https://escholarship.org/uc/item/46p8j3t6
pp. 23–36 in S. Seagroves, A. Barnes, A.J. Metevier, J. Porter, & L. Hunter (Eds.), *Leaders in effective and inclusive STEM: Twenty years of the Institute for Scientist & Engineer Educators*. UC Santa Cruz: Institute for Scientist & Engineer Educators.
https://escholarship.org/uc/isee_pdp20yr

Facilitating Learning in the Professional Development Program

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Abstract

In teaching for experiential learning, we measure our success not by how well we presented the material or designed an activity but by how well our students learned. Facilitation, the moment-to-moment twists and turns of live interactions between educators and learners, is a critical tool for student learning. Over the 20 years of the Professional Development Program (PDP), we have refined our articulation of the desired learning outcomes and have developed a set of strategies and "moves" that contribute to attaining those outcomes. Here, we examine these as well as describe materials and training developed in the PDP to build the skills of novice facilitators.

Keywords: equity & inclusion, facilitation, formative assessment, inquiry, professional development

Vignette

Antoine, Linda, and James were stuck. They were one of a dozen investigation groups engaged in an inquiry learning experience on the topic of light and shadow. The undergraduate students in this lab started by experiencing a number of light and shadow phenomena, generating questions, and forming small groups based on common interests. This group was intrigued by a phenomenon with pinholes. When they placed a pinhole in the fuzzy shadow of a large tree, they saw sharp, dark silhouettes of twigs and leaves. They had not expected this and were wondering, "What the heck is going on here?" Their question was a perfect blend of puzzlement and engagement. They eventually refined their question to, "How do pinholes make fuzzy shadows sharper?" and began to look at

how various factors affected this phenomenon. They tested a variety of variables like size and shape of the pinhole, distance from the ground, shadows of different trees, and more, and they tried to draw ray diagrams to explain what they saw. But they were running out of ideas and getting frustrated with the process… stuck.

Maria, their facilitator, had been checking in with the group throughout their investigation. But what should she do now? How could she help this group move forward but not take away their feeling that they owned their own learning in this experience?

Maria's questions are typical of many such questions that facilitators have to deal with as their learners proceed through an investigation. How is this group approaching a problem? Are they on a productive path? Is there something I could do to help, or would it be best if I do not intervene now? How do I help this group work more collaboratively? And for those of us who train facilitators, the big question is, "How do we prepare Maria and her peers to handle these situations?"

1. Introduction

The light and shadow inquiry described above was an experience within the Professional Development Program (PDP.) The PDP:

> "… is at the heart of the education programs of the Institute for Scientist & Engineer Educators. The PDP was originally developed by the Center for Adaptive Optics (UC Santa Cruz), and since, has been instrumental in developing and advancing a growing community of scientist- and engineer-educators. Participants come to the PDP early in their careers — most as graduate students — and they emerge as leaders who integrate research and education in their professional practice. The PDP engages participants in the innovative teaching and learning strategies of inquiry. Participants put new knowledge into action by designing inquiry activities and teaching their activities in undergraduate science and engineering laboratory settings." (Hunter et al, 2010)

The PDP participants built the understandings necessary to design and teach inquiry laboratory activities by, first, engaging in a model inquiry such as the light and shadow inquiry referred to in the vignette above. There, they had a first-hand experience of the techniques instructors use during inquiry, which are collectively called facilitation. Facilitation encompasses the moment-to-moment twists and turns of live interactions between educators and learners (Ball, Hunter, & Barnes, 2022). Within the PDP, we define facilitation as the on-the-fly things that instructors are doing and/or saying in order to achieve the intended learning goals (ISEE 2022a). Rather than being the director of student learning, the facilitator becomes the supporter of student learning. In experiential learning, like the inquiry lab, the facilitator responds to what the learners are doing as they interact and experiment with physical and/or virtual materials, talk with each other, and progressively develop their ideas. The facilitator's job is to make the learner's thinking accessible, to help them progress toward the learning goals while supporting their ownership, and to enable equitable and inclusive collaboration.

