Slowly Shifting a Culture of Teaching in Higher Education: A Case Study of Biology Instructors' Micro-Processes of Collaborative Inquiry into Teaching and Learning

By

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Dedication

To all educators who are passionate about teaching and learning.

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Abstract

The Vision and Change reports (American Association for the Advancement of Science, 2011, 2013) have identified a need for change in undergraduate biology education by emphasizing student learning of content knowledge and competencies. Missing from this report and larger efforts to improve undergraduate education (Brainard, 2007; Henderson et al., 2011; Sunal et al., 2001) are guidelines for *how* to support instructors' professional learning to change teaching practices. I am exploring one possible support structure by studying a collaborative professional learning group. This study employs the Lesson Study model (Lewis et al., 2006) to engage seven biology instructors in iterative cycles of collaborative course development, implementation, analysis, and reflection on their teaching and students' learning in their weekly group meetings over two semesters. The purpose of this qualitative case study is to examine the micro-processes of this collaboration and how these micro-processes afford and limit the ability to change one's teaching practices.

Wenger's (1998) concept of "community of practice" provides a theoretical framework for data analysis. I view an instructor's professional learning as social and situated in a combination of experiences and social practice. Therefore, learning involves negotiating new meanings, boundaries, identity transformation, and participation as part of an on-going collaboration. Wenger's framework allows me to attend to what is actually happening in the micro-processes when the concept of "communities of practice" is enacted. Data analysis shows that negotiation of meaning, characterized by friction and dissonance that can feel frustrating to participants, is an on-going, normal part of the micro-processes of collaborative group work. There are three friction points that are intertwined and influence each other: 1) rhythmic ebb and flow of negotiation about a common professional goal for the instructors and a common leanring goal for undergraduates in Biology, 2) pressure of time to produce an outcome, and 3) grappling with collective agency, authority and capacity. I argue that these friction points are necessary and important for understanding the micro-processes of negotiation in a collaborative process. Seeing how friction points unfold among a group of undergraduate instructors also illustrates how instructors in higher education are beginning to grapple with the complexity of redesigning a general biology class. Findings from this study highlight small steps that instructors can take to make instructional changes together through hard work that happens slowly compared with expectations reinforced by academic calendars. Furthermore, this study contributes to literature examining how the use of collaborative processes that are often counter-cultural to higher education norms and expectations will likely be necessary for instructional changes shared by higher education teachers (Henderson et al., 2011; Sunal et al., 2011; Wiemann et al., 2010).

This case study sheds light on the messiness and hard work of professional learning that is necessary if we are serious about changing teaching practices in higher education. It raises questions about how professional learning is (and isn't) possible in higher education cultures that provide uneven support for the work needed to develop pedagogical visions and skills aligned with how student learn. Additionally, this study raises questions about whether such professional learning activities are sustainable over a longer period. This case study shows that genuine instructional improvement is more complicated and less straightforward than the vision of change underlying reports like "Vision & Change" (2013, 2011).

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Chapter 1: Introduction

> During the time I've been teaching a general biology class at the undergraduate level for a couple of semesters, I've realized I am dissatisfied with both the content and my teaching of this class every semester. I have started to wonder how I could change my teaching to foster student learning. I've wondered if I should attend more workshops to learn more about teaching practices. I've also wondered how my group of colleagues (who all taught the same class) and I could work together on making changes. How could I implement changes and make sure it fosters my learning and my students' learning? Through informal conversations with my colleagues, I've sensed my colleagues also felt a certain degree of dissatisfaction with the outcome of the class. I felt we were ripe for a change and I had just read in a study (Opfer and Pedder, 2011) that a certain level of dissonance must be reached because it is a needed factor to motivate teachers to rethink and hopefully change their practice and envision how that change might help improve student learning. Were we at this point? Could I be an active part of this change?
>
> (Reflective thoughts from Anuschka, Fall 2012)

The Vision and Change reports (American Association for the Advancement of Science, 2013, 2011) have identified a need for change in undergraduate biology education, emphasizing persistent problems in supporting student learning of content knowledge and problems of practice developing competencies in undergraduate science coursework. In addition, these reports suggest pedagogical changes such as incorporating more active learning practices, utilizing an inquiry approach, and integrating undergraduate research opportunities into the classroom. Missing from these reports and larger efforts to improve undergraduate education (Brainard, 2007; Henderson et al., 2011; Sunal et al., 2001) are guidelines for *how* to support instructors' professional learning to change teaching practices in the sciences. I am exploring one possible support structure by studying the collaborative process of practitioner inquiry into teaching and learning biology to learn more about how a group of biology instructors works together to improve undergraduate biology education.

Research into effective professional development activities has generated consensus about what makes certain types of activities effective for supporting teacher professional

learning. The professional learning activity needs to be ongoing, collaborative, inquiry-based, focused on student learning and teaching practice, and localized (Garet et al., 2001; Hawley & Valli, 1999; Putnam & Borko, 2000). I employ Lesson Study as a practitioner inquiry model for this study because strong evidence exists it is supportive of collaborative professional teacher learning (Lewis, 2015; Takahashi et al., 2016). This model also overlaps with the previously mentioned characteristics of effective professional learning activities.

Our understanding of activities such as Lesson Study and findings from research into professional development and teacher learning are most often derived from studies done in K-12 settings. While these ideas of professional learning are agreed upon in the K-12 education community, they are newer to practitioners in higher education (Sunal et al., 2001). In higher education, common modes of professional learning often consist of brief workshops focused on implementing best teaching practices presented by an outside expert with hope that instructors will implement changes in their teaching practices (Van Driel et. al., 2012; Wilson & Berne, 1999). Furthermore, educators that work in higher education settings are part of institutional contexts where workplace culture complicates the use of collaborative professional development activities that support teacher learning (Hora et al., 2013).

I selected the Lesson Study model (Fernandez et al., 2003; Lewis et al., 2009) to create collaborative professional learning opportunities for a group of seven biology instructors in their weekly general biology group meetings over two semesters. The Lesson Study process is based on collaboration in which participants work through iterative cycles of course development, implementation, analysis, and reflection on their teaching and student learning. The Lesson Study model explores both instructor and student learning and makes changes in teaching possible by looking at how teaching is done through collaborative inquiry into each other's

practice. This approach is atypical in higher education as instructors are often working in isolation and changes occur very slowly (Sunal et al., 2001; Wieman et al., 2010).

The purpose of this qualitative case study is to examine the micro-processes of a collaborative process with a group of biology instructors in higher education. I investigate how these micro-processes shed light on the small details of practice important for the initial social, cultural, and pedagogical shifts needed for meaningful professional learning within a newly forming community of practice (Wenger, 1998). Ultimately, these small shifts could determine if instructors continue or discontinue their participation in professional learning activities, such as the activities that are part of a Lesson Study group, and therefore determine if the instructors continue or discontinue their efforts to change their teaching practices. My goal is to understand how educators begin to collaborate and learn together about problems in biology teaching and learning in higher education. My study pursues the following questions:

(a) What are the micro-processes of this collaborative process in higher education?

(b) How do these micro-processes afford and limit the small shifts in social, cultural, and pedagogical practice that are the beginning of meaningful professional learning?

By *micro-processes*, I mean the fine-grained, internal details of the social interactions that make up a community's mutual engagement in joint work. According to Little (2012), a micro-process is a systematic way "in which interaction is meaningfully situated, shaped by and constitutive of organizational structures, norms, and resources...as well as broader institutional and societal structures, processes, and logics (common arrangements for and ideas about education)" (p. 145). Therefore, micro-processes might help us understand more about the

macro-processes, meaning larger grain-size concepts of professional learning in activities like Lesson Study, that otherwise would not be exposed. As Little (2012) states, micro-process research "accounts for the ways in which local practice both instantiates and constructs more macro-level organizational and institutional structures, processes, and logics" (p. 145). Studies of micro-processes shed light not just on what people do in their workplace communities in their day-to-day practice but also on how interactions within communities contribute to the negotiation of meaning including the sense of struggle felt by group members, especially when they are beginning their efforts to collaborate. The following chapters tell the story of my study.

In Chapter 2 I highlight the characteristics of effective professional learning activities to make the case that Lesson Study is in line with the consensus on effective professional learning. Furthermore, I describe important aspects of the culture of higher education in which this study is situated. The macro-level elements of the institutional culture create a backdrop for my study to examine how the micro-processes are possibly influencing them and vice versa and are making pedagogical changes challenging for undergraduate biology instructors.

