated in the PDP for multiple years. An associated benefit of assuming a returning role was the opportunity to gain a "behind the scenes" picture of what PDP instructors did and how they worked together to prepare for and facilitate the PDP. Returners also gained perspective on how to run workshops and put all of its pieces together.

In summary, the PDP provided opportunities for returning participants to train, practice, and receive feedback in a variety of roles that required different levels of experience. While these experiences directly impacted participants' inquiry teaching as part of the PDP, participants report that they more broadly impacted their professional development and are still leveraged in their current positions today.

About the Authors

Dr. Raquel Martinez received her Ph.D. in astronomy from the University of Texas at Austin (UT) in 2021 and is now a postdoctoral scholar at the University of California, Irvine. Her career goal is to become an astronomy professor at an institution that primarily serves undergraduates, especially those from underrepresented backgrounds.

Dr. Emily Rice is an astronomer by training and an Associate Professor at the City University of New York (CUNY), a large urban public university with an enormous diversity of students representative of New York City and surrounding areas. After two years as a postdoctoral scientist at the American Museum of Natural History (AMNH), she maintains a resident research associate appointment in Astrophysics. From 2011–19 she was tenure-track faculty at the CUNY College of Staten Island, earning tenure in 2017, and is currently faculty at the Macaulay Honors College of CUNY. At CUNY she has taught lecture, lab, and seminar-style courses in astrophysics, physics, and science and mentored undergraduate and graduate research students.

Dr. Devin Silvia has a research background in computational astrophysics and is currently the Director of Undergraduate Studies and a teaching specialist in the Department of Computational Mathematics, Science and Engineering at Michigan State University (MSU). In his role at MSU, Devin is responsible for managing the growth and development of MSU's new Bachelor of Science in Data Science (started in Fall of 2019) and serving as the academic advisor for students in the program. He is also starting a new Computational Education Research Lab (CERL) at MSU in an effort to better understand how students learn to do computational work outside of traditional computer science classrooms.

Dr. Jason Porter is an Associate Professor in Optometry and Biomedical Engineering at the University of Houston. His laboratory investigates mechanisms that cause retinal and optic nerve head diseases (including glaucoma, traumatic brain injury /

concussion, and inherited retinal degenerations) and how the retina develops in healthy eyes and eyes that become nearsighted, primarily through the use of adaptive optics imaging. Jason has 15 years of experience teaching and mentoring postdoctoral, graduate, and professional optometry students. He was a participant during the first several years of the PDP before moving on to become a member of the PDP instructional team. Jason is also very familiar with ISEE, having served as a Steering Committee Member for the past 3 years and as the Chapter Lead at the University of Houston for 8 years.

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