Over the 20 years of the program, the PDP has learned a great deal about how to think about and carry out facilitation. It has refined techniques for doing facilitation and developed training for novice facilitators. This paper is designed to share what has been learned and serve as a resource to practitioners in this field.

2. Goals for facilitation

The purpose of facilitation is to help learners move toward a set of learning goals. But that set of learning goals is broader than the standard goal of knowing content. A more complete set of goals include:

- **Understanding content.** This aims at expanding and deepening knowledge and understanding of concepts pertinent to the field of study.
- **Increasing proficiency with science and engineering practices.** This aims at increasing the ability to perform practices such as asking questions and defining problems, constructing explanations and designing solutions, and defining requirements.
- **The affective and social dimensions.** Aims here include strengthening the learner's feeling of self-efficacy, ownership of learning, and identity as a scientist or engineer. They also include improving the learner's abilities to collaborate and function well within the scientist/engineering community.
- **Equity and inclusion.** Facilitators aim to foster a learning environment that can contribute significantly to learners' senses of identification with STEM, making them more likely to persist in the field.

3. Facilitating experiential learning

During an inquiry activity, the instructor's "role is to facilitate students' interaction with the material and with each other in their knowledge-producing endeavor… [to] move away from being the one who has all the answers and does most of the talking toward being a facilitator who orchestrates the context, provides resources, and poses questions to stimulate students" (King, 1993). In order to help learners move to higher levels of expertise, facilitators respond to what the learners are doing as they interact and experiment with materials. Effective facilitators need to develop the attitudes, skills, and knowledge to be able to infer the learner's thinking at a particular point and to help the learner make progress toward the learning goals for that investigation.

The following sections describe aspects of facilitation and tools that were used in the PDP, which instructors may find useful in working with learners in a wide array of experiential learning contexts.

3.1 Facilitator attitudes

Respect for the way learners think and the way they learn is at the heart of effective facilitation. This is a critically important attitude for facilitators to assume. To best meet the learning goals, learners need to have "ownership" (Ball, Hunter, & Barnes 2022) of the work they do and the ideas they construct during the inquiry. Most often, supporting learners' ownership of their work means letting them take the lead in determining what they will do next rather than superimposing the facilitator's own ideas onto theirs. Learners bring a lot of prior experience and their own ideas to their inquiries, and the facilitator needs to respect those experiences and ideas. Learners will have their own way of approaching questions, of experimenting with materials and of thinking about concepts, and the facilitator must be careful not to show them a "better" way unless it is very clear they need and welcome that kind of advice.

Another important attitude is that of genuine enthusiasm and curiosity. Successful facilitators show excitement about learning about a particular group's path of investigation and the way they think about the phenomenon or problem that they are investigating.

A critical facilitator attitude is that of assuming personal responsibility for creating an equitable and inclusive learning environment. Facilitators need to understand that they have agency with regard to this aspect of the learning environment and be proactive in developing and applying strategies to create such environments.

Finally, patience is a critical, and sometimes difficult, attitude. When a facilitator sees that learners are struggling to make sense of what they are working on, it can be tempting to step in and give an answer or an explanation. Most often that doesn't help. If the facilitator does so, the learner shifts from trying to understand a particular phenomenon to trying to understand the facilitator's understanding of that phenomenon. Even if the learner does understand the explanation, she will no longer have the cognitive benefit of figuring out the answer/explanation for herself, and it will be more difficult for her to integrate what she was told with the set of understandings that she already has.

3.2 Facilitation aims and moves

Facilitation moves are what the facilitator does during the course of an experiential learning activity to help the learners progress. In the PDP, the practices of facilitation are broadly grouped into three categories:

1. Making learners' thinking accessible (… by listening in on them, observing them, asking them questions…)
2. Helping learners progress toward the goals while supporting their ownership (… by encouraging, reassuring, making suggestions, asking leading questions, doing nothing…)
3. Enabling equitable and inclusive collaboration (… by monitoring group dynamics, modeling teamwork, eliciting engagement…)

These elements form the essential constituents of a formative assessment cycle. The facilitator gatherers evidence about the learners and interprets that evidence to infer learner thinking and judge the level of equitable and inclusive collaboration. Based on those inferences, the facilitator decides what she can do to help move the learners along. These interventions range from doing nothing at all to providing suggested next steps or encouraging reticent learners to speak up in their groups. The cycle continues as the facilitator gathers more evidence to judge the effectiveness of the intervention and to determine next steps. Facilitation addresses a number of learning and equity goals (referred to as aims) and encompasses many strategies and techniques (collectively referred to as moves) to accomplish those aims.