My conceptual framework, explained in Chapter 3, helps me analyze what is actually happening in micro-processes when Wenger's (1998) concept of communities of practice is enacted. This means learning is viewed as social participation (Lave & Wenger, 1991; Wenger, 1998) and helps to explain how participants are learning by participating in a collaborative process. This conceptual framework explains how three key elements -collaborative process, social learning and interaction, and collective agency, authority, and capacity - are important parts of the micro-processes in a community of practice. Furthermore, I also consider how this study is situated in the larger context of evolving higher education culture and how certain challenges create friction. The friction is viewed as part of making change possible. The data

analysis will show how these three key elements unfold in the interactions of the group and why they are rubbing against the existing higher education culture. But at the same time, this friction might be needed to contribute to an evolving higher education culture and to make changes in teaching practices possible.

In Chapter 4 I explain my professional development design by briefly describing the Lesson Study model that was used to structure the weekly group meetings. I selected Lesson Study as a practitioner inquiry model for this study because strong evidence exists that it is supportive of collaborative professional teacher learning (Lewis, 2015; Takahashi et al., 2016). I also describe the design of the professional learning activities to illustrate what the group is doing over the course of the study.

Chapter 5 describes the research design for my study. I included detailed descriptions of the overall study design as well as specific methods and procedures to produce, analyze and interpret data. Furthermore, I explain my position as a researcher in this study because I wore different hats during the course of my study. I was the facilitator of the professional learning activities modeled after the Lesson Study process, an observant participant in the negotiating of meaning in the weekly group meetings, and an educational researcher seeking to understand the micro-processes of the collaborative process. These roles allowed me to develop a deep understanding of what it meant for my participants to be involved in a collaborative process for professional learning, but also presented limitations worthy of follow-up in future studies.

In Chapter 6 I use a case study to tell my story about the on-going negotiation within my group about the goal of our joint work. There are three friction points that are intertwined and influence each other: rhythmic negotiation in the back and forth about a common goal for our group work, time pressure to produce an outcome, and grappling with collective agency,

authority and capacity. I argue that these friction points are necessary and important for understanding the micro-processes of negotiation in a collaborative process.

Chapter 7 discusses how and why changing long-standing teaching practices in higher education is not an easy endeavor because such change requires hard work, moves slowly in comparison to many expectations for change in academic timelines, and is often counter-cultural to higher education norms and expectations (Henderson et al., 2011; Sunal et al., 2011; Wieman et al., 2010). In this discussion section, I also consider how I might have asked the group of instructors to make too many cultural changes at once without taking time for our group to develop new norms and practices. Because meaning-making requires a lot of negotiation back and forth, some group members struggled to persist through the collaborative process as we faced frustrations and areas of dissonance. This point raises questions about how professional learning is (and isn't) possible or sustainable in higher education cultures where there may not be support provided for developing the pedagogical visions and skills necessary for instructional improvement, and where the visions and skills may run counter to long-standing cultural models of undergraduate teaching.

In Chapter 8 I conclude the dissertation with a summary of the case study and suggestions for implications. Because my motivation for this study was both practical and scholarly, I include implications for two audiences. For other undergraduate instructors interested in improving teaching and learning in their courses, I offer a few ideas about implications for starting and sustaining practitioner inquiry groups in higher education. For other researchers I offer some ideas about research that is still needed to understand how higher education instructors learn to collaborate and use inquiry-based professional development activities to improve teaching and learning in their university settings.

Chapter 2: Literature Review

Research into effective professional development activities has generated some consensus about what makes certain forms of activities effective for supporting teacher professional learning. The professional learning activity needs to be ongoing, collaborative, inquiry-based, focused on student learning and practice, and localized (Desimone et al., 2002; Darling-Hammond & Richardson, 2009; Garet et al., 2001; Hawley & Valli, 1999). One example of effective professional development that has a significant research base is the Lesson Study model of collaborative teacher learning (Lewis, 2015; Takahashi & McDougal, 2016).

However, our understanding of activities such as Lesson Study and findings from research into professional development and teacher learning are most often derived from studies done in K-12 settings. Research into professional learning activities geared toward changing teaching practices and fostering learning in higher education settings is less common. Teachers working in higher education settings are part of institutional contexts with workplace cultures that complicate the use of collaborative professional development activities to support teacher learning (Anderson et al., 2011; Hora et al., 2013). In this section, I will present a short overview of the literature on effective professional development for instructors, examine Lesson Study as a particular form of an effective professional development model, and unpack the working culture for teaching in higher education.

Effective Professional Development/Professional Learning

Researchers that have studied professional development (PD) activities in K-12 education settings have agreed upon a set of consensus findings about features of effective PD activities supporting professional learning that can lead to changes in teaching practices. A commonly held conjecture about the effectiveness of PD activities is that when instructors are involved in a

professional learning activity, they learn something about teaching and learning that will trigger them to make modifications to their teaching practices in the classroom. The goal of an effective professional learning activity is to change or refine an instructor's teaching practices in the service of student learning.

Effective professional learning can be accomplished by a variety of PD activities. In an effective PD model, instructors could, for example, deepen their content knowledge and pedagogical content knowledge to transform their thinking and teaching practice and thus, improve student learning (Garet et al., 2001; Hawley & Valli, 1999). This transformation is important for instructor's professional learning because the learning is happening in how people are talking and engaging in the activity and how this influences their thinking and teaching. This activity is in line with what Wilson & Berne (1999) found in their review of research: successful professional learning opportunities for instructors need to "engage them [teachers] as learners in the area that students will learn in but at a level that is more suitable to their own learning" (p. 194). Other possibilities for effective PD include developing and refining curriculum together (e.g., Johnson et al., 2016; Severance et al., 2016), refining professional vision for noticing and responding to student thinking in Video Club settings (e.g., van Es & Sherin, 2010), or working toward fundamental shifts in teachers' stances towards equity and student learning through critical conversations (e.g., Cochran-Smith & Lytle, 1999). While each of these PD activities is quite different, there are common threads running through them that are aligned with consensus findings about effective professional development.

For professional learning to occur, certain important features have to be present. These features are that the activity should be ongoing, collaborative, inquiry-based, focused on student learning and actual classrooms, and localized (Garet et al., 2001; Hawley & Valli, 1999, Penuel

et al., 2007; Putnam and Borko, 2000). In the following section I explain these advantageous features in more detail.

Why ongoing? Ongoing means the professional learning opportunities are extended over a longer period of time. Ongoing profressional learning could start, perhaps, with a summer institute but then the learning opportunity is extended by stretching out and continuing with organized, coherent PD sessions throughout the rest of the year or, ideally, multiple years. This ongoing element gives instructors time to try out new practices by collecting data and reflecting on their teaching practices as well as be engaged in comprehensive discussions of content, student conceptions and misconceptions, and pedagogical strategies (Garet et al., 2001; Hawley & Valli, 1999; Penuel et al., 2007).

Why collaborative? Working together in a collegial environment is necessary to create a space where instructors inquire and reflect on their practices, raise issues, feel safe to share dilemmas in their teaching practice, and take risks together (Darling-Hammond & Richardson, 2009). Teachers are not learning alone; instead, professional learning is collaborative, situated in specific contexts, and distributed across group members and tools (Putnam and Borko, 2000). According to Garet et al. (2001), the collaborative setting leads to change in teaching practice as it provides needed elements such as being able to discuss teaching and learning with colleagues in the same context. Wilson and Berne (1999) argue that "communities of learners … are redefining teaching practice" (p.194) and altering how teachers gain the knowledge needed to change their practices together.

Why inquiry-based and focused on student learning? An inquiry-based stance allows instructors to examine their teaching practice and focus on student learning and actual classrooms. According to Darling-Hammond and Richardson (2009), professional learning

opportunities need to deepen the instructor's content knowledge and skills for how to teach the content through active, hands-on learning investigating how students learn specific content (p.47). Wilson and Berne (1999) emphasize this point by saying "teacher learning ought not to be bound and *delivered* but rather *activated*" (p.194). Garet et al. (2001) underline the importance of active leaning which can come in different forms: observing and being observed in the classroom, planning and implementing, reviewing student work, and presenting, leading and writing.

