The Influence of Classroom Talk Moves by Facilitators during Science Professional Development

by

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The Influence of Classroom Talk Moves by Facilitators during Science Professional Development

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ABSTRACT

The purpose of this study was to understand how the facilitator affects the participants’ perception of the professional development based on the moves they make to engage educators in the learning experiences. The implementation of the Next Generation Science Standards has resulted in the development of a variety of science professional development offerings meant to support teachers’ growth in both science content knowledge and high-quality science instructional practices. This study employed a phenomenological approach to understanding the participant and facilitator experience during science professional development. This study was conducted using observations of a professional development series that meets the characteristics of effective professional development described in the literature. Facilitators of the professional development sessions were interviewed regarding their experiences and participants completed surveys identifying moments they felt particularly engaged or disengaged in the learning. The findings in this study include a reinforcement of the literature describing active learning as an important characteristic of effective professional development. This study adds to the description of the characteristic of time as not just the long term spacing of professional development sessions to allow for classroom implementation and feedback, but also for the efficient use of time within the professional development sessions. The interaction between the facilitators and participants affected the participants’ perception of the facilitators' experience and their engagement in the session. Facilitators were able to increase the participants’ feelings of engagement by using moves that supported the participants to engage in discourse with one another and actively participate in the sessions.
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To Madeline and Eleanor. May you always reach for the stars.
CHAPTER 1—INTRODUCTION

Introduction

As teachers begin to implement the Next Generation Science Standards (NGSS) in their classrooms, they are expected to shift their teaching practice from a focus on delivering scientific content to the practice of supporting students to construct explanations for scientific phenomena. In order to make this instructional shift, teachers need support to make both pedagogical and content focused changes in their classrooms. These new expectations of science instruction create a need for educational leaders to facilitate professional learning specific to NGSS for California teachers. Professional development can increase the use of new teaching practices in the classroom and participation in professional development can extend science content knowledge (Desimone et al., 2002; Loucks-Horsley et al., 2009). This strengthening of science content knowledge and pedagogical skills contributes to teachers applying new strategies in their classrooms. This may be due to a strengthening of the teachers’ self-efficacy, or belief in themselves, after the professional development experience (Lotter et al., 2018).

Five characteristics of effective professional development have been identified. They include a focus on content, the use of active learning for the participants, a coherent connection to state and school policies, professional development that occurs over a duration of time, and collaboration between teachers from the same school or department (Committee on Strengthening Science Education through a Teacher Learning Continuum, 2016; Desimone, 2009). This consensus regarding the characteristics of effective professional development does not account for the social aspect of learning that teachers and facilitators bring to the professional development experience. Lave and Wenger
(1991) explain that learning occurs when people are “full participant[s] in a sociocultural practice” (p. 29). Loucks-Horsley et al. (2009) describe the need for a professional learning environment that includes collaboration, challenging discourse, and a space for experimentation. With adult learners, this includes actions that allow the facilitator to connect to the participants and maintain a safe environment for the participants to engage in learning (Remillard & Geist, 2002).

This research uses a conceptual framework based on a model of the interaction of four elements of professional development proposed by Borko (2004). Borko describes these elements as the relationship between the program being used, the teacher participants, and the facilitators, as seen in Figure 1, as well as the context surrounding the professional development. The author suggests that the relationship among these elements may affect the impact of professional development on teacher and student learning.

Figure 1. Conceptual model of Borko’s four elements of professional development. Source: Borko (2004).
Both adults and children learn most effectively when provided with a high-quality instructional experience. High quality instructional experiences include opportunities to be creative, are student-centered, and include support for learners from the instructors (Pickett, 2015). Through her review of professional development literature using this lens, Borko (2004) suggests that teacher professional development often results in a range of participant learning that mirrors what is seen in student learning after classroom instruction. The context of the professional development affects the engagement of the group and individual educators in their learning (Loucks-Horsley et al., 2009). Borko (2004) also suggests that professional development programs should make use of situated learning opportunities. An example of this is teachers using their own classrooms as tools in their learning by trying on new instructional practices and collecting evidence of their effectiveness with students. Loucks-Horsley et al. (2009) suggests that facilitators who engage participants in challenging discourse through the use of probing questions provide an opportunity for educators to examine their own context to increase their engagement in the professional development experience.

In the classroom, teachers have been shown to increase students’ engagement in challenging classroom discourse through the use of talk moves. Michaels and O’Connor (2015), identified four goals for productive discussions in classrooms: helping individual students share their ideas, helping students listen to one another, helping students deepen their reasoning, and helping students engage with each other’s reasoning. These goals are met through the specific questions and phrases identified as talk moves that teachers use to facilitate the productive discussion between students in their classrooms. In this research, I will focus on how the moves of facilitators during professional development
mirror talk moves. This interaction between the facilitator and the participants may positively affect the professional development experience for the educators involved, as they engage in productive discourse.

**Statement of the Research Problem**

Participation in effective professional development can positively impact the classroom practices of teachers (Banilower et al., 2013). In order to allow for this participation, schools and districts need to consider the use of funding and time as they develop a professional development plan. According to D. Knight (2012), the cost of traditional or workshop professional development is less expensive, costing $500 per teacher compared to other forms of professional development such as instructional coaching which can cost about $3,350.00 per teacher. These amounts include the cost of the facilitator, teacher time, and materials needed to run the professional development. In 2015, Jacob and McGovern estimated that districts spend between six and nine percent of their budgets on professional development for their teachers. Professional development that focuses on the needs of one teacher at a time such as instructional coaching is even more expensive and time-consuming, causing many districts to look towards using a high-quality professional development series in order to engage more teachers each year in professional development without overspending their budget. As districts implement the NGSS, they expect a return on the investment they make into the professional development of each teacher, regardless of the model of professional development that they choose to follow.

As stated previously, there is much research on the program characteristics which make professional development effective but little research into how the experience of
educators during the professional development session is affected by the actions of the facilitators leading the session. Loucks-Horsley et al. (2009) describe the need for facilitators of mathematics and science professional development to have skills in three areas: (1) managing discussions among educators, (2) using protocols specific to professional development strategies such as looking at student work or conferencing with teachers, and (3) supporting adult learners’ engagement in the professional development. Additionally, the framework for professional development facilitators described by Perry and Boylan (2017) explains the need for facilitators to have the skills of facilitation, knowledge about facilitation, and knowledge of professional development in relation to the content. Most professional developers do not have training in facilitation skills or planning professional development experiences. Stoetzel and Shedrow (2019) found that instructional coaches often begin in their positions without training that would allow them to be successful. This includes training in one-on-one coaching as well as leading larger professional development experiences. The lack of this training can leave facilitators unprepared for teaching adults and without the skills needed to support educators in new learning.

Regardless of the number of characteristics of effective professional development met in the planning of a workshop, the delivery of the workshop by the facilitator affects the experience that the participants have. This, in turn, affects how engaged the participants are in the professional development session and how much they bring back to their classroom instruction. Many professional development leaders are chosen from experienced classroom teachers in districts, but being a strong classroom teacher does not necessarily mean that a teacher will transition to be a strong facilitator of adult learning.
Professional development facilitators need to be able to appreciate all of the experiences and learning that their adult students bring to the learning. They should view the teachers they are instructing as competent regardless of their background or social context (Karagiorgi et al., 2008). There is a need to understand the views of facilitators and how they make professional development relevant to the teachers that they lead (Patton et al., 2012).

As seen in the modification of Borko’s (2004) conceptual framework (Figure 2), the facilitator’s view of the teachers they are instructing affects the relationship between them during professional development. The reverse of this is also seen, with the participants' view of the personality and quality of the facilitator affecting their engagement in the session. This interaction between the facilitator and the participants impacts the experience of the participants during the professional development program. The teachers’ perceptions of the professional development program itself also affects their experience during the session. This research will explore how a professional development program is modified by the discourse moves made by the facilitator and the effect of these modifications on the experience of the participants and the facilitators during professional development.

**Purpose of the Study**

The purpose of this study was to observe how a scripted professional development experience is affected by the moves that facilitators make during the session. Professional development sessions that are planned with the characteristics of effective professional
Figure 2. Modification of Borko’s four elements of professional development.

development in mind still may not engage all of the participants in the learning.

Participating teachers were studied to explore their perceptions of how the moves that the facilitator makes affects their engagement in the learning experiences.

Being able to identify the categories of moves that facilitators can use to maximize the positive experience of participants during professional development can
lead to a better use of professional development resources as implementation of the NGSS continues.

**Research Questions**

The research questions addressed in the study are:

1. How do facilitation moves used by professional development leaders during Science Professional Development influence the participation of educators in the learning?
   a. What are the educators’ perceptions of their own participation in the professional development as a result of the actions of the facilitators?
   b. What do the facilitators perceive during the professional development that causes them to adjust their facilitation moves?

2. To what extent do facilitators’ moves during Science Professional Development mirror teacher talk moves in high quality science classrooms?

**Description of the Methodology**

This phenomenological study used a mixed-methods approach to look at the experience of both participants and facilitators during a professional development session. I observed two offerings of the same professional development session during the California Professional Learning #1 between January and March of 2021. I analyzed the script of the professional development session for planned facilitator moves and compared the scripted moves to the moves that the facilitators were observed making during the professional development sessions. I coded these facilitator moves and the moves identified in the session scripts using codes described by Michaels and O’Connor (2015) which overlap the three categories of talk moves with those moves that helped
participants *sustain an inquiry stance* identified by González et al. (2016). These categories of talk moves are helping individual students *share their ideas*, helping students *deepen their reasoning*, and helping students *engage with each other’s reasoning*.

Participants completed a brief survey each time they identified themselves as particularly engaged or disengaged in the professional development workshop. These surveys allowed me to relate the participant experience to the facilitator moves. I interviewed the facilitators regarding their motivations for adjusting the professional development script and their perception of the engagement of the participants. This will allow me to understand why the facilitators deviated from the scripted moves. I was able to consider the experience of the facilitator and the participants in regards to the actual facilitator moves made during the professional development, and then categorize the moves used during the professional development to understand which group of moves is most used by facilitators to influence the experience of the participants during professional development.

**Limitations**

These statewide professional development sessions were scripted originally for in person professional development and then updated for online professional development. The facilitators were chosen by regional county office science leaders. Due to this, I was not able to choose the facilitators who lead the sessions. This means that I could not control for the training or expertise of the facilitators in regards to leading professional learning. I also was not able to choose facilitators who have studied the use of talk moves in instruction. I did not have a list of participants before the session or know their
motivations for attending the professional development. There were different numbers of
participants in each series of the professional development. The virtual professional
development format affected the way that facilitators interacted with the participants
during the session and only moves made in the main room of the session were able to be
observed.

**Significance of the Study**

If facilitator moves can be identified that increase the engagement of participants
in professional development sessions, professional development experiences will be more
effective and useful to the educators who attend them. This can positively impact the
science content and pedagogy learning of science educators and in turn the experience of
students in science classrooms. Understanding how facilitator moves enhance the
experience of teachers during professional development is important in the current time
of expected professional development to increase educators’ knowledge and application
of the NGSS in their classrooms and can support ongoing professional learning needs of
teachers in the future.

This understanding of facilitator moves adds to the body of research focused on
identifying the characteristics of effective professional development. The current
literature outlines the practical aspects of planning professional development experiences,
but does not address the human aspect of educator and learner interactions.

**Educational Leaders**

The significance of the study for educational leaders is as a support for planning
system-wide professional development. Educational leaders will be able to identify
facilitators of professional development who have a strength in using discourse moves
during professional development sessions in order to increase the likelihood that their teachers will engage in and take on the new learning from the sessions they attend. They will also be able to improve on their own use of talk moves in the professional development they lead for their staff, thereby making their professional development workshops more effective. Finally, educational leaders who train or support teachers to lead professional development will have a tool to help these teacher leaders increase their effectiveness when working with colleagues.
CHAPTER 2—REVIEW OF THE LITERATURE

Next Generation Science Standards Implementation

Implementation of the NGSS in classrooms comes with a variety of challenges. Many K-12 educators do not yet have access to NGSS-aligned curriculum nor are they proficient in the instructional strategies that support NGSS instruction (California Department of Education, 2018). In asking teachers to shift their instructional practice to meet the reforms expected in NGSS instruction, teachers need professional development experiences that build both their knowledge of what they teach and their experience with how to teach science (Desimone et al., 2002; Garet et al., 2001). To support teachers in their implementation of NGSS, educators need to have professional development experiences that support them to understand science ideas and connect those ideas to phenomena, to use the practices of science and learn how to help students engage in the practices, and provide support in the use of classroom discourse to allow students to share ideas (National Research Council, 2012). B. J. Fishman et al. (2003), suggest that positively impacting teacher knowledge and beliefs during professional development can lead to improved student learning in the classroom.

In this review of the literature, I describe the types of professional development that science teachers engage in as a part of the NGSS transition. I will outline the characteristics of effective professional development, describe characteristics of facilitators (the science educators who are leading the professional development), and the characteristics of participants (the science educators who are learning during the professional development). This is followed with a description of the instructional strategy of talk moves which is used by teachers to increase classroom participation.
through student discourse (the student-to-student conversations that occur in classrooms) and can be used by professional development facilitators to increase educator participation during their learning experiences.

**Professional Development**

Professional development is often studied for its ability to support teachers to implement new content, pedagogy, or curriculum in classrooms. Teachers might attend professional conferences, workshops, district professional development sessions, participate in professional learning communities or study groups at their sites, read on their own, or informally collaborate with other teachers (Banilower et al., 2013; Shaw et al., 2018).