Aims for facilitation moves fall within the three categories described above. A sample of specific aims within those categories were delineated in the PDP's Aims and Moves Worksheet (ISEE 2022b) and are sampled here.

Making learners' thinking accessible

- notice/observe learner's thinking
- actively make learner's emergent thinking transparent or "visible"
- make learner's thinking accessible to other learners
- ascertain/expose partial, alternative conceptions (aka misconceptions)
- expose competing ideas or explanations of phenomena
- promote metacognition (learners actively reflect on their own thinking)

Helping learners progress toward the goals while supporting their ownership

- affirm learner's ownership/agency; affirm learner's approach
- dodge/resist learners' attempts to solicit directives
- push learner's thinking forward (& support ownership)
- expose flaw in learner's thinking
- redirect learners to take a different approach
- prevent learners from going to a "dead end"
- focus investigation

Enabling equitable and inclusive collaboration

- create/encourage engagement manage dominant learner
- manage interpersonal conflict
- recognizing learners' unique contributions
- ensure all voices/perspectives are shared
- encourage dialogue among team members / collaborators

Table 1 provides a sample list of associated moves developed in the PDP (ISEE, 2022b; Institute for Inquiry, 2005).

Many of these moves may accomplish different or multiple aims depending on when and how they are used. For instance, asking for a drawing can help make the learner's thinking visible. A visual representation of the learner's thinking may also help to advance that thinking. Another move, listening to or observing without talking to the learner directly, can make the learner's thinking accessible without interfering or interrupting. It can also allow a facilitator to check in with a learner in a more informed, less interruptive way at a later time. It also addresses equitable and inclusive learning in that it helps maintain the learner's ownership of their own pathway toward figuring something out. Part of becoming a good facilitator is to develop a repertoire of these moves and the insight of how and when to use them.

Another part of the transition from novice to expert facilitator is coming to grips with how the aims of facilitation can be in tension with each other. Supporting learners' ownership might suggest "leaving them alone" for a long time, letting them get established on a learning path that they trailblaze for themselves. But an "early and often" approach to making learners' thinking accessible can alert the facilitator when the learners' path isn't even in the general direction of the activity's goals. The facilitator who is too hands-off in the beginning may find they rob the learners of ownership later with a U-turn. But the facilitator who can offer tiny helpful nudges to the learners' course — even though this might feel very hands-on to a novice facilitator — might ultimately support learners' ownership better.

Table 1: Example facilitation moves.

Verbal Moves	Non-Verbal Moves
make small suggestion/"nudge"	observe
repeat/paraphrase learner(s)	demonstrate
summarize	listen/observe without talking to learner directly
ask for plan	back off
ask for drawing	walk away
ask for explanation	pause
restate motivating problem or question	feign confusion (facial expression)
ask for prediction	use wait time
ask clarifying question	glance
feign confusion ("I'm not sure what you mean")	hand or cursor gesture (e.g., point)
ask if hypothesis is testable	highlight text
ask/suggest a comparison	reposition physical stance
ask for summary	use body language
redirect question	use eye contact
suggest simplifying	show enthusiasm
suggest new or alternative tool/materials	show mirth/laughter
lay or revisit ground rules	pick up or drop off materials
suggest learner(s) take a break	inspect materials/ equipment

4. Training novice facilitators of inquiry

In recent years, inquiry labs and other forms of experiential learning have gained traction in higher education science and engineering (Aicjinclos et al., 2014; Brewer & Smith, 2011; Buck, Bretz & Towns, 2008; Gormally, Sullivan, & Szeinbaum, 2016; National Academies of Sciences, Engineer-

ing, and Medicine, 2017; National Research Council, 2003; Spell et al, 2014). However, the success of these endeavors depends on how well they are taught (Bohrer, Stegenga, & Ferrier, 2007; Gormally, Sullivan, & Szeinbaum, 2016; Wheeler, Maeng, & Whitworth, 2015). Often, they are taught by graduate teaching assistants who have little, if any, experience with this kind of learning. Their training in inquiry learning and facilitation has proven to be critical to the success of these efforts (Wheeler, Maeng, & Whitworth, 2017; Hughes & Ellefson, 2013).