Why localized? Localization is important because it means that the professional learning opportunities are occurring in the contexts where instructors generate and revise their teaching practices. Without such localization, professional learning might not be transferred to teaching practices because knowledge does not exist as "discrete packages" that can be taken from one context to the next (Garet et al., 2001, p. 935). Furthermore, professional learning opportunities should not only be localized but also integrated into instructors' daily routines (Garet et al., 2001; Severance, S., Penuel, W.R., Sumner, T. & Leary, H., 2016). This focus is important because as Putnam and Borko (2000) state, "all knowledge is situated in contexts" and "teacher learning should be grounded in some aspect of their teaching practice" (p. 12).

These are the main features that constitute effective PD and I will focus on these in this study to understand how they contribute to professional learning with hope for future changes and refinements in teaching practices in science in a higher education setting.

Lesson Study As an Example of Effective Professional Learning

I selected Lesson Study as a practitioner inquiry model for this study because there is strong evidence that Lesson Study is supportive of professional learning. The advantages of Lesson Study as a PD model are that it is ongoing, collaborative, inquiry-based, focused on

student learning and actual classroom practice, and can be modified to local needs. These characteristics overlap with the research consensus on features of effective PD explained earlier (Garet et al., 2001; Hawley & Valli, 1999; Penuel et al., 2007; Putnam and Borko, 2000). Additionally, Lewis, et al. (2009) have constructed an explanatory model of Lesson Study to document its features and explain its potential impacts on teachers and their practice.

Lewis and colleagues (2009) have found that Lesson Study cycles create changes in three areas: teachers' knowledge and beliefs, professional community, and teaching-learning resources. These kinds of changes in practice, outlook, and other forms of professional learning are certainly themes in existing empirical studies about Lesson Study (Fernandez, 2002; Lewis et al., 2009; Meyer & Wilkerson, 2011; Rock & Wilson, 2005). Data collected in these case studies suggest improvements in teachers' content knowledge (e.g. knowledge of mathematics and science) and changes in their teaching knowledge (e.g., knowledge of pedagogies for teaching mathematics and science). These studies also showed how participation in Lesson Study can foster growth in teacher's professional community through establishing norms and processes for collaborative and continuous instructional improvements. Furthermore, research participants developed high quality teaching-learning resources such as instructional tasks/activities, lesson plan templates, formative assessment tools, and routines for scaffolding learning. Studies conducted by Fernandez (2003, 2010) further show that Lesson Study contributes to professional learning and is a systematic and sustained way to support inquiry into teaching practice.

Hiebert, Gallimore, and Stigler (2002) view Lesson Study as a way to build a professional knowledge base for teaching, in contrast to "archived research knowledge," which they note has not had much of an effect in the classroom (p. 10). They argue that professional knowledge must derive from practitioners and the problems they encounter in their practice. The

research lesson, a focal part in the Lesson Study process, "provides a unit of practice in which the knowledge of teachers gets integrated into a useful form" (Hiebert et al., 2002, p. 10). Hiebert et al. (2002) maintain that this knowledge must be public, storable, shareable, and have a mechanism for verification and improvement.

Finally, Lesson Study is consistent with situated perspectives on learning because it is context-specific with authentic classroom activities and goals common to a group of teachers and students in a particular context (Putnam & Borko, 2000). While these ideas of professional learning are well-established in the K-12 teacher education community, they are newer to practitioners in higher education (Sunal et al., 2001). Especially in higher education, common modes of professional learning opportunities often consist of brief workshops focused on implementing certain best teaching practices presented by an outside expert with the hope that instructors will implement changes in their teaching practices (van Driel, 2012; Wilson & Berne, 1999).

Lesson Study in Higher Education

Some studies exist that are focused on the implementation of Lesson Study in higher education, but these studies are less common than studies in K-12 settings and the results have been less conclusive and more mixed in higher education settings (Cerbin et al., 2006; Demir et al., 2012; Kamen et al., 2011). The handful of studies of Lesson Study activities in higher education settings suggest that deepening the knowledge base (content and pedagogical content knowledge), the structure and protocol of Lesson Study with opportunities to observe each other teaching, and focusing on student learning over a longer period are important for fostering productive professional learning in a collaborative process among instructors. For example, Cerbin et al. (2006), who conducted the most widespread effort to use Lesson Study in higher

education in the University of Wisconsin System, found that a shared language was developed about teaching and learning, observation of teaching was valuable, and focusing on student learning created a helpful shift in lesson planning. Furthermore, the same study maintains that "broad scale teaching improvements in higher education might be possible if teachers work together to build a professional knowledge base" (p. 256) because the Lesson Study model scaffolds reflective practice among college instructors.

Similarly, Kamen et al. (2011) found that Lesson Study-style collaboration was a powerful experience for postsecondary teachers and participants and therefore, an effective model for instructor's professional learning. Their project illustrated that different variations of participation, including web-based technology using online chats in debriefing meetings, are possible in Lesson Study. Such modifications point to the flexibility of Lesson Study-style activities depending on the needs of a local context. These above examples indicate that collaboration and changing teaching practice is possible by using Lesson Study as a practitioner inquiry model in higher education.

However, another study (Demir et al., 2012) suggests that the collaborative process of Lesson Study and the practice of observing each other's teaching present challenges for productive professional learning in higher education settings. Demir et al. (2012) found that faculty members struggled with implementation as the participants did not view the collaboration valuable and demonstrated resistance to observing each other teach. Furthermore, the same study found that instructors were not willing to fully engage in self-reflective practices to learn more about their teaching, their professional learning, and their student learning. Additionally, Demir, et al. (2012) describe how faculty members were resistant to suggestions for changes in teaching

practices offered by their colleagues. This study shows some constraints to implementing the Lesson Study model successfully in higher education settings.

Mixed findings from studies of Lesson Study activities in higher education show uneven progress in participation among group members and do not clearly show instructional improvement in the same way that studies from K-12 settings have shown (Cerbin et al., 2006; Demir et al., 2012; Kamen et al., 2011). There are a number of reasons why findings from higher education settings have been mixed. First, there simply are not very many examples of research on Lesson Study activities in higher education settings and none exist that attempt to use this model for a whole course re-design. In many cases, such as Cerbin and colleagues' (2006) efforts to use Lesson Study activities across the University of Wisconsin System, rigorous educational research is not part of the professional development effort, which limits what we can learn from such reports. Second, mixed findings may suggest that collaborative inquiry into improving teaching is more difficult in higher education settings. This difficulty may be due to any number of reasons including the institutional structure of colleges and universities, roles and expectations for faculty and instructors, or pedagogical routines and norms of teaching in higher education.

However, because there has been robust success for Lesson Study in K-12 settings, and inconclusive results from instructors engaged in Lesson Study in higher education settings, this model for professional development might still hold promise as a way to understand how change in teaching practices and changes in the cultural landscape could be initiated and fostered in higher education. Additional research is necessary to sort out these mixed findings about Lesson Study activities in higher education settings.

Culture in Higher Education

In this subsection, I review scholarship describing the culture of higher education. Cultural elements of higher education such as values, norms, overall goals, and roles of faculty and instructors within higher education institutions may influence professional practice and present challenges for collaborative inquiry into practice. I give a short overview of the context of higher education. Then I explain some of the characteristics of the higher education culture connected to teaching and learning. Lastly, I illustrate why teaching reforms in higher education are challenging.

Characteristics of Higher Education Culture

Even though the focus of this study is not to examine the culture of higher education *per se*, it is important to provide a general description of the culture of higher education to situate the study in its larger context. If the goal is to change teaching practices in the sciences by being involved in on-going professional learning activities, one needs to understand the composition of the culture in higher education. I argue that elements of the higher education culture influence instructors' teaching practices. The culture also affects the potential for instructors to learn together during professional learning activities geared toward changing or refining those teaching practices.

Socially Constructed Institutional Culture. A prevailing understanding of culture in academia is to identify it as a homogenous whole, but this identification does not account for the entire complexity of the matter. A homogenous perspective means to "view culture as a unitary set of beliefs, values, and practices that can be ascribed to entire disciplines or institutions" (Ferrare & Hora, 2014, p. 795). According to Ferrare & Hora (2014), this homogenous standpoint merits critique because institutional cultures are actually more complex where "norms

and practices are internalized by individuals as they interact with a variety of social groups and situations, which leads to more differentiated, contextualized, and at times, contradictory views of culture and its relationship to action" (p. 793).