Banilower et al. (2007) analyzed 25,016 surveys completed by 18,657 teachers who participated in Local Systemic Change professional development programs funded by the National Science Foundation in 1995. These surveys were analyzed for eight outcomes related to high quality science instruction such as the teachers’ attitudes towards standards-based instruction, how prepared to instruct in science the teachers perceived themselves to be, and the time that teachers devoted to science instruction in their classrooms. The results of Banilower and colleagues’ (2007) survey analysis suggests that different types of professional development might be better correlated to different learning needs of teachers. For example, learning a new pedagogical skill might improve at a workshop while improving teachers’ focus on student thinking may better occur in a grade level team. Therefore, a range of professional development experiences might need to be available to teachers as they transition to NGSS facilitated by site, district, county, or state presenters.
Professional development experiences can be grouped into two types of activities: traditional activities, such as workshops, college courses, or conferences; and reform activities, such as study groups, professional learning communities, or mentorships (Garet et al., 2001). The traditional learning experiences can take place within sites or districts or at a county-wide or state-wide workshop open to any educators who register. These professional development experiences often include planning to use instructional materials, analyzing student assessment data, or focusing on the state standards (Banilower et al., 2013). Reform models of professional development tend to focus on changing instructional practice by utilizing teacher learning communities. These professional development experiences are often teacher led, and allow teachers to put their learning into immediate practice in their classrooms (Little, 2002). It is often assumed that professional development following reform models might be higher-quality experiences for teachers than traditional professional development. Based on an analysis of Teacher Activity Survey data from the Eisenhower Professional Development Program, Garet et al. (2001) found that many teachers’ experiences of professional development, whether they were based in traditional structures or used reform practices, do not use the characteristics of high-quality professional development. These characteristics will be discussed in the next section.

**Elements of Professional Development**

Four elements of professional development were proposed by Borko (2004) based on a synthesis of the literature. Borko describes these as the relationship between the program being used, the teacher participants, and the facilitators, as seen in Figure 1 as well as the context surrounding the professional development. The author suggests that
the relationship between these elements may affect the impact of professional
development on teacher and student learning. Through her review of professional
development literature using this lens, Borko suggests that teacher professional
development often results in a range of participant learning that mirrors what is seen in
student learning after classroom instruction. Borko also suggests that if the professional
development program makes use of situated learning through the opportunity for teachers
to use their own classrooms as tools in their learning, there is increased participant
learning from the professional development experience. I explore the characteristics of
the program (professional development), participants, and facilitators.

**Characteristics of Professional Development**

A consensus of the literature describes characteristics of effective professional
development. Regardless of the type of professional development that educators attend,
research suggests there are some features that make the learning high-quality for
participants. Odden et al. (2002) define effective professional development as
“professional development that produces change in teachers' classroom-based
instructional practice, which can be linked to improvements in student learning” (p. 53).
Studies over the last two decades have described a consensus of five characteristics of
effective professional development experiences. These characteristics include a focus on
content, active learning of the participants, a coherent connection between school,
district, and state policies, professional development activities that span sufficient time,
and the collective participation of teachers who work together (Darling-Hammond &
Richardson, 2009; Desimone et al., 2002; Penuel et al., 2007). Each of these
characteristics has been individually studied for its impact in professional development and will be further described.

*A focus on content* means that the learning will be centered on a big idea or multiple big ideas in science that the educators expect to use in their classrooms. These might be related to scientific phenomena or scientific practices. Desimone et al. (2002) surveyed all of the teachers who taught mathematics and science from one elementary, one middle, and one high school in each of ten school districts that had adopted a diverse approach to professional development (the use of multiple formats of professional development) from across the country. Teachers completed a survey one time each year across three school years in order to allow for an analysis of the relationship between the teachers’ professional development experiences and classroom practice. This study suggests that having a content focus for professional development connected to more teachers implementing that content in their classrooms with students. In his recommendations for NGSS professional development, Reiser (2013) describes a need for teachers to interact with cases of students engaging in sense-making related to a specific phenomenon in order to build both the skills and content needed for high-quality classroom instruction.

*Active learning* of the participants in science can be described as hands-on, minds-on. Active learning includes experiences where learners engage in activities that are meaningful to the content and expect learners to think about the activity and content (Prince, 2004). In professional development experiences, these active learning experiences might be reviewing student work, participating as a learner in a science experience, or engaging in discourse with colleagues. During an examination of the
pedagogy used during physical education professional development, participants shared that engaging in active learning as a group allowed them to work collectively in both the actual physical activities they did and in the discussions they engaged in (Patton et al., 2013).

*coherent connection* delivers a clear message across each level of education so that all of the science educators in the system understand how state-level standards and frameworks connect directly to the expectations of site administrators for science instruction (Penuel et al., 2007). This directly relates to the context element identified by Borko (2004) as the setting in which the professional development takes place in the system. Lave and Wenger (1991) state that “learning is an integral part of generative social practice in the lived-in world” (p. 35). This definition of situated learning describes the needs for teachers to have their day-to-day instruction or their lived-in world connected to the systems in which they are working including the site, district, county and state guidelines for instruction. This coherency allows for situated learning to occur during professional development, in that teachers are able to connect the learning they build during professional development experiences directly to their classroom practice. It also allows for the learning that occurs during professional development experiences to be built into the context that teachers are actively working within at their schools (Borko, 2004; Darling-Hammond & Richardson, 2009; Putnam & Borko, 2000).

*Sufficient time* of professional development refers not just to the difference between a two-hour workshop and an eight-hour workshop, but also to the need for professional development to be extended over the course of a semester or school year (Desimone, 2009). This allows educators to try on what they learn in professional
development and then bring back those experiences to share with peers. The results from Garet et al. (2001) indicate that “sustained and intensive professional development is more likely to have an impact . . . than is shorter professional development” (p. 935). From the PRACTISE project, which was a study conducted regarding the extent to which 37 elementary teachers instituted the use of instructional strategies to support students engaging in scientific argument in the classroom, comes an example of this need for sufficient time. These teachers participated in a week-long summer professional learning and four follow up sessions during the school year. The follow up sessions focused on teachers watching videos of their own classroom practice to analyze their use of the instructional strategies and participating in one-on-one coaching sessions. All of the teachers were found to have a significant increase in their use of the instructional strategies over the course of the year (E. J. Fishman et al., 2017).

Tied to this approach of learning over time is the characteristic of collective participation, the idea that learning with peers at similar sites or grades will allow teachers to form cohorts that support one another with ideas and strategies beyond the formal hours of the professional development. This creates a space for learning from professional development to be infused into daily teacher practice and shortens the feedback loop as educators try on new learning in classrooms (Patton et al., 2015). Reiser (2013) describes this as teachers constructing collaborative learning environments that allow them to transfer the abstract learning from professional development to concrete classroom use.

While these characteristics appear to be features of effective professional development, results from studies testing each of these features suggest “that these
features may capture surface characteristics and not the mechanisms that account for
teacher learning” (Committee on Strengthening Science Education through a Teacher
Learning Continuum, 2016, p. 118). Examples of these mechanisms might include
characteristics of the facilitator, moves used by the facilitator, or the social dynamics of
the participants themselves as will be explored below as the elements of professional
development.

**Participant Characteristics**

The characteristics of participants contribute to the professional development
experience. During a professional development, educators might be expected to learn
both about the science they teach and about how to teach science (Garet et al., 2001). The
*active learning* characteristic of effective professional development described previously
means that participants will be expected to share their ideas of both science content and
pedagogy as learners during a workshop. This involves a layer of vulnerability with the
facilitator and their peers. It is also known that teachers often grow in their learning when
confronted with a contradiction to what they already know (Wood et al., 1990). Due to
this, participants might feel anxious about being accepted by the other participants in the
room, being thought competent by the participants and the facilitator, or their ability to
connect with and understand the content of the professional development (Heron, 2010).

Learning is also a social endeavor (Lave & Wenger, 1991; Patton et al., 2013). This means that learning occurs as a community of learners come to terms on what they
understand and negotiate the meaning of shared activities. With these considerations,
effective facilitators of professional development must build in activities and space for
discourse and participants to be learners while being empathetic to the variety of
experiences and expertise that the participants bring to a learning experience. Participants must be supported to form this nonjudgmental learning community with a focus on student learning and shared experiences (National Research Council, 2000).

**Facilitator Characteristics**

The characteristics of facilitators who lead professional development vary based on their expertise and training. The facilitators might be instructional coaches at school sites, teachers on special assignments in school districts, paid consultants, or county office of education content coordinators. Facilitators bring a range of classroom experience and leadership experience to the professional development they lead.

Remillard and Geist (2002) add to the needs for the facilitator in this learning relationship. They found that the facilitator must balance sustaining an inquiry stance with maintaining a safe environment for the participants to engage in the learning experience. Remillard and Geist observed three facilitators involved in piloting Developing Mathematical Ideas (DMI) materials prior to their publication. These materials are case studies of students’ mathematical thinking design to be used by teachers participating in professional development together. The materials include the participant materials and a facilitator guide that provides structure and activities for each session. Remillard and Geist observed the sessions, and interviewed the facilitators. All three facilitators experienced opportunities, or openings in the curriculum, to engage with participants’ questions or challenges that were not expected or planned for in the materials. The ways that facilitators responded to these openings played a critical role in “fostering inquiry and explorations” within professional development (Remillard & Geist, 2002).
Schifter and Lester (2005) describe the active role of a facilitator as having three qualities: facilitators need to deeply understand the content they are presenting, they must know and stay focused on the learning goals of the professional development, and they must be open and responsive to participants’ ideas and perspectives. Patton et al. (2012) conducted semi-structured interviews and informal conversational interviews with twelve physical education professional development facilitators. Through these interviews, Patton et al looked to describe the role of facilitators in professional development. They identified three beliefs that professional development facilitators tend to have in common: (1) teachers bring knowledge and experience to the professional development, (2) adults learn in an active manner, and (3) learning occurs in a social context. Both of these studies illustrate a need for facilitators to be content skilled as well as adept in working with adult learners.

Participants expect their facilitators to be experts in the body of scientific knowledge, skilled in teaching techniques, attentive to the learning needs of the participants, and competent communicators (Heron, 2010). As Heron (2010) discusses, facilitator-style is unique to each facilitator and facilitators can grow their skills in being fully in the moment during professional development, noticing and responding to the feelings that participants are experiencing about their learning, and using verbal and nonverbal methods to sustain a supportive learning environment for participants.

Teachers bring their history with them to professional development experiences. For novice teachers, this might be their experience as learners in the classroom. For experienced teachers, this history includes memories of previous professional development workshops along with their years of classroom instruction. Participants
want to be viewed as experts themselves, with validation from the facilitator for the knowledge and teaching experience that they bring to professional development (J. Knight, 2009). During professional development, educators are asked to take a learner stance. This is often described as taking off a teaching hat and putting on a learning hat, or moving from outside the box to inside the box. It requires that the facilitator promote a level of trust between themselves and the participants. “Helping teachers become comfortable with the role of learner is very important” (National Research Council, 2000, p. 195).

**Training of Facilitators**

While facilitators clearly affect the experience of the participants during professional development and are expected to be able to lead with expertise in science content, science education pedagogy, and an understanding of the needs of adult learners, they are often given little to no training (Perry & Boylan, 2017; Stoetzel & Shedrow, 2019). Over 5 months, Perry and Boylan (2017) supported seven professional development facilitators to engage in workshops and online discussions centered on sharing videos of themselves leading professional development. The participants discussed which activities were effective in the professional development they led, learned about four models of professional development, and shared their views regarding professional development. In their study of facilitators, Perry and Boylan identified the areas that facilitators need support, including knowledge about professional development structures and models along with a significant need for facilitation skills and knowledge. Stoetzel and Shedrow (2019) interviewed four international instructional coaches regarding their participation in an online coaching certificate program. They found that
coaches are entering their roles without the training to effectively support teachers using this professional development facilitation role. They found that this training needs to occur during the initial phase of a facilitator’s role and then continue in an ongoing manner.

**Online Professional Development**

While there has been an increase in the use of online professional development in education, there is not an extensive body of research describing its effectiveness. Online science professional development allows more educators access to learning experiences, such as those that work in rural areas and those that work in districts which do not have teacher leader support for science. In their analysis of 23 articles about online professional development and learning communities, Macià and García (2016) described the need for building trust in online communities of learners. This trust grows through engagement in learning tasks and sharing of ideas. This need for collaboration during online learning is reinforced by Francis and Jacobsen (2013) who worked with 11 teachers during four synchronous, online mathematics professional development sessions. During these sessions, the teachers solved mathematics problems together and used those shared experiences to discuss the learning needs of students in their own classrooms. Based on the recordings of the sessions, field notes, and interviews with the participants, the researchers described effective online professional development as those that allow participants to get to know one another, build comfort with the technology, and work collaboratively. Similarly, Macià and García (2016) also discussed the need to support participants “to engage and share knowledge especially at the beginning” as well as choose technological tools that allow for participant collaboration.
Discourse

Discourse in Professional Development

During professional development experiences, discourse can be used as a tool to increase participant interaction. In an effort to increase active learning and support the social process of learning, facilitators often ask the participants in professional development to engage in academic discourse as a learning method. There is currently limited research available studying the use of facilitator moves during professional development. González et al. (2016) studied five high school mathematics teachers engaged in a one-year study group. During the study group sessions, the teachers looked at animations of student work and teacher actions before progressing to teaching a research lesson and then using videos of that lesson as the basis for the study group discussion. The facilitators of the study group sessions would prepare by watching the videos or animations themselves, identifying possible responses from the teacher participants, and engaging in role-playing with the other facilitators to develop their ability to respond in-the-moment to the teacher participants. González et al. (2016) found that “understanding the facilitator moves during professional learning can help to educate facilitators and to broaden the resources for promoting teacher inquiry” (p. 463). Through analysis of transcriptions of the study group sessions, four categories of facilitator moves were identified. These moves included those that oriented participants to the task, sustained the inquiry of the group, maintained the content focus of the professional development, and supported the collaboration of the group members.