Over 20 years, the PDP developed and refined a professional development curriculum for the knowledge, skills, and experience necessary to design and facilitate inquiry learning experiences. The full PDP experience included active participation in a series of workshop-based "intensives," design and development of an inquiry activity, an experience teaching that activity, and time for reflection. Together, a participant's cycle in the PDP included about 90 hours of professional development in which they experienced inquiry from the learner's perspective, reflected on their experience, practiced inquiry as educators, and reflected on their practice (Hunter et al 2010).

4.1 Initial training

The initial training activities took place in the Inquiry Institute, a four-day workshop attended by new and returning participants. The workshop included many different sessions that prepared participants to begin designing their own inquiry activity. It began with an activity, designed by the Exploratorium Institute for Inquiry (Institute for Inquiry, 2006) where participants experienced and compared three types of hands-on science; a tightly directed approach, a design challenge, and a very open approach. This was followed by small group discussion analyzing that experience and looking at what learning goals each approach supports. This activity helped participants to start to think about pedagogy and the choices they make as instructors. Continuing this theme of pedagogy, the participants engaged in a structured discussion of the principles from Ambrose et. al. (2010) to give them some background in what is known about learning from the learning sciences. This discussion included the application of the principles to the analysis of a teaching vignette.

Participants then engaged in a model inquiry learning experience. This activity was the centerpiece of the new participant experience: all PDP participants experienced inquiry as learners and reflected critically on this experience before they designed and taught their own activities. The inquiry began with demonstrations and brief explorations of engaging phenomena. While these phenomena appeared to be simple, they were rich enough to challenge participants with backgrounds ranging from little experience to professionals in the field of study. Participants generated questions about the phenomena, and then formed small investigation groups based on common interest in a question. Investigations included cycles of hypothesizing, designing, and executing experiments, and devising explanatory models, and were aided by materials and a PDP instructor who served as a facilitator. Facilitators guided groups and individuals to come to their own understandings. Participants summarized their investigations and conclusions in semi-formal presentations to their peers. Finally, PDP instructors synthesized the content of the phenomena under investigation. Here, participants experienced facilitation from the learner's point of view and gained a vision of what it is that facilitators do. After completing the inquiry activity, new participants moved into the teacher stance with a reflective discussion. As part of this, they examined how the inquiry was facilitated and how that facilitation allowed learners to retain ownership over their own knowledge gains.

Returning participants experienced a second inquiry activity, different from the one they experienced as new participants. One of the PDP model inquiries was more science oriented, where they

worked to explain a phenomenon the other PDP model inquiry was more engineering oriented, where they worked on the requirements for a design. In their reflective discussion they were asked to compare the two experiences along several dimensions. In the facilitation dimension, they were asked to brainstorm a few "moves" that facilitators use to accomplish each element of facilitation. Table 2 shows sample responses.

The remaining two days of the Inquiry Institute included sessions on equity & inclusion, assessment, and work on designing an inquiry activity. About a month later, participants spent focused time developing an inquiry activity at the two-day Design Institute. There were several sessions, reading assignments, tools, and systems of support within the PDP that moved participants toward designing, teaching, and assessing an inquiry activity, but they are beyond the scope of this paper, which is focused on preparing participants to facilitate.