Along the same lines, Umbach (2007) defines "culture in higher education" as "the collective, mutually shaping patterns of norms, values, practices, beliefs, and assumptions that guide the behavior of individuals and groups and provide a frame of reference within which to interpret the meaning of events and actions" (p. 266). This implies that "culture is socially constructed and includes shared norms and values" (Umbach, 2007, p. 266). Therefore it is dependent on the situation and interaction of the people involved and cannot be homogenous for all higher education settings. Furthermore, to counter this homogenous perspective, Umbach (2007) argues there are three cultures at the university that influence how faculty teach and interact with students. The three cultures are: professional, institutional, and disciplinary culture (Umbach, 2007). He further argues there are also higher education subcultures and contends, "faculty work in a complex web of interconnected cultures" (p. 278) and not in a homogenous culture.

The current landscape of teaching and learning in higher education is influenced by how the culture establishes itself in an institution. According to Umbach (2007), these cultural manifestations are visible in artifacts, in behavioral patterns and processes, in espoused values, and in underlying assumptions. Artifacts are all the elements of an organization that "one can see, hear, or feel, e.g. organizational structure, language, and traditions" (Umbach, 2007, p. 266). Behavioral patterns and processes are "enduring behavioral activities with standardized form and content, either formally defined or developed by organizational members" (Umbach, 2007, p. 267). These patterns and processes often lay the groundwork for social interactions, e.g. certain

teaching behaviors, including rapport, organization, and task orientation. Espoused values are "stated values that organizational members openly communicate" (Umbach, 2007, p. 268). These values are often stated as explicit goals in mission statements, such as pursuit and dissemination of knowledge, and are part of creating an institutional identity. Values also exist as underlying assumptions such as the "taken-for-granted beliefs that help people make meaning of an organization" (Umbach, 2007, p. 268). Faculty autonomy and academic freedom are examples of embedded values characteristic of institutions of higher education. These cultural elements affect the work of faculty because they guide daily action.

Tension Between Research and Teaching. Contemporary higher education institutions are characterized by a tension between research and teaching. Umbach (2007) calls this tension the "paradox of academic work" (p. 295) because many faculty members teach most the time but research is more valued than teaching excellence at many universities. I argue that even at a non-research-intensive university that does have an emphasis on teaching, most science instructors are trained at research-intensive universities and bring those embedded values to the institutions that emphasize teaching (Connolly et al., 2016, Hutchings et al., 2011). According to Anderson et al. (2011), departmental and university culture often do not adequately value, support, and reward effective pedagogy (p. 152). The value put on research is reflected in the reward system, which is often underlined by institutional practices of recruiting, promotion and tenure (Mitchneck et al., 2016, p. 149). Mitchneck et al. (2016) point out that changes have happened to the professoriate, but "many embedded values and expectations for what counts and the timeline for when things count toward advancement have remained fairly static" (p. 149). Furthermore, promotion and tenure are often inflexible and seem like "an exercise of counting publications, external funding, and impact factors" (Mitchneck et al., 2016, p. 149). Often more value is given

to publication with a single authorship instead of collaborative research efforts (Mitchneck et al., 2016). Overall, even if there are rewards within a university for teaching, such rewards do not eliminate the tension faculty members experience between research and teaching.

The Challenge of Pedagogical Reforms in Higher Education. The workplace norms described above, such as giving a high value to autonomy, individualized curriculum design, teaching practices, and isolation of faculty from one another (Demir et al., 2013; Sunal et al., 2001; Tagg, 2012) coupled with tensions between research and teaching create a culture in higher education that makes the effort of changing or refining teaching practices a difficult endeavor. According to Henderson et al. (2011), it has been documented that a widespread change in undergraduate science teaching is difficult even though calls for reform in undergraduate science teaching are common. Reform efforts in undergraduate science education, such as the Vison and Change report (AAAS, 2013, 2011), often focus on certain competencies for students – critical thinking and applying biological concepts – and suggest pedagogical changes such as incorporating more active learning practices, utilizing an inquiry approach, and integrating undergraduate research opportunities into the classroom. These calls for reform also maintain it is important to create networks between higher education institutions to help implement changes. Furthermore, many biology education research publications exist on the subject of changing teaching practices toward evidence-based teaching in STEM as well as awards and grants to support these changes (Pelch, 2016; Tagg, 2012). But previous research into undergraduate science education reform efforts has shown that changes happen slowly in higher education, especially in connection with teaching practices (Brainard, 2007; Demir et al., 2013; Sunal et al., 2001; Umbach, 2007).

Research examining barriers to changes in teaching practices in higher education often indicates that insufficient training in pedagogy, too little time, and too few incentives may explain why changes happen slowly and are often confined to pockets of individual faculty members rather than more broadly across departments (Brownell et al., 2012; Demir et al., 2013; Henderson et al., 2011). Wieman et al. (2010) found that faculty and staff have to be exposed to new teaching strategies and research about learning for "one or two years before they are comfortable in making changes" (p. 13). These authors also found it was "harder to have faculty think about student learning goals" (p. 14), but this is an important part of the transformation process which takes time and does not happen easily. Brownell et al. (2012) argue that lack of faculty and staff training, time, and incentives are the most common barriers to changing teaching practice. Another possibile inhibitor of changes in teaching practices of science instructors might be due to an underlying assumption about how people learn science. Wieman et al. (2010) discovered a great barrier to change in science teaching in higher education is that many faculty and staff believe "the 'deficiency' lies in the student for poor educational outcomes" (p. 13).

Ferrare & Hora (2014) argue some aspects of cultural models of teaching and learning in math and science may inhibit changes in teaching practices. According to the authors, a cultural model of teaching and learning is a combination of an expressive/conceptual model and a task model. The first part of the model is a theoretical category helping to simplify complex processes and interactions. For example, biology instructors may operate on the theory that non-majors have no background knowledge and the instructor has to provide all needed information. The second part of the model is like a "script" that instructors rely on in instructional situations (Ferrare & Hora, 2014, p. 798). For example, a cultural script for a general biology lecture could

be that 1) a big biology idea is introduced, e.g. natural selection; 2) key terminology is explained, e.g., adaptation, trait; 3) instructor examples are presented, e.g. historical 'peppered' moth example; 4) students apply what was presented to a new example, e.g., camouflage coloring of another animal species. They conclude that these cultural models may explain why faculty members resist certain changes in teaching or embrace changes very slowly because reform efforts introduce new ideas about what teaching and learning in the sciences should look like contradicting ideas and concepts central to cultural models of math and science teaching. The authors also emphasize there is not just one universal or typical cultural model of teaching and learning in higher education, but rather various types of models exist within one instructor or among a group of instructors. As these models encompass instructors' thoughts about teaching science, beliefs about student learning, and expectations of their students, these models may be an additional element that hinders change in teaching practices.

Another factor that makes pedagogical reforms in colleges and universities challenging is that higher education institutions are still in the middle of this shift toward embracing practitioner inquiry into teaching as a scholarly activity. In 1990, Boyer (as cited in Hutchings et al., 2011) was instrumental in calling for the creation of a professional culture of teaching to improve teaching and learning. High hopes were attached to this effort as a way to transform higher education; as Huber et al. (2006) state, "making the private work of the classroom visible, talked about, studied, built upon, and valued – [these are] conditions for ongoing improvement in any enterprise" (p. 25). This call to study university teaching is relatively recent.

Another element that makes changes challenging is that it takes time to alter the difference in tradition between research and teaching. As Huber et al. (2006) point out, higher education has a long tradition of fostering a "robust academic commons for sharing the results of

scientific and scholarly research" (Huber et al., 2006, p. 26) that is necessary for the development of knowledge and its uses for social advancement. But teaching – and research on teaching – does not have such a tradition in higher education. Therefore, Huber et al. (2006) call for creating "Teaching Commons", which is "a conceptual space in which communities of educators committed to pedagogical inquiry and innovation come together to exchange ideas about teaching and learning and use them to meet the challenges of preparing students for personal, professional and civic life" (p. 26). This concept is needed because instructors must participate in the efforts to change teaching practices by being a reflective practitioner and create a tradition for the exchange of teaching activities for the advancement of practices, and ultimately for student learning. But this will take time and long-term commitment.

As this shift is relatively new in higher education, instructors and faculty may be focused on broad pedagogical changes such as shifting from teacher-centered to student-centered pedagogy. Research in STEM fields is currently identifying evidence-based teaching practices, such as moving toward student-centered approaches, which have shown promise in helping students to be more engaged, to learn science concepts better, and to become more fully engaged in doing science and talking about science (Pelch, 2016; Wieman, 2010). Examples of evidence-based teaching strategies that are becoming more common in higher education settings include active learning via the use of clickers, peer instruction, or flipped classroom approaches, all of which aim to make the shift towards more student-centered learning environments (Freeman et al., 2014).