Moves that oriented participants to the task, include launching the discussion, contextualizing the discussion, or moving the discussion along with a transition to a new
activity. To sustain the inquiry stance of the group, facilitators used moves to highlight or lift up participants' ideas, pressed participants for more details, clarified, offered their own explanation, or countered a participant’s idea with an alternative. Redirecting the group to the goals of the session, pointing to evidence from the videos and connecting participants’ ideas together were moves used to maintain the focus of the group. To support the collaboration of the group, the facilitator distributed participation by encouraging all of the participants to contribute to the discussion, validated participants' ideas and stood back to allow the participants to do the majority of the speaking.

**Discourse in the Science Classroom**

In the science classroom, discourse is used to increase interaction between students during instruction. Facilitators might make use of strategies that enhance participant discourse by using strategies such as talk moves that have been shown to increase academic discussion in classrooms (Michaels & O’Connor, 2015). Productive talk in science classrooms is focused on students providing explanations and participating in evidence-based argumentation related to science content.

Researchers and teacher educators have tackled the challenge of helping teachers at all stages develop skills in facilitating discussion so that it is the students who do the heavy lifting in terms of explaining, justifying claims with evidence, and critiquing and improving ideas in concert with peers. (Michaels & O’Connor, 2015, p. 333)

Talk moves are specific questions and phrases that teachers are able to use to facilitate productive discussion in their classrooms. These have been identified through observing classroom instruction and patterns of teacher language during discussions.
Michaels and O’Connor (2015), identified four goals for productive discussions in classrooms: helping individual students share their ideas, helping students listen to one another, helping students deepen their reasoning, and helping students engage with each other’s reasoning.

While observing the classrooms of teachers that had participated in Talk Science professional development, Sassi et al. (2013) coded this teacher facilitation of discussions into four types of moves that mirror the four goals identified by Michaels and O’Connor (2015). *Expand moves* build on student ideas by asking students to say more or revoicing their ideas. *Listen moves* encourage students to listen carefully to their peers by asking students to repeat or explain their classmate’s ideas. *Press for reasoning moves* push students to provide evidence or dig deeper into their thinking by asking students why they think something or providing a discrepant event to be explained. Finally, *think with others moves* include asking students to add on to their peers' ideas or disagree with their peers using evidence. Teachers who use these practices regularly seem to increase the productivity of their students’ science discussions. This leads to increased learning by individual students and the class as a whole.

In a study of how teachers use their own questions or responses as moves to support students to discuss their mathematical ideas with one another, researchers found that teachers do not use the same set or order of moves with students each time, but tailor their moves based on the discussion itself (Franke et al., 2015). Franke et al. (2015) identified *invitation moves* as requests for students to engage with one another’s ideas. An example of this might be to ask one student to explain their understanding of another student’s solution. They identified *support moves* as those moves that used probing,
scaffolding, or positioning by the teacher to help students engage with one another’s mathematical ideas. Probing and scaffolding supports from the teachers generally ask students to provide more details about their ideas or others’ ideas. Positioning moves by the teacher were used to help students make connections between different student’s ideas. These three categories of support moves allowed students to provide more detail about each other’s ideas, to clarify their own understanding, and to connect their ideas to other students.

During the PRACTISE project described earlier, similar categories of teacher moves used to support students’ discourse in the science classroom were identified as ask, press, and link moves. Ask moves are characterized as open-ended questions from the teacher to the students. Press moves, like the support moves discussed previously, push students to elaborate on their reasoning. Students are asked to connect their ideas to the ideas of others, when teachers use link moves which are similar to the positioning moves described earlier (E. J. Fishman et al., 2017).

By having these moves available to them, teachers were able to deepen students' thinking in the classroom. According to Franke et al. (2015) by using these moves to invite and support students to engage with one another’s ideas, teachers created a climate of learning that allowed students to participate in a way that shaped their knowledge of math and their identity as mathematicians.

**Intersection of Talk Moves and Facilitator Moves**

Talk moves intersect with the facilitator moves used to increase discourse during professional development. NGSS is based on the collective participation of learners to share ideas and construct new science knowledge, making discourse a necessity in both
the science classroom and science professional development. The most used category of facilitator moves during the professional development described by González et al. (2016) was helping participants to sustain an inquiry stance. These moves promoted the majority of the opportunities for teachers to learn during the professional development experience. These inquiry stance facilitator moves mirror the talk moves we see in the classroom context described by the Inquiry Project as *expand, press for reasoning*, and *think with others*. They also align to the *support moves* described by Franke et al. (2015) as those moves teachers used to engage students in one another’s mathematical ideas and those described by E. J. Fishman et al. (2017) as integral to students’ scientific discourse.

A description of pressing, a facilitator move used to sustain an inquiry stance in the participants, is asking the participant for more details about a comment they made or a comment of another participant. Sassi et al. (2013) described this as a move to *press for reasoning* by the teacher, asking students to dig into one another’s ideas. This aligns with the probing support moves used by mathematics teachers to engage students in providing details about their solutions.

In offering their own explanation, facilitators might provide participants an opportunity to make sense of ideas together. Using the *think with others* talk move provides students with a similar opportunity to agree and disagree with one another until they come to a consensus of understanding. This is also seen in mathematics classrooms as *positioning*, the support moves that teachers use to engage students in connecting ideas together.

Returning to the four goals for productive classroom discussions identified by Michaels and O’Connor (2015), helping individual students share their ideas, helping
students listen to one another, helping students deepen their reasoning, and helping students engage with each other’s reasoning; there is an intersection between the facilitator moves used to sustain an inquiry stance in participants and the talk moves used by teachers to support student discourse is in the three goals of helping individuals share their ideas, helping individuals deepen their reasoning, and helping individuals engage with each other’s reasoning. The goal of individuals listening to one another is not seen explicitly in the facilitator moves described by González et al. (2016) but might support the active learning and collective participation characteristics of effective professional development.

**Participant Engagement**

In their study of apprentices, Lave and Wenger (1991) argue that participation is crucial to learning. This allows the learning not just of a skill, but of the context that surrounds that skill (the language, access to exemplars, the various stages of production, and the details of the work itself). This adds weight to the need for active learning in effective professional development as described previously. For active learning to occur in professional development, participants need to willingly engage in the activities, discussions, and learning of the workshop.

In a classroom setting, engagement is difficult to quantify. Axelson and Flick (2010) state that learners can be emotionally, behaviorally, or cognitively engaged in a topic. Emotional engagement in the learning is focused on how much the learners are interested in the topic or content. Cognitive engagement is focused on how much learners think about and put effort into the learning of the topic or content. Behavioral engagement is focused on observable learner behavior such as taking notes, leaning
forward, asking questions, or watching the speaker. Axelson and Flick also suggest that if the learning environment suits the student, the learner will show more behavioral engagement. This implies that the level of engagement cannot be directly correlated to a specific learning environment, but instead might look different based on each learner. While their study focused on students, it has implications for the difficulty in defining how engagement of an educator might look during professional development.

Silver and Perini (2010) use a rubric to describe student engagement (Table 1). The behaviors of students range from Deep Engagement, shown through high levels of energy and a willingness to ask questions and take risks, to Passive Compliance characterized by following directions in a rote way. The lowest level of engagement on their rubric is Resistance which occurs when students who do not participate in learning activities. This rubric does not clarify the amount of times that a student needs to ask questions or take a risk in order to show the difference between Deep Engagement or normal engagement. It also does not differentiate between the behaviors of learners who are resistant to the learning activity because they do not want to engage in the learning versus are not able to engage in the learning.

Table 1

<table>
<thead>
<tr>
<th>Levels of Student Engagement</th>
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<tbody>
<tr>
<td><strong>Deep Engagement</strong>: Students take full ownership of learning activities.</td>
</tr>
<tr>
<td><strong>Engagement</strong>: Students begin taking ownership of learning activities.</td>
</tr>
<tr>
<td><strong>Active Compliance</strong>: Students participate in learning activities and stay on task without teacher intervention.</td>
</tr>
<tr>
<td><strong>Passive Compliance</strong>: Students follow directions in a rote or routine manner.</td>
</tr>
<tr>
<td><strong>Periodic Compliance</strong>: Students’ attention and participation fluctuate.</td>
</tr>
<tr>
<td><strong>Resistance</strong>: Students appear “blocked” - unable or unwilling to participate in learning activities.</td>
</tr>
</tbody>
</table>

Source: Silver and Perini (2010)
The engagement of educators during professional development is equally difficult to quantify. Facilitators might use their observations of the number of times a participant speaks, completes an activity, asks questions, or engages in group discourse as evidence of participant’s engagement in the learning. How facilitators define engagement of their participants may affect the moves they use with individual participants. For this reason, I am not defining engagement of participants but instead will rely on facilitators to describe what participant responses they individually react to as they make decisions about the moves to use during professional development.

**Application of New Research**

If the characteristics of effective professional development can be seen in any professional development setting and facilitators can use specific moves that allow participants to be more socially involved in their learning, connecting the use of facilitator moves based on the actions of participants during the professional development as evidenced by discourse of the participants furthers the knowledge about how to make professional development experience more impactful to science teachers as they continue their NGSS journey.
CHAPTER 3—METHODOLOGY

Overview

With the implementation of the NGSS, teachers need to shift their teaching practice towards a constructivist model. Reiser (2013) describes three shifts in teaching connected to NGSS instruction: moving from students learning facts to students explaining phenomena, engaging students in the science and engineering practices to build their scientific knowledge, and using storylines of science ideas to create a coherent schema for students. In order to make these instructional shifts, teachers need support in making both pedagogical and content focused changes in their classrooms. Professional development can increase the use of specific teaching practices in the classroom (Desimone et al., 2002) and participation in professional development can extend educator science content knowledge, particularly when educators experience high quality professional development that supports them to implement new practices in their science classrooms (Whitworth et al., 2017). The actions that facilitators make during professional development experiences can affect the experience of the participants, thereby increasing how much educators learn about science instruction.

This was a mixed-methods study designed to be primarily qualitative, focused on the lived experiences of the participants and the facilitators during professional development. There was a focus on the shared experience between the participants and the facilitators, placing this as a phenomenological study (Merriam & Tisdell, 2015). This is appropriate because participants were asked to share their feelings and opinions regarding the professional development sessions based on how engaged or disengaged they felt in relationship to the facilitator and the program. In addition, facilitators were
interviewed about the moves they made during the session based on how they feel about the engagement of the participants. This study began with collecting quantitative data regarding the planned facilitator moves written into the script for the professional learning (Figure 3). These professional development sessions were observed to see which moves were used by the facilitator while leading the session and were generally compared to the moves identified in the script. By following the story of the collected data there were opportunities for reflection about what was being learned and the relationships between the data. The moves taken by the facilitator were categorized based on the talk moves used in science instruction to increase student participation in learning through discourse. The participants’ survey responses included their reactions to and perceptions of the facilitation of the professional development. The facilitators were interviewed regarding the choices they made regarding facilitation of the professional development, their perception of the engagement of the participants, and their thinking related to the moves they used during the virtual professional development experience compared to those they might use during an in-person professional development session.

Figure 3. Overview of data collection.
Research Questions

The research questions addressed in the study are:

1. How do facilitation moves used by professional development leaders during Science Professional Development influence the participation of educators in the learning?
   a. What are the educators’ perceptions of their own participation in the professional development as a result of the actions of the facilitators?
   b. What do the facilitators perceive during the professional development that causes them to adjust their facilitation moves?

2. To what extent do facilitators’ moves during Science Professional Development mirror teacher talk moves in high quality science classrooms?

Study Context

The CA NGSS Statewide Implementation Professional Learning #1 sessions were chosen as the professional development to observe due to the attention given to the characteristics of effective professional development during the writing of the sessions. The professional development series was planned and implemented by the CA NGSS Collaborative. The Collaborative consists of the leaders of CA science education including the CA Department of Education, K-12 Alliance at WestEd, the CA Science Project, the CA Association of Science Educators, and the CA County Superintendents Educational Services Association. The sessions were written by a team of California science educators selected by the Collaborative for their expertise in both literacy and the NGSS. The sessions were vetted twice through a peer-vetting format and then the final scripts and slide decks were used to train the statewide facilitators of the sessions.
Observing a professional development series that was developed by an experienced collaboration of science leaders and was robustly vetted, allowed this researcher a measure of certainty that the professional development was planned with a consideration for the characteristics of effective professional development: a focus on content, active learning of the participants, a coherent connection between school, district, and state policies, professional development activities that span sufficient time, and the collective participation of teachers (Darling-Hammond & Richardson, 2009; Desimone et al., 2002).