The Equity & Inclusion strand of the Inquiry and Design Institutes set the stage for participants to consider how their facilitation affects the experience of learners through a different lens. Through readings, presentations, and discussions, participants examined a set of ideas and strategies that, among other things, contribute to the goal of enabling equitable and inclusive collaboration. Participants were introduced to a set of four focus areas, with a practice-oriented perspective, that highlight the ways that inquiry is connected to a diverse body of literature on equity and inclusion. These focus areas provided a structure for insight into why inquiry pedagogy holds such promise for reducing disparities (Seagroves et al., 2022). These equity and inclusion focus areas were as follows:

1. **Multiple ways to productively participate:** More learners are included, and more of their skills are developed, when they are provided with multiple ways to engage, learn, communicate, and succeed.
2. **Learners' goals, interests, and values:** Inclusivity is supported by leveraging learners' goals, interests, values, and sources of motivation through activities that are relevant, meaningful and challenging.
3. **Beliefs and biases about learning, achievement, and teaching:** Learners and educators develop beliefs about learning, achievement, competency, and intelligence that affect performance and success in STEM.
4. **Developing an identity as a person in STEM:** STEM learning experiences are part of the process of learners negotiating their individual identities and their sense of being a person in STEM, which has cultural norms and values of its own.

These focus areas formed a foundation for thinking about the practice of facilitating for inclusion. For example, in a reading that we gave to participants,

Table 2: Facilitation moves associated with major facilitation goals.

Making learners' thinking accessible	Helping learners progress toward the goals, while supporting their ownership	Enabling equitable and inclusive collaboration
Listen to or observe without talking to the learner directly Ask for a summary of work so far Ask for a plan Ask for a drawing, explanation Ask for a comparison, prediction	Ask for a plan Ask for a drawing, explanation Ask for a comparison, prediction Suggest simplifying Suggest new tools or materials Repeat, paraphrase, summarize, affirm Do nothing, back off, walk away	Lay ground rules Speak to the whole group / speak to individual learner(s) Call on particular learner(s) Use eye contact and/or body language Monitor and assist group formation

Carlone and Johnson (2007) identify competence, performance, and recognition as key components for building STEM identity. Facilitators learned that student recognition from themselves and from others (particularly meaningful scientific others) can make a strong contribution to developing a STEM identity. Facilitators could then plan how to provide that recognition, and how to structure opportunities for student's peers to provide that recognition.

4.2 Facilitation workshop

The Inquiry Institute and the Design Institute focused primarily on inquiry design. They provided a strong foundation for thinking about facilitation but addressed it directly, principally in reflections on participants' inquiry experience.

After completing their activity design and shortly before teaching, design teams were each given a workshop specifically aimed at facilitation.

Before the workshop, participants read a overview of the facilitation ideas presented so far in this paper. This reading re-emphasized the three aims of facilitation. It emphasized that facilitators should show respect for learners, make suggestions rather than give directions, and guard against depriving learners of ownership by not giving the learners the answer. The workshop began with a brief discussion of that reading, where participants were asked to note what they noticed about facilitation that is different from the usual teaching they had experienced. This session ended with the introduction of the Personal Facilitation Plan worksheet (ISEE, 2022c). In this tool, participants were asked to identify a couple of goals or concerns around facilitation that they wanted to work on, what their aims were in each of these areas and what moves that they would use to accomplish those aims. The worksheet included some examples such as:

> Goal: I would like to give fewer answers and direction to the learner than I typically do.
>
> Aim: Affirm learners' ownership.
>
> Move: Paraphrasing or just waiting instead of jumping in to answer.

Participants completed the Personal Facilitation Plan worksheet based on discussion in the facilitation workshop.

This was followed by an extended discussion based on another pre-workshop reading on supporting learner ownership (Ball, Hunter & Barnes, 2022). The discussion began with an open-ended prompt asking what participants found that could apply to their own facilitation. It moved on to discuss a vignette within the reading with a focus on moves that impacted learner ownership. Further prompts centered on ideas of cognitive autonomy and facilitation moves that help maintain the learner's ownership of their learning.

In the next part of this workshop, participants were asked how they personally plan to attend to equity and inclusion in their own facilitation. Individuals were asked to articulate specific goals and their strategies for achieving those goals. They were reminded that they would be asked to reflect on this in their post-teaching reports.