According to Brint (2009), the quest for evidence-based practices result in an emphasis on student learning outcomes, but there is no consistency across higher education institutions in terms of how to create learning experiences, implement new teaching practices, or assess student

learning. As a result, university and college science departments now advocate that instructors use strategies such as implementing active learning. But many instructors remain dissatisfied because there is little or no support to help teachers figure out how to implement these student-centered pedagogies into their science classrooms in ways that are meaningful and relevant to students in their local contexts.

Taken together, these institutional norms, work cultures and recent shifts toward embracing practitioner inquiry into teaching as a scholarly activity might offer possible explanations for why the traditional way of teaching in higher education is often through lecture and why, despite many efforts, it might be hard to change (Henderson et al., 2011). Situating this study in the larger context of higher education setting builds a backdrop for understanding how one group of biology instructors in higher education tried, and struggled, to change their teaching practices by being involved in a collaborative professional learning activity.

Chapter 3: Conceptual Framework

In the following section I present the conceptual framework that guides my study to examine the micro-processes of collaboration within a group of biology instructors in higher education, and how these micro-processes afford and limit the ability to change teaching practices. The goal is to understand how educators begin to collaborate and learn together about problems in science teaching and learning, in this case biology, in higher education. A diagrammatic model of my conceptual framework is depicted in Figure 3.1 and shows what is happening in the collaborative micro-processes with three key elements. First, I explain the collaborative process of engaging in a professional practice such as the Lesson Study cycle. Next, I discuss social learning and interaction. Then I describe collective agency, authority and capacity. Last, I explain how these three components influence one other and are also influenced by the context of higher education culture because the context in which the micro-processes happen influences instructors' professional learning.

The phenomenon under investigation in this study is figuring out how a group of biology instructors work together to refine their teaching practices in higher education. I examine this phenomenon from a "communities of practice" point of view because this allows me to attend to what is actually happening in the micro-processes when Wenger's (1998) concept of "communities of practice" is enacted.

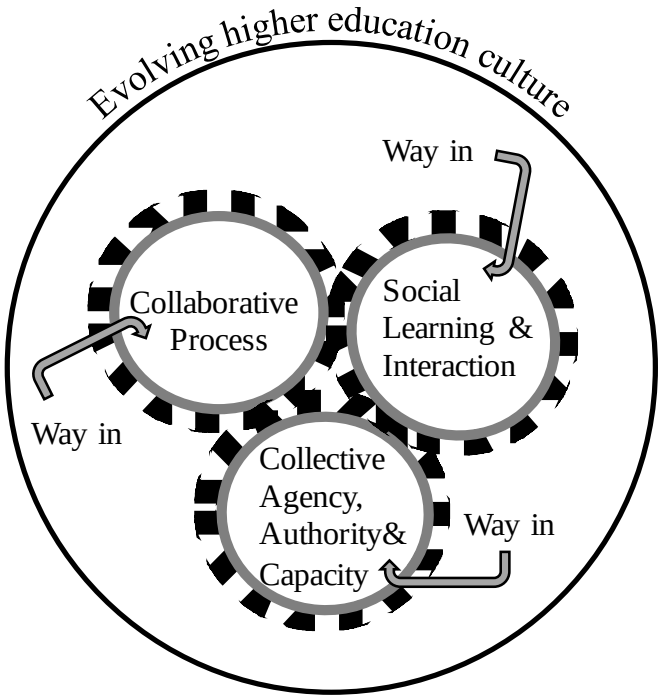

Figure 3.1: Model of Conceptual Framework

In Figure 3.1, a community of practice is represented by three inner gears that are connected and interdependent for the overall functions and dynamics of the micro-processes of this community. Depicting these elements as gears working together suggests that the system is in motion and key elements influence each other. The setting is represented by the larger circle labeled "Evolving higher education culture". The grey arrows depict potential "ways in" – or potential entry-points for different participants to find ways that they can engage with this community of practice. In the following section I will explain what each component means and how together they make up the whole "community of practice" and interact with each other.

Collaborative Process

The first gear, labeled Collaborative Process, represents the work required for a group of instructors who are participating in a professional practice such as a Lesson Study cycle. I define participating in a professional practice as the process by which a group of people work together

toward a common professional goal for the instructors and a common learning goal in biology that instructors are trying to aim toward in social and cultural spaces. Ideally, this group views science teaching as collaborative work. Instructors' engagement in a collaborative process hopefully leads to refinements in teaching practices and therefore advances the learning of the participants and the students they teach. A professional community is formed as a group of instructors discusses new meanings to create a shared vision, (e.g. What are the student learning goals for a general biology class?; How should we teach in order to reach these goals?; How should we work together to accomplish an agreed-upon group goal for our joint work?). Therefore, when analyzing elements of the collaborative process of the group in this study, I am interested in how group members develop a common goal for the group's joint work, how they negotiate the collaborative nature of working together to improve teaching, and how they navigate their own professional vision for teaching to develop shared visions for teaching; these are all important dimensions of engaging in a professional practice through a collaborative process.

This definition overlaps with Wenger's theoretical construct (1998) that a practice is "a process by which we can experience the world and our engagement with it as meaningful" (p. 51). He adds that a "community of practice" is "an ongoing, social, interactional process" (Wenger, 1998, p. 102), which I refer to as collaborative process. This community operates around three relational dimensions: mutual engagement, a joint enterprise and a shared repertoire that keeps the community together (Wenger, 1998, p. 73). According to Wenger (1998), mutual engagement "exists because people are engaged in actions whose meanings they negotiate with one another" (p. 73). This process of negotiation results in a joint enterprise as a reflection of "the full complexity of mutual engagement…[and] is defined by the participants in the very

process of pursuing it [the joint enterprise] … [and] creates relations of mutual accountability among participants that become part of the practice" (p. 77). As the participants pursue the joint enterprise, a shared repertoire is developed as "a set of shared resources created for negotiating meaning" (p. 82). These three dimensions – mutual engagement, joint enterprise, and the negotiation of meaning – are interrelated and influence each other to shape a collaborative process and contribute to the professional learning of those involved in the community.

Another element of the collaborative process is the role of leadership and how it influences the collaboration of people involved in a practice. Spillane's (2006) "distributed leadership" perspective defines practice with the focus on leadership as "interactions between leaders, followers and their situations" (p. 84). He argues for instructional changes by working together for a new goal for the instructors that might not previously have been part of the workday, e.g. in a group meeting people engage differently in leadership activities toward an agreed-upon goal for their professional growth and student learning goal. The idea is that these activities are productive, meaning what a group is doing moves them forward to accomplish their professional goals and the student learning goals for their joint work. An important factor in being productive is that leadership is distributed, meaning the practice of leadership is spread across different people and not just located in one leader. Therefore, Spillane's perspective (2006) deals specifically with the practice aspect of leadership – the activities people engage in – and also views the idea of community of practice as an ideal model of how a group functions towards a common new goal for their work together.

Another important component for engaging in a professional practice are the teaching and learning resources that the group creates, modifies and uses. Thus, a group participating in a practice produces shared resources like tools, e.g. artifacts, vocabulary, styles and sensibilities.

Spillane (2006) also examines teaching and learning resources as routines and tools that are part of a "distributed perspective." Routines for Spillane (2006) are "a repeated and recognizable pattern of interdependent actions that involve two or more people" (p. 56). Tools are "external representations of ideas that are used by people in their practice" such as "student assessment data, lesson plans, and observation protocols" (Spillane, 2006, p. 18). According to Spillane, these tools "mediate how people practice, shaping interactions among leaders and followers in particulars ways" (Spillane, 2006, p. 18). His perspective can be applied to this study because it can help determine how interactions shape the study group's practice, how leadership might be distributed, and how certain tools and routines that are part of specific situations are enacted and modified by the group.

Overall, both perspectives, Wenger's and Spillane's, help explain how a community is developed and sustained and what it means to engage in a collaborative process of participating in a professional practice. In this case, a group of biology instructors is engaged in working on science teaching and learning as a group. This collaborative process means instructors together set student learning goals for a class, plan units and lessons together, observe how one instructor teaches the planned lesson and collect data to reflect on what they learned from the observation. Ideally, this process will lead to changes in teaching practices, professional learning for the involved instructors, and students who are learning science. In this study, the collaborative process is structured through the Lesson Study practitioner inquiry model that provides certain components like goal setting for instructors and students, planning together, and observation and reflection to move the group along through the collaborative process.