The CA NGSS Statewide Implementation Professional Learning #1 is entitled *Building Student Sensemaking Through Disciplinary Literacy*. Participants were asked to register as a team of educators with an administrator. At registration, participants were asked to choose between four available sessions: *Argumentation: Moving Beyond CER to Help Students Make Sense*, *Discourse for Sensemaking in Science*, *How to Use Science Text*, and *Use of Notebooks for Sensemaking in Science*. The *Use of Notebooks* strand of this series was offered three times in 2021 between January and March, though it was only observed in February and March. The observed sessions were a 12-hour deep dive into a disciplinary literacy science topic, offered in a four-day format over two weeks, in the evenings in February and in the mornings in March. This was followed by action periods for participants to try on their new learnings in the classroom, and reflection sessions at the end of each action period. These follow up sessions were not observed. Both the February and March offering of this professional development series were enacted as a K-12 experience and included classroom teachers, teacher leaders, and administrators.
Both the writers and veters of the sessions have a history of participation in CA NGSS Professional Learning offered by the Collaborative as well as a wealth of experience in developing and leading science professional learning for districts and schools. The CA NGSS Professional Learning #1 was originally planned as an in-person professional development experience. This would have been offered at multiple county office locations across the state in a two-day format. Participants would have attended two 3-hour sessions each day. Each session would include hands-on science experiences connected to science disciplinary literacy as well as discussions to allow participants to consider how their learning applies to the classroom. Much of this discussion also would take place informally as teams sit together for lunch or connect during breaks. Facilitators usually lead a full day of sessions during these live events, and will often sit in on the sessions they are not leading as part of their own learning. This allows for relationship building between the facilitators and participants across the two-day experience. When the sessions were rewritten for an online format due to COVID, the activities were kept as similar to those originally planned as possible. Card sorts were moved to Jamboard, model sharing was moved to shared Google slides, and introduction activities were moved to Padlet. The hands-on activities were simplified and could be completed with materials that participants should have in their homes. Discussions that would have occurred at tables were moved to breakout rooms and in the large group, became chat responses. The informal discussions between teams were lost with the change in format.

**Study Participants**

The study participants were chosen based on their facilitation of and attendance at the California NGSS Statewide Implementation Professional Learning #1. There were
over 50 participants during the February offering and fewer than 20 participants during the March offering. Due to the virtual nature of this professional development series, there were educators representing counties from across the state of California, from both urban and rural counties. A handful of educators in each offering had never had NGSS professional development prior to this experience.

Facilitators for these sessions were chosen by the CA NGSS Professional Learning #1 writers as well as by their local county offices of education as local science education leaders. Of the 17 facilitators observed in February, 12 of them had experience leading previous CA NGSS Professional Learnings (CA NGSS Rollouts), as well as leading professional development regularly in their role as regional directors for K-12 Alliance at WestEd, directors of CA Science Project sites, and County Office Coordinators. Six of them have written, vetted, and led sessions at all seven of the previous professional learnings offered by the CA NGSS Collaborative. The other five facilitators in February were district science teachers on special assignment, responsible for leading professional development at sites within their districts. In March, one facilitator did not have previous experience leading professional development. The other 13 facilitators had a similarly extensive amount of experience as the February facilitators.

The facilitators were trained by session writers to follow the session scripts during a trainer of trainers event a few months prior to the initial professional learning offering. During this training, the facilitators acted as participants while the writers facilitated the sessions. This was not an exact replica of the professional development session, but instead included both the activities that the professional development participants were expected to experience during the six 90 minutes sessions which all participants attended.
together, as well as overviews of the six choice sessions that participants were able to choose from for the second 90-minute session of the second and third days of the professional development. This meant that while the training experience included all of the activities, the facilitators discussions were kept brief and included points about how to lead the activities and a focus on the expected outcome of each 90-minute session.

The observations and data collection for this study focused on the *Use of Notebooks for Sensemaking in Science* session of the California NGSS Statewide Implementation Professional Learning #1. The facilitators at the two observed offerings of the session included a writer of the session and multiple trained local science leaders. There were a pair of facilitators for each 90 minutes section of the 12-hour professional development series. This allowed for a large variety of facilitators to be observed with each group of participants. By observing the same session in two of the California NGSS Statewide Implementation Professional Development #1 offerings, I was able to note the facilitator moves used and the adjustments that facilitators made based on their perceptions of the participants’ engagement, while keeping the content of the professional development the same for comparison. *Use of Notebooks for Sensemaking in Science* was selected as the session to observe because it does not have a focus on discourse which might skew the results of the facilitation and it was offered more than once due to a high number of registrations compared to the other strands of the California NGSS Statewide Implementation Professional Development #1.

**Data Collection and Instruments**

I observed the *Use of Notebooks for Sensemaking in Science* session of the California NGSS Statewide Implementation Professional Learning #1 during the
February 2021 and March 2021 offerings. I used the session scripts to log expected facilitator moves prior to the first offering. I recorded the 24 hours of professional development sessions using a screen recording program and kept recordings on a password protected computer. I also took field notes during the professional development sessions to support my data collection and interviews with the session facilitators. I surveyed participants using an anonymous Google Form during the course of the professional development sessions and interviewed as many of the session facilitators as was possible after their section of facilitation.

**Facilitator Moves**

Facilitator moves were identified using script analysis and transcripts of the recordings of the professional development sessions. First, I identified the expected facilitator moves that were written into the script. This gave me a foundation for the kinds of talk moves that facilitators were expected to use and how facilitators were supported by the script to engage participants in the learning. During the professional development, I took field notes on any noticeable facilitator moves and participant responses based on the facilitator moves. I used the recordings of the professional development sessions to identify the facilitator moves made during each session.

**Professional Development Participant Experience**

The participant experience was collected throughout the professional development. Due to the length of the professional development sessions, I provided the participants with a survey to respond to when they felt particularly engaged or particularly disengaged. This included a comment section for them to explain what was happening during the program and what the facilitator was doing or saying at that
moment that caused them to feel engaged or disengaged. The implemented survey was modified based on the results of a pilot. I piloted this as a survey given at set intervals during a vetting of another professional development session in California NGSS Statewide Implementation Professional Learning #1. During this pilot of the survey instrument, the educators checked if they actively participated, passively participated, or disengaged from the session learning and explained what they thought the facilitator did to contribute to their engagement. This pilot showed that the participants need to be able to respond about their feelings in the moment, or their explanations become very general such as, “I think the facilitator did a good job with the presentation.” This original instrument was adapted from the StRIP Student Instrument described by DeMonbrun et al. (2017). This student instrument was designed to meet the need of assessing students' responses to instructional strategies used in the classroom. Since this mirrors the work of the facilitators, providing high quality learning experiences, I felt that this survey allowed me to assess the participant experience during the professional development with a focus on the instructional moves used by the facilitators. These surveys were anonymously submitted in 125 unique instances and were time stamped. This allowed me to collect evidence of how the participants’ experienced the professional development session and to connect those experiences to the facilitator actions.

**Professional Development Facilitator Experience**

The facilitator experience was assessed during interviews at the end of each session. Using the timestamped participant surveys which I monitored in real time, and my observation notes, I prompted the facilitators to share what caused them to adjust their facilitation away from the script when they were observed to do so during the
sessions. I conducted interviews with the professional development facilitators at the end of the session of the professional development when I was able to. Overall, I conducted a total of eight facilitator interviews with sixteen facilitators. These interviews focused on the facilitator experience preparing for and leading the professional development session. I asked facilitators to describe adjustments they made to the session from the script and the reasons behind their adjustments. I also asked the facilitators for their perspective on the quality of the professional development, how prepared they felt to lead the session, their experience during the session, and how their use of talk moves during this professional development compares to the moves they might use during an in-person session.

**Procedures**

In accordance with the approved IRB process, data was collected using the scripts of the professional development, observation notes made during the professional development sessions, transcripts of recordings of the professional development sessions, surveys completed by the participants during the professional development session, and interviews with the facilitators of the professional development sessions.

Ethical issues related to the study were limited to access to evaluative statements of the facilitator by the participants and the recordings of the professional development sessions. The surveys were kept confidential and were submitted anonymously with access to their responses only available to the researcher through password access. The session and interview recordings were made on a password protected computer and were only available to the researcher. These recordings were deleted once the session transcripts were made.
Data Analysis

Initially, I coded the data gathered from the scripts regarding the facilitator moves that were planned to occur during the session using the three categories of talk moves from the four goals for productive classroom discussions identified by Michaels and O’Connor (2015) that overlap with the facilitator moves seen by González et al. (2016) as those moves that facilitators used to help participants sustain an inquiry stance. These categories of talk moves are: helping individual students share their ideas, helping students deepen their reasoning, and helping students engage with each other’s reasoning. After initial coding, facilitation moves that did not fit into the three identified talk move codes were identified. These facilitation moves fell into two groups and were coded as relationship building moves or direction moves. Sixty-five facilitation moves were identified in the scripts. Fifty-nine percent of these moves were coded as moves that supported participants to share their ideas, 15.3 percent were coded as moves to help participants deepen their reasoning, 9.2 percent were coded as moves designed to engage participants with each other’s reasoning, 6.2 percent were coded as relationship building moves, and 10.8 percent of moves in the script were coded as directions.

After analyzing the scripts, I repeated coding with the actual moves made by the facilitators during each session of the professional development that I observed. I compared the number of each type of move enacted by the facilitator to the expected moves coded in the script. This allowed me to focus on the moves the facilitators made during the professional development experience based on their perspective of the participants’ engagement and ask the facilitators about adjustments they made to the script during their interviews. I was able to specifically code the facilitation moves as
those moves identified by González et al. (2016) as used to sustain an inquiry stance as well as moves designed to build relationships with participants and give directions to participants as seen in Table 2. For reliability, 25 percent of the professional development session transcripts and scripts were double-coded by another researcher. The percentage agreement between the two raters was initially 90 percent and discrepancies were reconciled through discussion.

Table 2

Facilitator Moves Code Book

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Exemplar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helping Individuals Share Their Thinking</td>
<td>Facilitator moves designed to support participants to share their ideas in the chat or verbally.</td>
<td>Please type in the chat one of your noticings.</td>
</tr>
<tr>
<td>Helping Individuals Deepen Their Reasoning</td>
<td>Facilitator moves designed to support participants to expand on their ideas or explain what their ideas mean more fully.</td>
<td>Would you like to explain more about what you wrote in the chat?</td>
</tr>
<tr>
<td>Helping Individuals Engage with Each Other’s Reasoning</td>
<td>Facilitator moves designed to support participants to discuss their ideas with one another or explain their understanding of one another's ideas.</td>
<td>Come to a consensus on a common explanation (refinement part) that you can orally share with other groups.</td>
</tr>
<tr>
<td>Relationship Building</td>
<td>Facilitator moves designed to support participants to build comfort or trust with the facilitators and/or with other participants.</td>
<td>Remember the norms that we are using in these sessions. Say hello in the chat.</td>
</tr>
<tr>
<td>Basic Directions</td>
<td>Facilitator instructions for activities.</td>
<td>Write “done” in the chat when you are finished. Write in your notebook . . .</td>
</tr>
</tbody>
</table>

I used the participants’ survey responses to understand their perceptions of their own engagement in the professional development session. I also used the survey responses to identify the moves the facilitators made related to the moments of engagement or disengagement identified by the participants. I coded the surveys based on if the participants perceived themselves to be engaged or disengaged and if the reason they gave for their engagement was due to time, perception of the facilitator, activity, or
breakout rooms. The surveys were time stamped which allowed me to connect the participant perceptions of the experience with the moves being made by the facilitator during that section of the professional learning. I also noted that the participant responses were often connected with the characteristics of effective professional development.

I analyzed the facilitator interviews for their perceptions of the engagement of the participants. I identified the descriptions of the participant actions the facilitator described noticing during the sessions, as well as the general perception of the quality of the session by each facilitator. I initially coded the facilitator interviews based on categories related to the facilitators’ preparation and delivery of the professional development sessions. These initial codes included participation, time constraints, previous experiences, training, participant viewpoint, and support. Then I analyzed the facilitator interviews for patterns among their perceptions of the facilitation of live professional development compared to a virtual professional development setting as well as their use of talk moves. These codes included proximity, relationships, ability to read the room, and activities.

**Limitations**

The two offerings of this professional development series had different numbers of participants. This likely affected how much facilitation led to discussion in the main virtual learning space in the February session compared to the March session. I have been a participant, writer, and facilitator of previous CA NGSS professional development sessions, which could have caused me to infer purpose into the moves made by facilitators. This bias was lessened due to the random selection of participants and facilitators based on the session I chose to observe. I observed the moves of the many
facilitators while leading professional development instead of choosing a facilitator that was known to use talk moves as part of their practice. I interviewed facilitators alone, in pairs, and once in a group due to the time allowed between the end of each section and the beginning of either the next section or the team meeting for facilitators and writers at the end of each day’s session. This variation in how facilitators were interviewed may have affected their interview responses. The online format and the convenience sampling of facilitators may have affected how many moves I saw the facilitators use. Due to the qualitative nature of the study and the small sample size of the participants and facilitators, this research is not able to be generalized to all professional development.
CHAPTER 4—FINDINGS

Introduction

During this phenomenological mixed-methods study, the lived experiences of participants and facilitators of science professional development were analyzed to better understand the perceived quality of a professional development experience. The impact of the interaction among facilitators and participants is part of a conceptual framework based on a model of the relationship of four elements of professional development proposed by Borko (2004) which also includes the elements of the program being used as well as the context surrounding the professional development. As more teachers are expected to implement the NGSS in their classrooms, they need support both with the pedagogy of NGSS and the content mastery to organize storylines that students can engage with in the classroom (Reiser, 2013). By participating in high quality professional development, educators may extend their science content knowledge and begin to use new teaching practices in the classroom (Desimone et al., 2002, Loucks-Horsley et al., 2009).