The final pre-workshop reading was a longer vignette about learners choosing a question to investigate (ISEE, 2022d, 2022e). Participants were asked to use a written tool, the Facilitation Aims and Moves Worksheet (ISEE, 2022b), to analyze the facilitation moves within the vignette transcript. Participants were asked to identify moves or missed opportunities for moves, place the moves within a major move goal category (e.g. making learners' thinking accessible), and to suggest possible specific aims for the move or missed opportunity. The worksheet contained a broad sample of facilitation moves (see Table 1 above) and a table of example facilitation aims associated with major facilitation goals (see Table 3). Participant responses formed the basis for extended discussion. From their pre-workshop analysis and workshop discussion, par-

ticipants learned to distinguish the motivating facilitation aims (functional intentions) from the means by which they work towards achieving those aims (i.e. form, the "moves they make"). As an additional resource, participants were given access to a series of problematic facilitation scenarios with suggested strategies and considerations that commonly occur while facilitating inquiry. These scenarios dealt with topics like difficulties raising investigation questions, struggles eliciting learner's understanding, difficulty determining where an investigation group is going, groups struggling to make progress, groups that seem to have come up with a wrong answer, individuals who are not engaged and more. These scenarios were particularly useful for novice facilitators who did not know what difficulties to expect, and could use some help thinking about how to handle these difficulties.

Finally, participants were asked to pick one thing about facilitation that they would focus on while teaching their activity, and that they would report on during the post-teaching debrief. Typical foci included not jumping in too soon to give answers, asking productive questions, and giving non-judgmental feedback.

4.3 Practical experience facilitating learners

A critical component in developing new facilitators was their actual experience of facilitating learners in an inquiry lab where they could apply what they had learned. The PDP provided a number of venues where new facilitators could try their inquiry designs and practice their facilitation skills in 3–8 hour lab experiences. Inquiry topics ranged across the sciences and engineering fields. Most PDP participants worked in teams of two or three with small groups (12 to 25 students) of undergraduates. In this context, new facilitators had multiple opportunities to formatively assess student progress and try to determine what interventions, if any, would help move students toward their learning goals. This extended experience also allowed them to monitor the success of their interventions, and to try something different if the initial attempt was not working. By working with a team of facilitators, they could also consult with a teammate to develop a plan for particularly difficult situations.

Inquiry labs are designed around explaining a phenomenon (science) or designing a solution to a problem (engineering). In assessing student progress to those ends, facilitators paid attention to

Table 3: Example facilitation aims.

Making learners' thinking accessible	Helping learners progress toward the goals, while supporting their ownership	Enabling equitable and inclusive collaboration
Notice / observe learner's thinking Actively make learner's emergent thinking transparent or visible Ascertain / expose partial, alternative conceptions (aka misconceptions) Expose competing ideas or explanations of phenomena Promote metacognition (learners actively reflecting on their own thinking)	Affirm learner's ownership / agency Affirm learner's approach Dodge / resist learners' attempts to solicit directives Push learner's thinking forward (& support ownership) Expose flaw in learner's thinking Redirect learners to take a different approach Prevent learners from going to a "dead end" Focus investigation	Create / encourage engagement Manage dominant learner Manage interpersonal conflict Recognize learners' unique contributions Ensure all voices / perspectives are shared Encourage dialogue among team members / collaborators

several factors. Progress toward conceptual understanding was one. In the design of the lab, the facilitator team paid a great deal of attention to what it might look like if students were understanding, or not understanding, the key conceptual ideas for the lab, and what common misconceptions might be. This gave facilitators a good idea of what to look for when facilitating. They also brainstormed, in their preparation, how to handle some of these common misconceptions without taking away student ownership of the learning. Facilitators might gather information on student thinking by listening in on investigation teams' conversation, or looking at drawings that they made. Or, they might simply ask students to tell them what they were thinking at that point. Based on what they found out, facilitators could then steer their students incrementally toward greater understanding by asking questions, suggesting materials, or suggesting another way of thinking about something.

Facilitators also paid attention to how their students were trying science and engineering practices. In these labs, facilitators asked investigation groups what question they were trying to answer, or what problem they were trying to solve. They often worked with groups to refine their question into something that was more investigable, or to state their problem in terms of functional requirements. Along the way, facilitators looked out for problematic experimental design (such as difficulties with control samples), struggles with organizing and analyzing their results, and groups that mistook explanations as generalizations of their data, as opposed to application of scientific principles. In each case, the facilitators intervened with just enough help to allow the students to feel that they were figuring out how to do the practice better.