Social Learning and Interaction

The second gear in the model represents another key element of a community of practice: social learning and interaction. Social learning is based on the assumption that learning happens through social involvement. Thus, I understand learning as social and situated in experiences and interactions. Participants learn through interaction with each other, such as learning how to talk to one another in a certain way about the learning and teaching of science. As people are working together, they interact in certain ways, e.g. they discuss, they argue, and they try to make decisions. Professional learning, therefore, is located at the level of the group's process and is not exclusively an individualized form of learning.

This understanding connects with the concept that learning happens as "social participation" (Lave &Wenger, 1991; Wenger, 1998). According to Wenger, social participation is "a process of learning and knowing" (Wenger, 1998, p. 4) in which participants learn as they "define enterprises and engage in their pursuit together" (Wenger, 1998, p. 45). Over time, "this collective learning results in practices that reflect both the pursuit of our enterprises and the attendant social relations" (Wenger, 1998, p. 45). This means learning happens by social involvement and affects participants by being engaged in a collaborative process that defines common goals for their joint effort and works toward accomplishing these goals.

Moreover, this group process also connects to Lave & Wenger's (1991) conceptualization of learning as "legitimate peripheral participation" (p. 29). Learning is more than accumulating information and skills; it is not internalized solely in the individual, but occurs through interactions and conversations within a community (Lave & Wenger, 1991). Furthermore, if learning is viewed as a practice and "process of social participation," how one thinks, what one does and who one is, influence one's identity (Wenger, 1998, p. 4). Through participation, e.g.

social interactions, one learns how to make sense of being part of the community, which might lead to changes in one's identity (Lave & Wenger, 1991; Wenger, 1998). Additionally, this participation influences how one interprets what the group is doing, which is reflected in the practices of a specific group. The social participation of a member in a community shifts from starting as an outsider, gradually moving through Lave & Wenger's (1991) idea of "legitimate peripheral participation," to becoming a full, central participant in a community as one learns how to become part of a community. This process is illustrated by beginning as an apprentice and eventually becoming an expert in one professional learning community. This process of learning is also impacted by the situation.

Interactions between group members are also an important part of social learning and influence the collaborative process. Again, Spillane's concept of distributed leadership offers a way to examine how group members participate in different ways in the group process and perhaps take up distinct leadership roles depending on the situation, e.g. which routines or tools the group is utilizing (Spillane, 2006). As Spillane (2006) emphasizes, it is the interactions between leaders, followers, and situations that make up a practice and these interactions shape practice. These interactions also could have an affect on one's identity and one's learning as well as influencing the practice of a group because they change who plays a leadership role, who takes charge and when.

Lastly, the social learning and the interaction aspects of a community of practice are a place for both knowledge acquisition and creation. This is where Wenger furthers the idea of learning by focusing his concept of community of practice on "what people do together and the cultural resources they produce" (Wenger, 1998, p. 283). This means the group is developing a shared language, shared vison, and shared goals for the general biology class that in this case

study is their common endeavor. Furthermore, Wenger's (1998) concept of communities of practice proposes explanations for how participants negotiate new meanings, how they deal with boundaries, how they might transform their identity, how they participate, and how they negotiate power relations regarding who makes decisions. These aspects are all part of an on-going collaboration. Wenger (1998) argues that a community of practice "has transformative power as a locus of engagement in action, interpersonal relations, shared knowledge and negotiation of enterprise" (p. 85). This means through the interactions between participants within the collaborative process, synergy is created and it becomes a place for changes. Therefore, it underlines the possibility not only of knowledge acquisition, but also of knowledge creation. In sum, these components of social learning and interaction are an important key feature of a community of practice. They help explain how participants are learning by participating in a collaborative process and how these interactions create professional learning opportunities.

Collective Agency, Authority and Capacity

The last gear represents a third key element of a community of practice: collective agency, authority and capacity. Biesta et al. (2015) define agency as "not something that people can have – as a property, capacity or competence – but is something that people do" (p. 626). Furthermore, Priestley et al. (2012) explain that "agency can be understood in an ecological way, i.e. strongly connected to the contextual conditions within which it is achieved and not as merely a capacity or possession of the individual. Agency is achieved in particular (transactional) situations" (p. 13). This means agency is influenced by the context of the situation, for example the structure and culture of a setting, whereas capacity means the individual "professional knowledge and skills" (Biesta et al., 2015, p. 636). By collective capacity I mean the ability or

perceived ability that the group can accomplish the tasks at hand by having time, resources, and shared skills.

Agency can exist both in individual and collective forms as people are actively involved in negotiating meaning to find a consensus, in deciding which ideas are taken up and/or postponed for later consideration, and in moving the group forward toward action. Collective agency is visible in how members contribute to the negotiation of meaning in the group process. As Severance et al. (2016) state, collective agency is "the efforts of groups working together to break away from current forms of activity and envision new forms of activity" (p. 533). This agency implies an element of change because it is the joint effort to envision and bring about new ways of doing things.

Furthermore, collective agency in Wenger's terms means the joined efforts to move forward and succeed in the enterprise of participating in a practice. As participants are involved in negotiating meaning, two processes interact with each other. One process is participation, which Wenger (1998) defines as "social experience of living in the world in terms of membership in social communities and active involvement in social enterprise" (p. 55). The other process is reification defined as "giving form to our experience by producing objects that congeal this experience into thingness" (Wenger 1998, p. 58). Therefore reification is everything that becomes real and solidified. Reification could be shared language, a tool, a routine, or a structure. Wenger (1998) suggests a duality that "in terms of meaning, people and things cannot be defined independently of each other" (p. 70). Thus some reification is needed to know how to participate. But at the same time, we need to be able to modify reifications or else we risk limiting participation. Therefore, collective agency embodies how individuals are part of a collective decision-making process.

The notion of authority also plays a role in the enactment of "communities of practice" in two ways. The first aspect of authority deals with who is in charge, meaning who has control of certain decisions and in certain situations. On one hand, authority can be somewhat formally embodied within people who are given the function to make decisions or credibility to be in charge or to be a facilitator of a process. As Wenger (1998) states, "different participants contribute and benefit differently, depending on their relations to the enterprise and the community" (p. 118). Authority may also be expressed in the informal roles participants enact, for example a person may play the role of the decision-maker, somebody else may play the role of a person who asks good questions, and another person may be recognized as a person who is attentive to logistics - keeping track of the nuts and bolts necessary for coordinating joint work.

Authority can shift as leadership activities are distributed fluidly among group members. According to Spillane (2006), leadership is "stretched over the work of two or more leaders who work together in place and time to execute the same leadership routine, such as facilitating a faculty meeting" (p. 60). This authority shift does not mean the leaders have to be formally assigned to these roles but are enacted through collective agency and authority within the interactions of the group members. As Spillane (2006) states "members of a group have a sense of themselves as an ensemble of the collective. They don't just think about their individual actions but think about what they do in terms of other members of the group" (p. 59). This identification shows collective agency and authority within the interactions across group members. Additionally, this demonstrates the concept of distributed leadership is filled with ideas about shared and distributed agency and authority across people so they can build the capacity needed to carry out complicated, long-term joint work needed for growth in education.

The second aspect of authority, in a more literal sense of the word, has to do with who gets to be an author. In other words, whose ideas get to be represented in the collaborative process? Additionally, who puts an idea forward and who is willing to discuss it and convince others that it is a good idea? Wenger (1998) describes this kind of authority as a form of participation, especially a form of "legitimate peripheral participation," enabling "newcomers to become included in a community of practice" (p. 100). This participation means authority, agency, and capacity can serve as a way for a person to move from the periphery to the center to fully participate. If someone is willing to be an author, they show a willingness to fully participate in that part of the micro-processes of the collaborative work. This raises questions of how the participation might change the participant's membership within the community; for example, whether some participants are still at the periphery or instead are a central part of the professional community (Lave & Wenger, 1991; Wenger, 1998).