Data for this study were collected during two observations of the Use of Notebooks for Sensemaking in Science strand of the California NGSS Statewide Implementation Professional Learning #1. During this strand, participants attended eight 90 minutes sessions as shown in Table 3, including the choice of two of the following pedagogy sessions: Notebooking 101, Using Student Thinking Tools, Modeling, Assessment, Publishing, or Claim, Evidence, and Reasoning. Fifty-four educators attended the February strand and fewer than 20 educators attended the March offering, providing 125 unique responses to the participant engagement survey. Seventeen
facilitators were observed in February and 14 facilitators were observed in March.

Sixteen of these facilitators participated in a total of eight interviews. Four of these 15-minute interviews were completed with individual facilitators and the other half took place in pairs or groups.

The findings of this study are organized by the research questions. Facilitator interviews, participant surveys, and session scripts and transcripts were analyzed to address the research questions. The questions in this study are:

1. How do facilitation moves used by professional development leaders during science professional development influence the participation of educators in the learning?
   a. What are the educators’ perceptions of their own participation in the professional development as a result of the actions of the facilitators?
   b. What do the facilitators perceive during the professional development that causes them to adjust their facilitation moves?

2. To what extent do facilitators’ moves during science professional development mirror teacher talk moves in high quality science classrooms?

| Table 3 |

**Observed Professional Development Sessions**

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1</td>
<td>Introduction to Notebooking</td>
<td>Learning Experience Part 2</td>
<td>Learning Experience Part 3</td>
</tr>
<tr>
<td>Part 2</td>
<td>Learning Experience Part 1</td>
<td>Pedagogy Session Choice 1</td>
<td>Pedagogy Session Choice 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● February - Modeling March</td>
<td>● February - Claim, Evidence, and Reasoning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Student Thinking Tools</td>
<td>● March - Claim, Evidence, and Reasoning</td>
</tr>
</tbody>
</table>
Research questions 1a and 1b will be discussed first as they lead to question 1 overall. Research question 2 will then be discussed, followed by further considerations for professional development which arose from the study analysis.

**Research Questions 1a and 1b**

What are the educators’ perceptions of their own participation in the professional development as a result of the actions of the facilitators?

What do the facilitators perceive during the professional development that causes them to adjust their facilitation moves?

The relationship between the facilitator and the participants is vital to the experience of professional learning. Remillard and Geist (2002) found that the facilitator must balance sustaining an inquiry stance with maintaining a safe environment for the participants to engage in the learning experience. As part of this balance, facilitators are also expected to be experts in the body of scientific knowledge they are presenting, skilled in pedagogy, attentive to the learning needs of the participants, and competent communicators (Heron, 2010). The experiences of both the participants and the facilitators are intertwined with the characteristics of the professional development and their perceptions of the educators they are working with during the session.

**Participant Perception**

Participant perception of the professional development was identified using survey responses made during the course of the sessions. Responses to this survey included both the participants' perception of themselves as engaged or disengaged at that moment of the session, as well as a description of what the participant felt caused them to respond that way. Participants' reasons for their self-identified engagement or
disengagement were categorized using four codes: Activity, Breakout Rooms, Perception of the Facilitator, and Pacing/Timing.

Over half of the participant responses to the survey were when they felt engaged, as seen in Table 4. Eighty-one percent of the times that the participants identified themselves as engaged were when they were doing an activity or working in a breakout room during the professional development. The activities included completing an individual self-reflection, participating in a Jamboard brainstorm, and coming to consensus on a solution to a problem. One participant shared that they were engaged “when we had a breakout room where we each had unique information to share, that others needed to collect” and another stated that “answering the [reflection] survey helped me think hard about my own practice.” When participants identified themselves as disengaged, none of their responses were coded as an activity. Participants who identified themselves as disengaged while in a breakout room, described the group they were assigned to work with as the reason that they were disengaged. Examples of the reasons for participants’ perceptions of disengagement while in a breakout room included the statements that the participant believed themself to be in a “low functioning group” and “others in the group are moving the stickies into groups that I don't believe in.” In an engaged response about breakout rooms, a participant shared that they were in a “functioning group this time. Everyone is participating.” Another participant shared that the breakout room was engaging because of its small size, “there are 3 of us and I feel engaged and welcome as well as willing to share.”
Table 4

Participant Survey Responses

<table>
<thead>
<tr>
<th>Code</th>
<th>Engaged</th>
<th>Disengaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakout Room</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Activity</td>
<td>27</td>
<td>0</td>
</tr>
<tr>
<td>Perception of the Facilitator</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>Pacing / Time</td>
<td>4</td>
<td>23</td>
</tr>
</tbody>
</table>

Three-quarters of the participant responses that were coded as Perception of the Facilitator were about moments they felt disengaged. These responses ranged from descriptions of the facilitators’ preparedness to lead the professional development, such as “speaker not confident and reads from slides” and “the presenter was reading every single slide with her notes and she seemed unfamiliar with her notes so her reading was not very smooth.” to perceptions that the content of the session was incorrect such as this participant:

The science explanation being presented for the cliff collapse is incorrect. I have a lot of prior knowledge involving coastal erosion (we run an informal education program focused on sea level rise and coastal change) and the cliff collapse in the video was caused by soil saturation and a faultline, NOT by waves. The cognitive dissonance is making it hard for me to engage.

When the participants noted that they were engaged due to the facilitator, their responses described the ability of the facilitator to provide “clear explanations” or directions and that they felt respected as a learner.

The participants also often identified as disengaged due to the pacing of the session. One participant shared on the first day of the series “it's been 45 min and we still have not done anything. It has been a review of why notebooks are important, but we
know that since we signed up for this workshop”. A second participant described being disengaged when they had “too long in the breakout room looking at models; too long in breakout rooms talking about problems. We enjoyed chatting with each other but it felt like a waste of time.” A few participants also shared that they felt disengaged when they felt like the facilitation was going too fast to be understood because there was not enough time in the session. Responses in this theme include when the facilitator “mentioned that they are running out of time and will speed things up” as well as feeling disengaged “when there is not enough time to finish a Jamboard or discussion and we are thrown back into the main room.”

Based on this analysis, the perception of the professional development program by the participants was positive overall due to the engagement they felt while doing the activities. Their perception of the facilitation varied depending on how the facilitator used the time in the session and how competent they felt the facilitator was both with the science content and their pacing of the learning. This supports the conceptual framework for this study shown in Figure 2, which illustrates that the interaction of the participants with the facilitators and the professional development program itself affect their experience.

**Facilitator Perception**

Facilitator perception of the professional development sessions can be grouped into two themes: the actions of the participants and their own actions. Three of the facilitators described being unable to tell if participants are engaged or not during the professional learning due to the size of the group. For example Anna said “with this big of a crowd I think most people aren’t standing out” or because of the length of time they
facilitated the group, such as Shawn who said “I was facilitating for 45 minutes of a 12 hour series. I don't feel I had enough time to make that determination.” During six of the facilitator interviews, the actions that participants made during the session were identified as the cues they used to tell if a participant was engaged. These actions included the use of the chat feature, actively speaking during a breakout room or whole group discussion, the use of the Jamboard, and the facial expressions or hand gestures used by participants in response to the facilitator. Participants working on the activities or discussing the science in their breakout rooms contributed to the facilitators’ perception that they were engaged as well. For example Margie stated that “The groups seemed engaged, they actually wanted more time [for the activity]” and Julia shared “you know when I jumped into the [breakout] rooms, there was conversation going on” and “The fact that there was conversation, that they came to a consensus, and that they put stickies on the Jamboard” led to her thinking the participants were engaged. Facilitators used participant responses in the chat as a tool to perceive the engagement of the participants. This was described by Dave who stated “they were using the chat at a good enough frequency for me to think that they were engaged” and by Christine who noticed that a participant “used the private chat feature of Zoom to interact with me [they were] actually like seeking out to participate.”

Facilitators made moves during the session based on participant actions. When Dave was concerned about the level of participation, he added a move designed to engage participants with the chat feature.

I just felt like at first I'm just giving a lot of information, so people can just phase out, tune out, because you don't engage them with some interaction right off the
bat. Like they may not be engaged. So to increase engagement, I chose to ask them to put something in chat about the phenomenon.

The facilitators’ actions during the professional development were also influenced by their previous facilitation of the same professional development session. In general, their perception of a session was improved based on the adjustments to the script which were made after previous facilitation of the same session. Terry describes this thinking regarding a change from an activity happening completely in a breakout room versus beginning in the main room.

So the last time what we found was that our participants did not have much background knowledge about claim, evidence, and reasoning. And so throwing them into the breakout, I was in the reasoning breakout and they had no idea what a claim or evidence was, so they couldn't do the reasoning part. So we kind of shifted it a little bit to make sure they had a little more experience with Krajcik’s claim, evidence and reasoning. And we kind of slowed that part down a bit to make sure, do we all know what a claim is, you know. And then they could go on and do the evidence and reasoning [in breakout rooms].

Anna shared how the writers’ previous experience facilitating the session led to the change she made from the script

I really only adjusted on the introduction part. Sort of laying the groundwork of what an adult learner is and how they were going to create their own notebooks.

That came straight from conversation with the writers.

These moves improved the facilitators’ perception of the professional development experience. From these adjustments, five facilitators felt that the session was higher
quality than previous sessions. Terry stated, “Eleanor and I presented this last month, and it did not go nearly as well as this session” and June added, “we got to spend a little more time on the habits of mind than last time and several people in the chat said that was the best.”

Prior to facilitating the CA NGSS Professional Learning #1, facilitators were able to participate in a Trainer of Trainers sessions. This Trainer of Trainers professional development was facilitated by the session writers and all facilitators were able to be participants in the session that they planned to lead for the statewide professional learning series. Participation in the Trainer of Trainers session gave facilitators the perception that they understood their participants' viewpoint of the professional development series. Nine of the sixteen facilitators interviewed attended the Notebooking Session Trainer of Trainers as participants. Of these, eight mentioned that this gave them an understanding of what their participants were going through during the professional learning session. Margie described having a “similar experience to a couple of the participants, where I wanted to propose a solution that wasn't one of the options” which led her to be sure to ask for alternate ideas during her facilitation of the session. Dave shared that “having had the chance to experience [the professional development] as a participant” benefitted his facilitation because he had empathy for his participants. Alex shared a similar idea during his interview,

Living that experience, right, so putting ourselves in the shoes of what the participants are feeling. I think that's super beneficial, it helped me anticipate where we might run into speed bumps here or there and what might be confusing to other folks.
Only two facilitators described ways that they deviated their facilitation from the script in the moment such as Kelly’s description of “skipping slides” to focus on the most important parts of the professional learning, while six facilitators described adjustments they planned prior to the beginning of the session to adjust for the time constraints. Facilitators were asked to provide a score from one to five, five being excellent, describing how they felt the session went and then provide reasons for their score. All of the facilitators interviewed rated their experience to be a four out of five. The general sense for why the session did not rate a five had to do with the facilitator's perception that there was too little time for the expected content to be delivered within the session. Christine describes this as “a 90 minute to a two hour session, inside of 75 minutes” and Liz stated “just because of the time crunch and not being able to devote [more time] to the activities that we wanted to,” while Eleanor shared that the moves she made were to “compress a lot. I wish there were a little bit more time.” The facilitators felt that the session was not perfect, but that the participants engaged in the learning and that they led the session to the best of their ability given the context of the session.

**Research Question 1**

How do facilitation moves used by professional development leaders during Science Professional Development influence the participation of educators in the learning?

The characteristics of high-quality professional learning have been studied for over two decades. The consensus of these studies centers on five characteristics: a focus on content, active learning of the participants, a coherent connection between school, district, and state policies, professional development activities that span sufficient time, and the collective participation of teachers who work together (Darling-Hammond &
Richardson, 2009; Desimone et al., 2002; Penuel et al., 2007). The experiences of the facilitators and participants in this study reinforced the need for active learning of the participants and added an angle to the characteristic of sufficient time that supports the need to not just see participants over a lengthy period of time to allow for classroom implementation and reflection, but also to allot sufficient time within each workshop to adequately complete the planned activities.

**Active Learning**

Active learning moves made by the facilitator supported the participants to engage with one another in activities such as using Jamboard to complete a card sort, developing a consensus argument, and reflecting on their own classroom instruction. As seen in Table 4, 81 percent of the participant survey responses that were marked engaged occurred when the participants were working on activities individually or in breakout room groups. This highlights the need for participants to do more than passively take in content during professional development by working collectively as described by Patton et al. (2013). The facilitators also described the times that participants were completing activities as signs of their engagement. This included participants’ use of the chat and participants making sticky notes on the Jamboard. Kelly stated that when she went into breakout rooms, her groups were “sharing their models on the slides” making her feel that they were engaged in the learning.

**Time and Pacing**

Time and pacing were brought up by both the participants and facilitators as a detriment to the professional development. The current research describes time in effective professional development only in relationship to allowing for enough time for
participants to try on new strategies and bring back their learning to share with the group. Neither the facilitators nor participants referred to the inclusion of follow up sessions in the professional development series when describing their experience. Instead, they both focused on the use of time during the professional development sessions. The participants wrote that when the facilitator “talk[ed] over the thinking time” or was giving directions “at an extremely slow pace” they felt disengaged. The facilitators shared their concerns that there was too much material in the professional development program for the time allotted. Alex shared that he could not ask for as much discussion out loud and instead relied on the asking for responses in the chat as his instructional move “because it allows more ideas to be heard in a shorter timeframe.”

**Research Question 2**

To what extent do facilitators’ moves during Science Professional Development mirror teacher talk moves in high quality science classrooms?