Finally, facilitators paid attention to group dynamics in order to ensure equitable and inclusive collaboration. Facilitators observed how the group was working together and how they responded to the facilitator in interactions with the group. One common problem in student group work is that the group will be dominated by one strong personality. In that case, when the facilitator interacted with the group, they would notice that one person who always answered questions or explained the results. Facilitators dealt with this by addressing their questions to other individuals in the group and/or by saying, "I have heard how person A thinks about this, I would like to hear how you, person B, thinks about it." By applying a series of moves like this, the facilitator gave a strong message to the group that they should all be involved.

4.4 Post-teaching debrief and reflection

After teaching their activity, teams were brought back to reflect on the experience. As part of this reflection, each person discussed their work on their facilitation focus. They were also asked to articulate one thing about facilitation that they thought they did well and one thing that they would work to improve in the future.

PDP participants were also supported in reflecting on their facilitation experience through a post-teaching report, in which they were prompted to write about what they experienced and learned. They were asked to write about their experience facilitating using three different lenses: their STEM content goal, their STEM practice goal, and equity & inclusion.

5. Training advanced facilitators

Participants who went through the PDP at least twice were offered an opportunity to "shadow" during the inquiry activities. Shadowing was a quiet observation that followed the progress of an activity. The shadower was neither a participant/learner nor an instructor/facilitator, but an observer of both, shadowing for their own learning experience. The goal of the Inquiry Shadowing Strand was for participants to increase their understanding of facilitating learning in an inquiry activity, and to expand their repertoire of facilitation moves. Participants in

this strand defined their own goal for what they'd like to learn more about, and worked independently or in pairs to accomplish their goal. Participants synthesized and reported on what they learned in different ways over the years of the PDP. Some examples included contributing to a collaborative document, creating vignettes of facilitation scenarios, and reporting to the whole PDP group.

Shadowers worked with each other and PDP instructors to figure out their question or focus during a pre-institute preparation session. During the investigations, shadowers usually focused on one inquiry activity and took notes. Depending on their goals, a shadower followed one PDP instructor or multiple instructors as they facilitated. Some shadowers used a guide (ISEE, 2022a) that listed common scenarios needing facilitation, such as:

- The facilitator believes learners have a misunderstanding
- A learner is taking too dominant a role in a group
- Facilitator sees that learners need help with a STEM practice

The shadowers took notes on the moves the facilitator made and what impact the moves had.

Shadowers also observed formal and informal instructor meetings. They listened in on the mid-point check-in, as the instructors debriefed their activities, discussed the groups they were facilitating, and planned the final portion of the inquiry activity.

Following the inquiry activity, the shadowers debriefed with one instructor. Each shadower discussed their focus question, how it changed along the way, and a few important things that they learned. They shared their notes from the shadower guide, bringing up any scenarios that they observed, what kinds of moves facilitators made, and how learners responded. During the debrief, the shadowers typically brought up other observations, such as how the dynamics of teams are different when the instructor is present versus when teams are working independently. Finally, shadowers were given an opportunity to debrief with the instructors of the activity they observed. This gave them the opportunity to ask about facilitation moves that they observed and instructors thinking about those moves.

6. Summary

The 20 years of the PDP's work in inquiry developed a deep store of knowledge both about the facilitation of experiential learning and the training of novice facilitators. The strategies and moves of facilitation live on in the teaching practices of the program's alums — even when they use other pedagogical approaches besides inquiry. This paper documents some of that thinking, and those strategies, and provides a tool to help spread facilitation practice to a wider audience.

Acknowledgements

The PDP was a national program led by the UC Santa Cruz Institute for Scientist & Engineer Educators. The PDP was originally developed by the Center for Adaptive Optics with funding from the National Science Foundation (NSF) (PI: J. Nelson: AST#9876783), and was further developed with funding from the NSF (PI: L. Hunter: AST#0836053, DUE#0816754, DUE#1226140, AST#1347767, AST#1643390, AST#1743117) and University of California, Santa Cruz through funding to ISEE.

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