The three key elements of my conceptual framework, depicted as inner gears, are dynamically interwoven and make up a "community of practice" which is a complex system. That means these elements work together and influence each other in different ways so the collaborative process gets started and rolling. But gears can also become misaligned, grinding to a stop at other points. A central goal of this study is to better understand the variety of reasons and explanations as to why the complex system of "gears" is sometimes able to get started and moves forward productively, while at other times the "gears" become misaligned and the system stops. These starts and stops can perhaps be explained by what is happening within each of the gears (the micro-processes) and/or the interactions with neighboring gears that make up a "community of practice."

Context of Higher Education

In Figure 3.1, the larger circle depicts the evolving higher education culture as the dynamic context surrounding the community of practice in this study. The collaborative process of instructors inquiring together into biology teaching and learning introduces new practices into this context; therefore, the context is not static, but evolves somewhat as communities develop new practices, norms, and interactions. Collaboration among instructors is itself a new practice for many whose teaching experiences in higher education have typically been more isolated (Demir et al., 2013, Sunal et al., 2001; Tagg, 2012). Collaborative processes where participants work to agree on shared goals for their joint work, plan for science teaching, and observe and reflect on colleagues' classrooms are not consistent with how science teaching is usually done in the context of higher education (Cerbin et al., 2006; Demir et al., 2012). Viewing teaching as collaborative,and observing peers' teaching with a focus on student learning are not norms in higher education; however, these elements are central to Lesson Study-type practitioner inquiry groups. They are well-established as critical elements for collaborative instructional improvement. Each of the elements of practitioner inquiry could create challenges for college instructors because in a higher education setting, instructors typically value autonomy, often working in isolation on the design and enactment of courses (Anderson et al., 2011; Mitchnek et al., 2016; Umbach, 2007). Lesson Study-type activities then, could be viewed as counter-cultural.

Friction With Evolving Higher Education Culture

Challenges faced as participants try new practices with an evolving higher education culture can be understood as points of friction. In the diagram in Figure 3.1, points of friction could arise if the three gears do not work in sync; they might grind against each other or against

the larger higher education culture like bicycle gears that are not fine-tuned to work smoothly together. For example, when the collaborative process is in motion, it might rub against some cultural elements which may not align with the collaborative process. But, as Johnson et al. (2016) point out, some tension is needed to get somewhere as a professional learning community because tensions can provoke problem-solving and sense-making among communities. Severance et al. (2016) similarly view dissonance as necessary to eventually working out disagreements and coming to a consensus. They argue it is productive for "expanding teachers' agency in the process of improving teaching and learning" (Severance et al., 2016, p. 532) from the learning point of view. From the participants' point of view, dissonance or friction might be frustrating and could be seen as resistance, but from a learning sciences' point of view, friction is worthwhile because disagreement is a necessary part of negotiating meaning together. This presents challenges for new Lesson Study-style groups who may not persist through points of friction and therefore may not accomplish generative change as a learning community.

Another possibility to explain the challenges created through friction is the theoretical concept of cultural models of teaching and learning by Ferrare and Hora (2014). These models are defined as "networks of cognitive schemata that are distributed between and among groups of faculty and whose instantiation in the classroom is mediated by perceived constraints and affordances in institutional practices and environments" (Ferrare & Hora, 2014, p. 794). In other words, it is not the structure of an educational institution alone, but also the interactions between people and the tools and routines within the institution that influence teaching practices.

Friction can happen because communities of practice are made up of individuals who bring to the group certain ideas and experiences about teaching and learning. These ideas and experiences can be challenged or questioned through a collaborative process such as the Lesson

Study-type practitioner inquiry in this study; ideally these challenges and questions are generative and provoke professional learning, but they could also be points of friction that stall collaboration among college instructors. The cultural models concept (Ferrare & Hora, 2014) is helpful in explaining these challenges because the collaborative process reveals how this collaboration works against participants' individualized ideas about teaching and learning and that is not necessarily part of the higher education culture.

Cultural models of teaching and learning (Ferrare & Hora, 2014) might help or hinder the professional learning in the group process and influence instructor's practice of how teaching is done and how it can be refined. As reflection is part of the collaborative process, collaboration in a practitioner inquiry group could assist instructors in understanding and changing teaching and learning by challenging cultural norms and creating productive frictions. While this friction may be difficult or frustrating for some participants, it might foster shifts in the community of practice and the ways participants are engaged within the community. In addition, this cultural model perspective might also help explain resistance to change as participants move back and forth between cultural models while going through the collaborative process. It is possible that analysis will show how uneven distribution of participation as well as changes in participants' thinking about teaching and learning within the group can happen.

In sum, when we look at the work of instructors in a group effort to redesign a course, these friction points, as explained above, are important for us to examine analytically because they may help explain how groups struggle to negotiate meaning and a shared sense of vision, how groups grapple with collective agency, authority, and capacity, and how groups bump up against the constraints of their institutional and cultural structures as they try to do their work collectively.

Finding Multiple Ways In: Participation in a Teacher Learning Community

Knowing that higher education science instructors may find the collaborative process of Lesson Study to be challenging, but promising, it will be essential that participants have multiple ways in – multiple entry points for participation in a teacher learning community. These possibilities for participation are incorporated into Figure 3.1 as grey arrows pointing inwards into the smaller gears. The arrows represent possibilities to jump into the collaborative process at the same point or different points for different people at different times in the micro-processes that make up our joint work. Participants may be able to join the collaborative process at different points in time and may be able to participate in different ways by taking on different roles in the micro-processes of our joint work. It opens up possibilities of taking part in the collaborative processes as peripheral participants partially appropriating different ways to be part of the larger community of practice.

One way to think of these ways into participation in the community is to think of each arrow as representing a possible way that participants can take up leadership activities within the group. Participants must take ownership to help the group decide how things get done. Spillane's (2006) distributed perspective on leadership can explain how different participants take distinct leadership roles. Spillane's concept might be needed to have the collaborative process continue and help explain how to deal with certain challenges created though the process in a higher education setting. The higher education setting can be equated with the situation dimension that makes up a practice. Spillane (2006) argues that "the situation is critical to all sorts of practice" and "the situation of practice can make it more or less difficult" (p. 74). He contends that "tools, routines, structures and other aspects of the situation often serve as a go-between in our interactions with others in the world" and those "aspects of the situation mediate our interactions,

and in these interactions, practices take shape" (p. 75). In other wrods, the setting in higher education provides certain structures that influence the interactions between the situation, leaders and followers, and influences practice.

Chapter 4: Professional Development Design

This study employs the Lesson Study model (Lewis et al., 2009) to create collaborative professional learning opportunities for a group of seven biology instructors in their weekly general biology group meetings. The group worked together to identify student learning goals and to start refining the general biology curriculum and their pedagogy over two semesters. The goal of this study is to investigate how practitioner inquiry might function as a support structure for instructors' professional learning to change their teaching practices in the sciences. In the following I explain briefly the Lesson Study model that was used to structure the weekly group meetings. Then I provide the rationale for picking Lesson Study as the specific practitioner inquiry model in this case. Lastly, I describe the design of the professional learning activities to illustrate what the group is doing. In the end of this section, I summarize in Table 4.1, including steps, timing, resources, and tools.

Lesson Study Process

Lesson Study is a cyclical form of PD that consists of four main phases: Investigation, Planning, Observation, and Reflection (see Figure 4.1). The first step of the Lesson Study model is the investigation or goal-setting phase. During this phase, participants set goals for aspects of student learning and development that instructors want to improve, investigate their existing curriculum, and identify a practitioner research topic of interest. In the second phase—planning—participants select a "research lesson" [called pilot lesson in this study] and start to plan the pilot lesson by identifying student learning goals, anticipating student thinking, and designing instructional activities and support. Instructors concurrently design how they will study the pilot lesson, including creating a plan for data collection, identifying the types of evidence to collect, and determining how the pilot lesson will be observed.

In the observation phase, one of the participants agrees to teach the planned pilot lesson while other instructors observe the lesson and focus on student learning through data collection. In the final reflection phase, all participants debrief what happened in the pilot lesson they observed by sharing and discussing collected data. Participants try to understand and agree on implications for pilot modification, teaching and learning, and understanding of students and the subject matter. Ideally the group will reteach the pilot and start the cycle again or switch to another topic of interest and move through the cycle of practitioner inquiry activities with a new focus and new pilot lesson.