Discourse in the science classroom is necessary for students to construct and revise their own understanding of science content and processes. The researcher looked at the talk moves identified by Michaels and O’Connor (2015) that overlapped with the facilitator moves seen by González et al. (2016). These facilitation moves which helped participants to *sustain an inquiry stance* fall into three categories of talk moves: helping individual students share their ideas, helping students deepen their reasoning, and helping students engage with each other’s reasoning. These three categories of talk moves were identified within both the scripts and the transcripts of the sessions as shown in Table 5. As shown in Table 3, the sessions observed included an introduction to notebooking, a four-part learning experience that asked participants to be learners solving a problem in
Table 5

Overview of Facilitation Moves

<table>
<thead>
<tr>
<th>Code</th>
<th>February Strand</th>
<th>March Strand</th>
<th>Total Moves (Feb and Mar)</th>
<th>Script Moves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helping Individuals Share Their Thinking</td>
<td>50</td>
<td>74</td>
<td>124</td>
<td>38</td>
</tr>
<tr>
<td>Helping Individuals Deepen Their Reasoning</td>
<td>5</td>
<td>7</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Helping Individuals Engage with Each Other’s Reasoning</td>
<td>16</td>
<td>8</td>
<td>24</td>
<td>6</td>
</tr>
<tr>
<td>Relationship Building</td>
<td>15</td>
<td>29</td>
<td>44</td>
<td>4</td>
</tr>
<tr>
<td>Basic Directions</td>
<td>82</td>
<td>91</td>
<td>173</td>
<td>7</td>
</tr>
</tbody>
</table>

the community, the pedagogy focused sessions during each strand, along with a final session devoted to planning for the use of notebooks within the classroom for classroom teachers or planning to support the use of notebooks within the classroom for coaches and administrators. Both the scripts and the transcripts were also coded for the facilitator moves of relationship building and giving directions.

Analysis of the scripts showed that 58.5 percent of the moves scripted into the 12 hours of professional development were expected to be moves that allowed participants to share their ideas with one another, as shown in Table 5. Only 32.9 percent of the enacted moves during the professional development were moves designed for participants to share their ideas. Moves that supported participants to share their ideas with one another also often asked for the use of the chat. A few examples of this include: “Now that you've had time to write some things down that you notice and some things that you wonder. Please choose one of each or just one and type that into the chat.” and “So if you could take a few minutes to go back to your notebook and see if you can find any evidence you felt you documented. And then, once you're ready, you can put it in the chat.” A few sessions asked participants to share the ideas gathered in their breakout rooms such as “all right, secondary folks, what did you learn about reasoning?”
Almost half of the facilitator moves enacted in the sessions were directions, as seen in Table 5. Examples of these moves include “Alright, so we're going to watch it again, and this time you're going to jot down some things that you notice on your t-chart and you're going to jot down some things that you wonder about” and “But can you just put your hand up if you've done the waterfall strategy before? Either you've participated or you've done it with students?” The most used direction move by facilitators was to ask participants to “write done in the chat” after completing an activity in the main room. These direction moves were used during the professional development more than four times the expected 10.8 percent of direction moves that were identified in the scripts. A similar increase in use of moves was seen with relationship building moves. Approximately six percent of the scripted moves were coded as relationship building while 11.6 percent of the enacted moves were focused on relationship building. Relationship building moves included asking participants to review and add to the norms if needed and moves used during the opening to get to know the participants or welcome them to the session such as “How many of you just got done teaching today, stick your hand in the air.”

Of the three talk moves that were observed, share their ideas was used the most during the session at 124 coded facilitator moves, while deepen their reasoning was only coded 12 times, and engage with each other’s reasoning was coded 24 times. When deepen their reasoning was used as a move during the professional learning, it was often connected to participants expanding on something they wrote in the chat or on the Jamboard such as “is there anything that you would like to elaborate on that you put up here?” The session scripts were coded for share their ideas talk moves 38 times, deepen
their reasoning ten times, and *engage with each other's reasoning* six times. An example of a scripted move asking participants to *engage with each other's reasoning* is “come to a consensus on a common explanation (refinement part) that you can orally share with other groups” while an example of a move designed to support participants to *deepen their reasoning* found in the script is to identify evidence in their notebook that can “can help support your argument for how is the matter being redistributed?”

Overall, the session had almost six times the number of facilitator moves enacted as the script directed facilitators to make. Some of this was due to facilitators repeating directions and prompts a number of times.

Twenty-two of the 24 times that facilitators used a talk move asking participants to *engage with each other's reasoning*, it occurred just before participants were sent into breakout rooms such as,

> And you're going to have that discussion now. And you may end up revising your model as you're hearing other people's thoughts and kind of seeing how your solution affects your model. You're going to fill out your column in the chart. And then, as a group you're going to want to develop an oral explanation for how your given solution works that you can then share with other groups.

This move was enacted the most often during the Day 3 pedagogy session of claim, evidence, and reasoning in March, as shown in Table 7. Only three participants selected this session and more discourse was used instead of the chat feature, which possibly contributed to the increased use of this move. Tables 6 and 7, show that the facilitators used talk moves the most during the observed pedagogy-focused sessions: modeling, student thinking tools, and claim, evidence, and reasoning.
### Table 6

**February Facilitation Moves**

<table>
<thead>
<tr>
<th>Code</th>
<th>Introduction</th>
<th>Learning Experience (4 sessions)</th>
<th>Modeling</th>
<th>Claim Evidence Reasoning</th>
<th>Planning</th>
</tr>
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<tbody>
<tr>
<td>Helping Individuals Share Their Thinking</td>
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<td>18</td>
<td>9</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Helping Individuals Deepen Their Reasoning</td>
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<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Helping Individuals Engage with Each Others’ Reasoning</td>
<td>2</td>
<td>11</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Relationship Building</td>
<td>3</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Basic Directions</td>
<td>10</td>
<td>46</td>
<td>5</td>
<td>14</td>
<td>7</td>
</tr>
</tbody>
</table>

### Table 7

**March Facilitation Moves**

<table>
<thead>
<tr>
<th>Code</th>
<th>Introduction</th>
<th>Learning Experience (4 sessions)</th>
<th>Student Thinking Tools</th>
<th>Claim Evidence Reasoning</th>
<th>Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helping Individuals Share Their Thinking</td>
<td>6</td>
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<td>1</td>
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<tr>
<td>Helping Individuals Deepen Their Reasoning</td>
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<td>3</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Helping Individuals Engage with Each Others’ Reasoning</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Relationship Building</td>
<td>9</td>
<td>16</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Basic Directions</td>
<td>9</td>
<td>46</td>
<td>10</td>
<td>16</td>
<td>10</td>
</tr>
</tbody>
</table>

### Further Considerations: Planning for High Quality Online Professional Development

This study contributed data beyond the scope of the research questions that can be used to consider aspects of planning for future virtual professional development sessions.

One aspect of this centers on the large number of facilitators involved in the observed professional development series, 17 facilitators over eight sessions in February and 14 facilitators over eight sessions in March. The participants described being disengaged when they felt “like we're doing something we already did” due to repetition of content by a facilitator that had not been present in the previous day of the professional
development series. The facilitators also described feeling “a little bit of a disconnect with coming in and presenting just a part” of the series because they didn’t know the group’s dynamic or names of the participants.

Another aspect of leading professional development that came up during facilitator interviews is the facilitator needing to read the room or respond to the participants during the session. Julia described an example of this as just figuring out the timing. Like you know, I'll do a turn and talk, and I can hear when they start talking about their weekend plans, rather than recombination. So it's not having that flexibility I think that makes it me feel like it takes longer in virtual than it does in person.

Margie described the need for participants to move around during professional development as reminding us to take breaks and that we have bodies is something that I constantly have to remind myself of with Zoom. In face to face it’s easier to say let’s do this next section of this learning sequence outside and let’s move around.

And Kelly shared that “in person yeah it is, it's all about reading the room and being able to pivot and go a different direction if you need to.” If facilitators had a mechanism to better read the room during online professional development, they may be able to lessen the number of disengaged participants due to the time lags that occurred while the facilitators tried to decide if participants were finished with activities.

Finally, the aspects of relationship building that occur during in person professional development are more difficult during virtual professional development. Terry described this difficulty during her interview,
I actually talk to every person in a room that I can, before I start. That’s just simply what we do, so we start to learn a little bit about them. And that can happen online. It still seems hard to get a real connection to the person, just a little bit harder.

Angelica shared a similar idea “just you know getting up and moving around and meeting new people and discussing and sharing ideas” about the ease of in person professional development versus online experiences. Alex added that one of the pieces that I would use in an in person setting would be proximity right? So moving all around the room, and that creates emphasis and highlighting points. One of the things is, people can hide a lot on zoom, right? I think we have all mentioned that. The challenge is calling people out without calling people, right? That’s the tricky part. There's no proximity on zoom. as well as sharing that he thought “it's harder to portray through the camera, a sense of welcoming.”

**Summary**

Chapter Four presented the data and findings for this phenomenological mixed-methods study. The data analyzed represent the whole of a scripted science education professional development series. From analysis of the scripts and transcripts of the sessions, five categories of facilitator moves were identified: moves that support participants to share their ideas, moves that support participants to deepen their reasoning, moves that support participants to engage with each other’s reasoning, moves designed to support relationship building among the participants or among the participants and the facilitators, and moves designed to give directions to the participants.
The three talk moves that support participants to engage in discourse with one another were all used during the professional development, though not as often as direction moves.

The participant surveys were used to understand the participants’ perceptions of their own engagement in the professional development and how the facilitation contributed to their feelings of engagement or disengagement. The themes that emerged from analysis of the participant surveys were the use of active learning and the perceptions of the facilitator, including their use of time during the session.

Finally, the facilitator interviews allowed for an understanding of the facilitators’ perceptions of the professional development session as well as the engagement of the participants. The themes which emerged were the actions of the participants and the actions of the facilitators. Actions of the participants included their use of the chat, discussion in the breakout rooms, and completion of activities. Actions of the facilitator included preparing to facilitate the session, adjusting the session for the time or to meet the needs of the participants, and supporting the participants to engage in the learning experiences.

Overall, this connects to the Modification of Borko’s (2004) Four Elements of Professional Development seen in Figure 2 that serve as the conceptual framework for this study. The interaction of the facilitators, professional development program, and participants were influenced by the context of the professional development (namely online, scripted, science professional development) and the perceptions of the facilitators and participants affected how engaging they found the professional development session.
CHAPTER 5—DISCUSSION

Purpose of the Study

The purpose of this study was to observe how a scripted professional development experience may be affected by the moves that facilitators make during the session. Even when professional development sessions are planned with the five characteristics of effective professional development: a focus on content, the use of active learning for the participants, a coherent connection to state and school policies, professional development that occurs over a duration of time, and collaboration between teachers from the same school or department (Committee on Strengthening Science Education through a Teacher Learning Continuum, 2016; Desimone, 2009), all of the participants still may not engage in the learning. This research explored how the discourse moves made by the facilitators of an online professional development series affected the experience of the participants and the facilitators themselves. The facilitator moves were looked at, not just in connection to participant experience, but in the context of talk moves. Talk moves have been extensively studied regarding their use by teachers in science classrooms as a tool to increase student engagement through discourse (E. J. Fishman et al., 2017; Franke et al., 2015). This study identified the types of moves that facilitators use the most during a series of professional development and then related those moves to the categories of talk moves used in high quality science classrooms as a mechanism to increase participant perception of their engagement in the professional development experience. Talk moves are specific questions and phrases that teachers use to facilitate productive discussion in their classrooms. Of the four goals that Michaels and O’Connor’s (2015) identified for productive discussions in classrooms, three are aligned with facilitation of adult learning
during professional development: helping individual students share their ideas, helping students deepen their reasoning, and helping students engage with each other’s reasoning.

This study used a modification of Borko’s (2004) Four Elements of Professional Development as a conceptual framework. Borko identified the four elements that affect the professional development experience to be the participants, the facilitators, the professional development program itself, and the context surrounding the professional development. As seen in Figure 2, Chapter 1, this researcher believes that the delivery of the workshop by the facilitator affects the experience that the participants have, which in turn affects how engaged the participants are in the professional development session. When educators are engaged in the professional development, they are more likely to institute new learning within their classrooms (Little, 2002). Due to this, I modified Borko’s (2004) elements to include the relationships between the elements. These include the facilitator’s perception of the participants as well as the participants’ perceptions of the facilitator. These perceptions affect the quality of the interactions between the facilitators and participants, thereby affecting their perceptions of the professional development program (Heron, 2010). Participants want to feel respected by the facilitator and their peers. They also want their facilitators to be experts in both science content and pedagogy (J. Knight, 2009; Wood et al., 1990). Facilitators affect the delivery of the program through the moves that they make while leading the professional development. Increasing discourse among participants can lead to facilitators and participants feeling that there is more engagement in the learning. This discourse connects to the social aspect inherent in learning (Lave & Wenger, 1991). As seen with students, talk moves can increase the amount of discourse during professional development by allowing adult
learners to share their thinking and expertise during the professional development session.

Understanding how the use of talk moves during facilitation of professional development affects the experience of participants can lead writers of professional development for the NGSS to script the moves that will increase the positive impact of the professional development. Connected to this, training for facilitators will allow educational leaders to develop and practice the skills needed to effectively lead these science professional development sessions.

**Summary of the Findings**

This study found that the facilitators of this online professional development series used a large number of facilitation moves when leading sessions and that many of these moves can be categorized as talk moves. The facilitation moves were weighted toward moves that ask participants to share their ideas or to generally give directions to participants. Participants perceived higher levels of engagement when they were involved in activities, working in groups they perceived to be high quality, and when they identified their facilitator to be knowledgeable in both content and pedagogy. Facilitator perception of the professional development experience is affected by both the actions that participants make, which the facilitator identifies as showing the participant’s engagement in the learning process, and the actions they make to complete the steps of the professional development session.

It was found that the interactions between the facilitators and the participants were important to the overall professional development experience for both the participants and the facilitator. During this study, the facilitators were focused on whether the
participants were able to complete assigned activities and if they made use of the chat to share their ideas, supporting Axelson and Flick (2010) in their description of behavioral engagement. Though the facilitators discussed the utility of planned facilitation moves when leading in-person professional development sessions, the facilitators were not found to use facilitation moves with a purpose in mind during online sessions, but instead seemed to use moves in an accidental fashion. Considering the wealth of experience that the observed facilitators have in leading science professional development, it is interesting to note that their facilitation moves were not made in response to what they noticed about participants engaging in the learning. This researcher wonders if this was due to the online format making it harder for the facilitators to notice the participant experience in the same way they might during an in-person professional development.

It is also worth noting that though the facilitators participated in a trainer of trainers session as described in Chapter 3, this training was not a professional development experience for the facilitators themselves. It was more of an orientation to the professional development series that they were then offering to participants. That left the facilitators to be reliant on the moves identified in the script or those that they saw or heard other facilitators use in previous professional development experiences. This may have impacted what I observed during the professional development sessions, if the facilitators did not see the moves made that would have asked them to sustain an inquiry stance during the trainer of trainers, then it is unlikely they would use those moves themselves during the professional development sessions.
Themes

Multiple themes emerged from the findings of this study related to the four elements of professional development and the interactions amongst those elements. The participants’ professional development experience was found to be affected by three themes: time, facilitator-participant interactions, and active learning. Additionally, the facilitator experience was affected by the active learning of the participants as well as the way they used the session time which included adjustments to the professional development in preparation for the sessions.

Time

Time was described as a hindrance to the professional development experience. This was unexpected because the consensus from the literature as described by Garet et al. (2001) is that professional development should occur over sufficient time to allow participants to try on their new learning in their own classrooms and bring their new learning back to the professional development. This professional development series took place over the course of two weeks and included the opportunity for two follow up sessions later in the academic year, which meets the requirements of sufficient time described by the literature. However, participants cited the pacing of the professional development session as a reason for their disengagement. This was either due to the time provided to complete activities being much too long or the instructions being given in too rapid a manner to be followed as described by a participant who identified themselves as disengaged because they had been given “too many directions at one time.” Facilitators also identified time as a constraint to their facilitation, describing the amount of material written into the professional development program as too much for the time allotted in
the session. To address this issue, four facilitators described adjusting the sessions from
the script due to previous experiences with the session material being too long for the
time available.

With the change to an online format, the issue of time might have been more
obvious than during in-person professional development. The facilitators were unable to
easily tell when participants have completed activities the way they might if they were
walking around a room observing tables. The transitions when starting the activities took
longer online, as participants have to identify the correct link, slides, Jamboards, and
handouts to use to for each part of their learning. Adding this context to our
understanding of the idea of time in professional development, this research identified a
need for writers to pilot the activities used to construct their professional development
programs both in person and online to better consider the times it takes those pilot groups
to complete activities. This would allow for a more clear plan for the amount of time it
will take participants to engage in the learning experiences.

Facilitator-Participant Interactions

Interactions between the facilitator and participants affected the experiences of
everyone involved in the professional development. Participant perception of the
facilitator affects the experience of the participants. The literature describes the qualities
facilitators need, including a deep understanding of the content and the pedagogy as well
as the ability to respond to participants in a supportive and positive manner (Schifter &
Lester, 2005). Remillard and Geist (2002) describe the need for facilitators to balance a
safe environment for the participants with the ability to support the participants to sustain
an inquiry stance during the professional development. Heron (2010) discusses that
facilitators need to be competent communicators who can notice and respond to participants. This was reinforced by the findings in this study when participants described being disengaged at moments that they perceived the facilitator to have a lack of scientific knowledge, confidence, or preparation. This is seen in a participant's response describing they were disengaged because the “presenter [was] reading everything from the slides and seemed unfamiliar with the content.” It was also shown in the moments that the participants identified themselves as engaged and attributed it to the facilitator being supportive in giving directions or being respectful of them as a learner. Considering the vast experience leading professional development that the facilitators have, it was surprising that participants responded to the survey indicating that they felt the facilitators were not competent in content or pedagogy at times. This may have been due to the facilitators being less responsive to the participants needs online than they might usually be during in person professional learning.

The facilitators’ perception of the participants caused them to make moves to strengthen the experience for the participants during the professional development session. These moves were made in response to the participants’ use of the chat and interaction with the Jamboard, as well as their experiences in the training session, and their or the writers’ previous experiences facilitating this professional development series. This is consistent with Patton et al. (2012) who discussed the three beliefs that professional development facilitators tend to have in common: (1) teachers bring knowledge and experience to the professional development, (2) adults learn in an active manner, and (3) learning occurs in a social context. While the facilitators described the importance of building relationships with participants and checking in on their progress
in order to make changes to sessions in the moment that might best support the learning of the participants during in-person professional development sessions, only Dave made an adjustment to the professional development session during a session because he felt that the participants did not have enough active learning opportunities. All of the other facilitators’ adjustments to the session were made prior to the session due to their experiences leading the session previously or because of their experience as a participant during the trainer of trainers. These previous experiences led the facilitators to believe that participants would not have the background knowledge needed to participate in the session unless they were supported through a reorganization of the learning activity.

Facilitation moves are the heart of the interaction among the participants and the facilitators, as well as amongst the participants themselves. Macià and García (2016) describe the need for facilitators of online communities to build trust between the participants to support their engagement in collaborative learning. The moves observed by the facilitator during this session were categorized under the theme of talk moves or general moves. General moves included both the moves that facilitators used to give directions which accounted for the majority of the moves made during each of the professional development sessions as well as moves that facilitators used to build relationships with the participants. During the facilitator interviews, relationship building was identified as an important component of professional development facilitation. It was also clear from the number of relationship-building moves made, that the facilitators did not build as robust relationships online as they do in person. The relationship moves were often made at the beginning of sessions and not continued throughout the three-hour time. Facilitators described this as difficult to do in an online setting, yet necessary to a high-
quality professional development experience. Terry described this relationship building as “the biggest thing. You have to have a personal relationship with every single person in a room, even if there's 200 in the room. They have to connect to you and I think it's just a big challenge [online], though not impossible.”

**Active Learning**

Active learning is the theme used to categorize the majority of the participants’ descriptions of moments that they were engaged in the professional development. This is consistent with the literature as active learning is considered to be necessary for high quality professional development. Prince (2004) describes active learning as learning experiences that engage learners in activities that are meaningful to the content and expect learners to think about the activity and content. During this study, it was found that participants identified themselves as engaged the most often when they were working together in small groups in breakout rooms or completing the activities assigned to them during the professional development program. These activities included completing an individual self-reflection of classroom practice using a Likert Scale, participating in a Jamboard brainstorms alone and in groups, sharing their models of erosion as a problem, and coming to consensus for a solution to beach erosion. Due to the extensive literature on active learning (Patton et al., 2013), it was expected that participants would find the activities that make up the learning sections of the professional development experience to be engaging. During these moments the participants were able to share their ideas, their expertise, and connect socially with other professional development participants. This is consistent with Lave and Wenger’s (1991) description of learning as a social endeavor and supports the need for professional development programs to be centered on
learning activities that allow participants to construct understanding of content and pedagogy together.

Facilitators were observed using moves during the professional development that allowed participants to sustain an inquiry stance in regards to their own thinking, the learning activities, and the thinking of the other participants as seen by González et al., in their 2016 study with mathematics educators. These facilitation moves were coded using the three categories of talk moves described by Michaels and O’Connor (2015) which helped individuals to: share their ideas, deepen their reasoning, and engage with each other’s reasoning. Facilitators prompted participants to share their ideas more often than any other talk move they used in the session. This was expected because moves designed to support participants to share their ideas were the majority of the facilitation moves written into the facilitation script for the sessions. Participants were prompted to engage with each other’s reasoning most often when they were sent to complete activities in breakout rooms. This makes sense due to the online format of the professional development. For teachers to engage in discussions about their thinking, they needed to be in smaller groups. Participants also identified these group breakout rooms when they could argue their perspective and discuss their understanding of the science as engaging moments in the professional development. It is expected that participants feel that their experience is high quality when they are engaging in learning together due to the social aspect of their experience as supported by the literature (Lave & Wenger, 1991; Patton et al., 2013). However, facilitators did not know how much participants engaged with each other’s reasoning once in the breakout rooms unless they visited each breakout room to listen into the small group discussions. Only one 90-minute session included multiple
moves made to provide opportunities for participants to deepen their reasoning. This session only had three participants, which allowed the facilitator to make talk moves in the same way they would make them during in person professional development, asking the participants to describe their thinking out loud or to share the reasons behind the responses they made on the Jamboard. During her interview, Christine shared that in other online professional development she will encourage discussion by giving people a chance to read what others have written in the chat and then use a talk move like, can you say more about one of the responses you read? So that’s when they unmute and talk. Not just sharing out loud or typing, but the share out loud is actually in reaction to somebody else's initial thoughts.

Observing the professional development and conducting interviews with the facilitators, such as this one, led this researcher to believe that there were many opportunities for asking participants to deepen their reasoning, even in a larger group, and they were missed during the online professional development experience.

**The Need for Facilitator Professional Development**

Science professional development is complex. Facilitators need to be masters of the various science content pieces as well as the pedagogy needed to implement NGSS. They must also be able to create a safe learning environment that allows participants to sustain an inquiry stance during the professional development though they might feel vulnerable while confronting the gaps in their own content or pedagogy. To juggle all of these parts of facilitation, professional development leaders need to participate in their own professional learning. They need the opportunity to identity the gaps in their facilitation skills and to build a toolbox of strategies to support adult learners.
It is not enough to simply participate in other science professional development or to attend trainings such as the trainer of trainers that was used in the observed professional development series. The use of online professional development adds to this need. Facilitators should participate in ongoing professional development that provides opportunities to develop skills to notice and respond to participants need both in person and online. They should debrief their learning, discuss the characteristics of effective professional development, and apply their understandings to the sessions they lead. Like classroom educators, facilitators of science professional development are more likely to improve their practice if they have a community of facilitators to learn alongside.

Implications

As we strive for classroom instruction in science to better reflect the research that describes high quality science educational experiences for students, we also need to use research to improve the experiences of educators participating in science professional development. This includes preparing educators to use research-based science pedagogy in their classrooms by using that pedagogy during effective professional development experience (Odden et al., 2002). In order for that to happen, facilitators need to be trained in developing and leading science professional development both in person and online.

Training is needed for all teacher leaders and facilitators before they are expected to begin leading science professional development. These training opportunities need to be available before educators lead professional development sessions for the first time as well as on an ongoing basis to keep facilitation skills sharp. Currently, educators are asked to lead professional development with little to no training in understanding the needs of adult learners (Stoetzel & Shedrow, 2019). This training should focus on the
actions that facilitators can take to increase the engagement of participants in professional development such as the ability to balance sustaining an inquiry stance with developing a safe environment for participants’ learning (Remillard & Geist, 2002). These trainings need to be more characteristic of effective professional development experiences than simply an orientation to the session they might be leading. This includes facilitators having the opportunity to practice using research based NGSS teaching strategies, responding to participants' needs in the moment, and both verbal and nonverbal communication skills (Heron, 2010). Facilitator training should also support educators to develop the characteristics needed for high quality facilitation. These characteristics include a willingness to be open and responsive to participants and a belief that teachers bring content knowledge and classroom expertise to professional development experiences (Patton et al., 2012; Schifter & Lester, 2005).

Professional development writers need to be experts in both science pedagogy and the science content they are using during the professional development (Heron, 2010). A valuable approach to planning professional development with high quality science content is collaborating on the creation of professional development experiences with science experts in order to cement the science being presented. This would allow facilitators to build their own expertise in the content they are presenting, which is described in the literature as a necessary characteristic of facilitators for effective professional development (Schifter & Lester, 2005). This would improve the participants’ perception of facilitators.

Writers of scripted professional development sessions need to intentionally support the content knowledge of facilitators as well as the moves they can use to support
participants to engage deeply in the learning activities. Facilitators use scripts of professional development to prepare to lead sessions they do not create. They lean on these scripts to understand the intent of the professional development writers as well as the goals of the professional development activities. With strengthened professional development session scripts, more participants would perceive themselves as engaged during professional learning experiences.

Post-COVID, there is likely to be continued use of online platforms for professional development. Educators in rural school districts are more easily able to attend online professional development sessions and science teachers can fit professional development into their schedules more often without having to drive to in-person events. Online professional development is very different from in-person professional development. It is harder for facilitators and participants to build a relationship, more difficult for facilitators to identify what participants need in the moment, and learning activities tend to take longer in the online space than they do in person. To prepare to lead these online professional development sessions in ways that support participants, facilitators need strategies that will enable participants to engage in quality discourse and engage with each other's reasoning. Discourse is a necessary component of learning experiences (Patton et al., 2013). One strategy for this includes using the chat feature as a springboard to asking participants to explain their reasoning or consider the reasoning of other participants instead of just reading chat responses. Facilitators will also need to monitor the discussions of the groups when they go to breakout rooms in order to support them to engage with each other's reasoning. This should include sessions with enough trained facilitators to attend to participants within breakout rooms to encourage discourse
and participation or sufficient time for the facilitator to move through each breakout room to provide this support. Online professional development sessions also need to include activities that can be observed from the main room through the use of Jamboard or shared slide decks that the groups are working on. This would allow facilitators to make the best use of the professional development time, mirroring the way that facilitators monitor professional development activities during in person professional development.

**Significance for Theory**

This study shows that even though a professional development session meets the current consensus of the five characteristics of high-quality professional development, there is a need for further reflection on those characteristics. The current literature includes structural aspects of professional development, but lacks the instructional aspects of professional development. Active learning definitions need to include discourse opportunities for participants as well as movement and completion of activities. The aspect of time needs to be expanded to include the appropriate use of time within the session itself as well as the current description of sufficient time to allow opportunities for in-classroom implementation of new learning. The interactions between the facilitators and participants which allow the participants to sustain an inquiry stance during the learning as well as those interactions that improve the participants’ perception of the facilitator need to be included in the characteristics of high-quality professional development.

**Significance for Practice**

The CA NGSS Professional Learning #1 is the eighth professional learning offering from the CA NGSS Collaborative. This group has worked together to create a
consistent message in the state regarding the implementation of CA NGSS. The professional development that comes out of these experiences shapes the professional development offered to teachers by the educational leaders who attend sessions as well as those involved in writing, vetting, and facilitating the sessions. This consistency allows for a shared implementation of science instruction across the state that has not been seen in other subject areas. This common ground is affected by the personal experiences had by the participants and facilitators during the sessions that they attend.

Each of the facilitators observed during this study interacted differently with the participants. This led to different learning outcomes for each participant, based on the facilitator that they had. With the goal of creating a shared experience that allows educators to better understand and then implement NGSS in their classrooms, the facilitator interactions with participants need to have a foundation in common across all of those leading the sessions. To improve the quality of these interactions, there must be high quality training and support for facilitators of professional development. This training might occur before they lead an experience for the first time and should continue in an ongoing manner so that facilitators can grow their facilitation skills over time. Facilitators need to learn what high-quality professional development looks and sounds like as well as how to lead sessions. Participating in effective science professional development can be used to support facilitators in recognizing quality professional development experiences. Debriefing the professional development experience with a mentor or as a peer group would allow the facilitators to build reflective practices to increase their own use of effective facilitation moves. Training for facilitators should also
include a mentorship aspect, allowing professional development facilitators to learn to use facilitation moves and lead sessions with competence.

**Significance for Educational Leaders**

To allow facilitators to receive training to improve their skills to lead professional development, time and funding needs to be provided to districts for their educational leaders to participate. County offices of education should offer an annual workshop series designed for new professional development facilitators in their districts to learn about their roles as science leaders, to connect with one another to provide support and mentorship, and to explicitly teach the skills needed to facilitate science professional development. New leaders in science education need time and support to understand their roles, develop and lead professional development, and connect to other science education leaders at the beginning of taking on a leadership position and throughout their careers. Experienced leaders in science education need space to understand changes in the field of science education and continue to strengthen their professional development skills. Districts and site leaders need to provide the release time to allow their science leaders to attend this professional development and the state should provide county offices the funds needed to support the workshops on an annual basis. If these professional development series were developed by a statewide organization such as the CA NGSS Collaborative, then common messaging about effective science professional development and effective science instruction would support the statewide implementation of NGSS. With funded ongoing training, educational leaders will be able to strengthen their interaction with participants during professional development, thereby increasing the likelihood of participants bringing their new learning back to their classrooms.
The state needs to address the continuing need for CA NGSS professional development for teachers, administrators, and science leaders by providing funding for each county office to have a science coordinator or program manager. These positions allow for dedicated people in each county to support districts with their science implementation. With the funded person, the state also needs to provide funding for each teacher in the state K-12 to attend, at the very least, one year of ongoing NGSS professional development. This professional development could be based on the already written and vetted sessions used by the CA NGSS Collaborative during the first seven CA NGSS Rollouts and the current CA NGSS Professional Learning series. The professional development offerings need to be both in person and online to allow teachers from urban and our most rural school districts to attend. They need to be common across the state to best support equitable science implementation for all students.

**Limitations**

This study included two observations of the 12-hour professional development series. This was due to the available offerings of the CA NGSS professional development. The facilitators were chosen by writers of the sessions, so I was unable to control for expertise or training of the facilitators. I also knew some of the facilitators and some of the participants due to my previous experience in the CA NGSS Rollouts, the former name for these professional development offerings. Additionally, I was asked to be a participant in the breakout rooms during the March offering of this professional development due to the lower number of participants in those sessions. Finally, the virtual professional development format affected the way that facilitators interacted with the participants during the session, notably during the February offering when there was a
very large number of participants and the chat feature was used almost exclusively for sharing of ideas in the main room.

I view the virtual professional development as an opportunity as well as a limitation. While the small sample size does not allow the study results to be generalized to all professional learning, virtual online professional development will likely continue in the future for both the CA NGSS Professional Learning offerings as well as other professional development opportunities. These will have variable numbers of participants and facilitators and will likely have a range of expertise in leading professional development.

**Recommendations for Future Research**

It is clear to this researcher that the interactions between the facilitator and participants in science professional development affect the experience for all involved and that there is a lack of current research focused on this topic. Future research recommendations include:

1. Extend the current study to in person professional development. The facilitators of the sessions were clear in their interviews that they believe they use talk moves more often during in person science professional development. It would add to the understanding of how facilitation moves influence the participant experience of science professional development to see expert facilitators using talk moves to engage participants in a setting that they are most familiar with.

2. Further research applying science classroom instructional best practices in the context of professional development. This would add to the field’s
understanding of the connection between science professional development and high-quality science instruction. Many of the classroom best practices have not been directly studied with adult learners. This could increase our ability both to develop and lead science professional development as well as implement science instruction in the post high school arena.

3. Study active learning from the perspective of an online professional development participant. New research could build on previous studies which led to the inclusion of active learning as a necessary characteristic for effective science professional development. There is a need for a study of the technological tools available to support discourse between participants and strategies for facilitators to monitor the active learning of small groups while utilizing breakout rooms.

**Concluding Thoughts**

Professional development is often considered to be the best way to support teachers to enact high quality science instruction in their classrooms. With districts in California spending upwards of $500 for an individual teacher to participate in a professional development workshop (D. Knight, 2012), this time should be worthwhile and lead to increased classroom implementation of NGSS. For this to occur, teachers need to feel empowered by the learning and engaged in the sessions as described by Loucks-Horsely et al. (2009). This study supports the idea that facilitators can increase or decrease participant engagement based on their interactions with the participants. This leads to a need for understanding how facilitators best implement effective professional development. The moves that facilitators make to increase discourse and active learning
among adults may not be a skill that leaders bring with them from the classroom. Further study in the area must be undertaken while simultaneously, facilitators of science professional development should begin to be trained in facilitation moves by acknowledged experts in the field.
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Facilitator Interview

1. Please describe your current role in education and your experience leading professional development.

2. How do you feel the session went (1-5, 5 being excellent)? Can you share some reasons for your score?
   a. What actions do you feel you took to increase the quality of this session?

3. How prepared did you feel to facilitate today’s professional development (1-5, 5 being very prepared)? Why?

4. Based on your experience at the Trainer of Trainers and your preparation to facilitate this session, were there any parts today in which you planned ahead to do something specific to keep participants engaged in the learning?
   a. Which parts and why?

5. Did it feel like any specific participants were or were not engaged during the session?
   a. What actions of theirs made you feel this way?
   b. What moves or adjustments did you make in response to their actions?

6. Can you please share anything specific that you added or changed from the script and why?

7. What stands out to you as the biggest differences in leading online professional development versus in person professional development?
Participant Experience Survey

Please use this form during today's professional development whenever you feel particularly engaged or disengaged in the session.

1. How do you feel?
   - [ ] Engaged
   - [ ] Disengaged

2. What did the facilitator do or say that contributed to this feeling?

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
Session Transcripts and Scripts

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Exemplar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helping Individuals Share Their Thinking</td>
<td>Facilitator moves designed to support participants to share their ideas in the chat or verbally.</td>
<td>Please type in the chat one of your noticings.</td>
</tr>
<tr>
<td>Helping Individuals Deepen Their Reasoning</td>
<td>Facilitator moves designed to support participants to expand on their ideas or explain what their ideas mean more fully.</td>
<td>Would you like to explain more about what you wrote in the chat?</td>
</tr>
<tr>
<td>Helping Individuals Engage with Each Others’ Reasoning</td>
<td>Facilitator moves designed to support participants to discuss their ideas with one another or explain their understanding of one another's ideas.</td>
<td>Come to a consensus on a common explanation (refinement part) that you can orally share with other groups.</td>
</tr>
<tr>
<td>Relationship/Community Building</td>
<td>Facilitator moves designed to support participants to build comfort or trust with the facilitators and/or with other participants.</td>
<td>Remember the norms that we are using in these sessions.</td>
</tr>
<tr>
<td>Basic Directions/Participation</td>
<td>Facilitator instructions for activities.</td>
<td>Write “done” in the chat when you are finished.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Write in your notebook . . .</td>
</tr>
<tr>
<td>Question</td>
<td>Code</td>
<td>Description</td>
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<tr>
<td><strong>Q2 - Scoring of the session 1-5 and Why</strong></td>
<td>Participation</td>
<td>Participant actions that related to how they scored the session</td>
</tr>
<tr>
<td></td>
<td>Able to adjust the session</td>
<td>Their own actions in changing the session related to how they scored the session</td>
</tr>
<tr>
<td></td>
<td>Felt supported by script/writer</td>
<td>The way the scripts or slides or meeting with the writer helped them score the session</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>The effect of time (being short) on their scoring of the session</td>
</tr>
<tr>
<td><strong>Q3 - How prepared they felt and Why</strong></td>
<td>Previous experience</td>
<td>Prior PD facilitation or rollout facilitation experience that helped their preparation</td>
</tr>
<tr>
<td></td>
<td>Script/Slides</td>
<td>Use of the script and slides as supports for being prepared</td>
</tr>
<tr>
<td></td>
<td>Training/Meeting with Writers</td>
<td>Attendance at the trainer of trainers and/or meeting with the writing team prior to presenting as preparation</td>
</tr>
<tr>
<td><strong>Q4 - Utility of participation in the Trainer of Trainers (ToT)</strong></td>
<td>The big picture of the session</td>
<td>The ToT helped to see what the whole four days of learning looked like. So they could see how their part fit.</td>
</tr>
<tr>
<td></td>
<td>Tech understanding</td>
<td>The ToT helped to ease concerns about the tech part of facilitation online PD.</td>
</tr>
<tr>
<td></td>
<td>Understood the participant viewpoint</td>
<td>The ToT gave an understanding of how the participants might feel during the 4 days of PD.</td>
</tr>
<tr>
<td><strong>Q5 - What made you think participants were engaged or disengaged?</strong></td>
<td>Can’t tell</td>
<td>Unable to make a determination due to online format or group size.</td>
</tr>
<tr>
<td></td>
<td>Participation</td>
<td>Participants making use of chat, speaking up verbally in the main room, talking in</td>
</tr>
<tr>
<td>Q6 - Changes made to the script and Why</td>
<td>Planned prior</td>
<td>Due to previous experiences with the session, changes were made during meetings before to the session</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>--------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>No changes</td>
<td>No revisions were made to the script</td>
<td>no I don’t think I changed anything.</td>
</tr>
<tr>
<td>In the moment due to perceived need</td>
<td>Revisions were made based on actions of the participants or ideas the facilitator had while presenting.</td>
<td>to increase engagement, I chose to ask them to put something in chat about the phenomenon</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q7 - Online vs In Person Facilitation</th>
<th>Use of proximity by facilitator</th>
<th>Getting close to the participants bodily.</th>
<th>proximity is super helpful and which you don’t really get in the online world</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to read the room/react to perceived needs</td>
<td>Changing the session due to in the moment participant actions (verbal or body)</td>
<td>reading the room and being able to pivot</td>
<td></td>
</tr>
<tr>
<td>Community/relationships building</td>
<td>Creating trust and relationships between Facilitator and Participants or Participants and Participants</td>
<td>connection between the facilitators and the participants,</td>
<td></td>
</tr>
<tr>
<td>Active movement of participants</td>
<td>Getting the participants up and moving during a session. Hands on activities.</td>
<td>having a lot of active moving around</td>
<td></td>
</tr>
<tr>
<td>Cofacilitation</td>
<td>Being able to pass the facilitation between two people.</td>
<td>when you're truly co facilitating, there's not that like just a jump right in part that like normally if we were in a room together</td>
<td></td>
</tr>
</tbody>
</table>

*Q1 not coded, used for relationship building*
| Code                              | Description                                                                 | Exemplar                                                                                                                                                                                                 |
|----------------------------------|                                                                            |                                                                                                                                                                                                       |
| Breakout Room                    | Participants appreciate the breakout room experiences.                     | Reading a document and sharing out in break out room for CER.                                                                                                                                         |
| – Engaged                        |                                                                              | We are moving stickies on a slide... others in the group are moving the stickies into groups that I don't believe in.. I said could we talk about first and was shot down that someone wanted to move them first and then talk. |
| Breakout Room                    | Participants did not like being in a breakout room.                         |                                                                                                                                                                                                       |
| – Disengaged                     |                                                                              |                                                                                                                                                                                                       |
| Activity - Engaged               | Participants enjoyed the activity.                                          | Using Jamboard is great!                                                                                                                                                                                |
| Activity - Disengaged            | Participants did not enjoy the activity.                                    | N/A                                                                                                                                                                                                   |
| Perception of the Facilitator -  | Participants think the facilitator is competent, knowledgeable, and doing a |                                                                                                                                                |