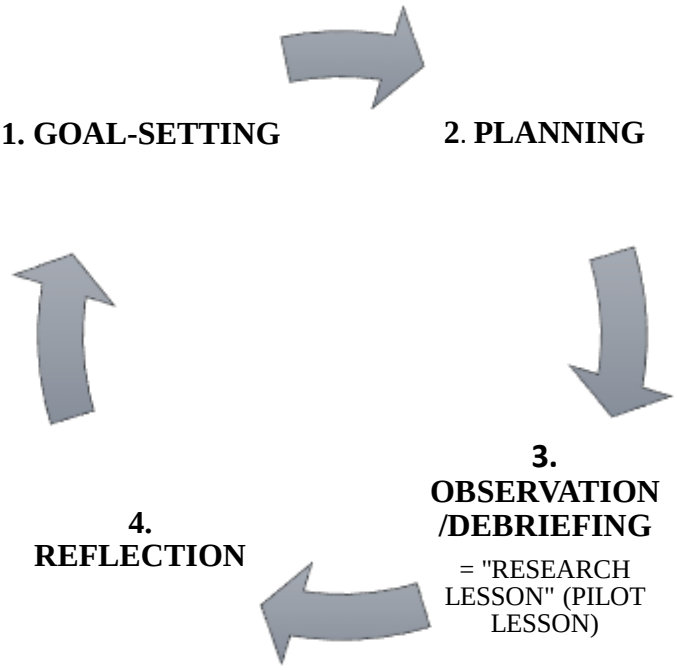

Figure 4.1: Lesson Study Cycle Model; modified from Lewis et al., 2006.

The Lesson Study process is based on collaboration in which participants work through iterative cycles of course development, implementation, analysis and reflection on their teaching and student learning. Lesson Study explores both instructor and student learning.

Lesson Study as a Model of Practitioner Inquiry

I selected Lesson Study as the model of practitioner inquiry for this study because strong evidence exists it is supportive of collaborative professional teacher learning (Lewis, 2015; Takahashi et al., 2016). This model also overlaps with the previously mentioned characteristics of effective professional learning activities. These activities need to be ongoing, collaborative, inquiry-based, focused on student learning and teaching practice, and localized (Garet et al., 2001; Hawley & Valli, 1999; Putnam & Borko, 2000). Therefore, Lesson Study is context-based and there are a number of possible adaptations and modifications for how to enact it in a variety of contexts. There is not one universal approach to Lesson Study and it can be replicated in different ways and adapted to any environment. These aspects make it an ideal professional development format for experimenting with the implementation of practitioner inquiry in a higher education setting.

Usually in Lesson Study, a team of instructors picks one lesson to work on as a team. In contrast to this conventional approach, in this general biology project I worked with my colleagues on an entire curriculum for one undergraduate course. One reason is that the class we had been working on was in desperate need of reform to enhance student learning. A second reason is that the process of Lesson Study seems to have the potential to be modified to work on a whole curriculum with a team of instructors. Fernandez & Chokshi (2002) suggest it is "a creative experimentation …that allows teachers to engage in high-quality learning experiences" (p. 129). Additionally, another justification might be the different structure for lessons in higher education as the class meets five hours a week (three hours of lecture [meaning meeting for 52 minutes on three days during a week] and one three-hour lab per week) for 15 weeks in one semester, which counts as five credits in the natural sciences for a general education requirement.

A ‘lesson’ per se might be much different in this higher education setting compared with a K-12 setting.

Another motive for using this model is that the process of Lesson Study involves goal setting at the beginning, which is ideal for promoting conversations about a whole course concerning its content and students’ learning outcomes. Furthermore, by working on the entire curriculum, change might be implemented faster than simply doing one research lesson at a time. Also Lesson Study meetings might provide the first opportunity for my colleagues to talk about student learning and the particular ways they are learning, so it seems to make sense to start broadly, then work on each individual unit and course lesson.

In sum, this discussion highlights how the process of Lesson Study provides parameters for setting the stage for changes in professional teacher learning and teaching practices to occur. In the following section I will describe the design of the professional learning activities for the group of colleagues I worked with.

Description of Professional Learning Activities

The professional learning activities followed the description of the Lewis et al. (2009, 2006) Lesson Study cycle with four parts: 1) Goal-setting, 2) Planning, 3) Research lesson [which in this study is called observation], and 4) Reflection as outlined in Table 1. This cycle structured the weekly instructor group meetings. To kick-off the professional development activities, I provided an organized learning opportunity at the end of the summer to talk about Lesson Study with the entire biology department. I facilitated a three-hour workshop to give an introduction to Lesson Study and give the department members a sense of how the group of instructors might get started with their project. Although this learning opportunity was not as extensive as the two-week summer institute that Perry & Lewis (2008) implemented in their

research, as I did not have the financial support to pay my colleagues a stipend for participation, it set the stage for getting started. The idea was to introduce the group to the Lesson Study process so we were all on the same page about the format we were working with to change the curriculum. In the first meeting with the general biology instructors, an external facilitator worked with us on group norms and consensus building and the group decided on meeting logistics for the semester. This initial meeting led us into the first step of our Lesson Study process: Investigation.

The goal-setting phase provided an opportunity to discuss as a group and decide on the overall goals for the general biology class. The idea was that by using the Lesson Study tool we would enhance instruction and student experiences in biology. There were two levels of goals: 1) Biology instructional improvements (curriculum goals, pedagogical goals, and collegial community goals), and 2) Improving student experiences in Biology (general learning goals, biology-specific learning goals and social learning goals). We discussed both long-term and short-term learning and development goals for students, student characteristics, and investigating different content areas, key concepts, existing curricula, standards, learning trajectory, and research. We needed to connect our student learning goals to learning outcomes of both general education and the biology department. Additionally, we needed to decide on a sequence of concepts we wanted to teach and why it made sense to teach that way in connection with how students learn the specific content. Thus we needed to include the resources of curricula other campuses are using and the Vision and Change report (AAAS, 2013, 2011) to align with efforts for developing a new undergraduate biology curriculum, biology department student learning goals, and general education learning outcomes from the small undergraduate university in the

Midwest where the study took place. This goal-setting step took us about two and a half months over nine, 50-minute weekly meetings. Then we proceeded with the second step: Planning.

When designing the study, I originally expected two stages of the planning step, but later when we moved through the collaborative process, things did not transpire the way I had anticipated. The planning step was to have entailed two levels and be guided by our specific student learning goals that led to action research questions we wanted to answer through our Lesson Study work. The goals and action research questions were to help us keep our focus and direct our work. The first level was to design the different units for the entire course. We would need to be aware of which sequence made sense in terms of student learning outcomes. Then we would need to plan different lessons that make up each unit. An important aspect was to envision how students were likely to respond to specific questions, problems and activities. According to Cerbin et al. (2006), the goal of instruction is to make students' thinking visible so one can observe and analyze it. To help this process we were to utilize a template for a unit and lesson plan, textbooks, other curricula, learning outcome goals for students, and research articles on how students learn different science and biology concepts and biology content in particular.

The second level of planning should have occured at the same time. It was to entail designing how we would study our different research lessons [called pilot in this study] from the various units. The plan would explain what type of evidence the team collected and how observers observed and recorded data during the research lessons. As part of planning the study for the pilots, we would incorporate student responses to certain activities, how the students made sense of the material, what they struggled with and how their thinking might have changed during the lesson. The focus would not be on *what* students were learning, but on *how* they were learning. Observation guidelines would help to indicate what kinds of data to collect, e.g.

detailed observations of students' activity and written work during the pilot. It would also be important to utilize time wisely. Fernandez et al. (2002) suggest strategic planning during which the fine details of the research lesson can be planned and written in subgroups, e.g. ideally two teachers who agreed on teaching the research lesson. Then the whole group meetings could be used to discuss and exchange feedback on the evolving lesson drafts. Ideally not more than three to four weeks should be used to plan the research lesson as the teaching, observing and reflection are the important parts of the Lesson Study process. The whole group would meet every other week during the fall semester to work on the lesson plans for each unit to discuss questions about: what will be done during the lecture and lab parts of the course?, will we have combinations or connections?, how will we manage the schedule logistically as certain people only teach lecture or only lab sections?. The subgroups would meet in between to work on the details of the lesson plans. The focus of both planning levels was student learning and what we wanted to discover about our students' learning. In the spring semester, we would plan for four research lesson cycles, ideally one per unit/theme, that would lead to the next two important steps in the Lesson Study process: teaching and observing the research lesson and reflection of the research lesson by analyzing the data collected.

The third step was observation and this occurred as planned. Observation would entail one member teaching a pilot while the others observed the pilot and collect data during the lesson. The detailed four-columned lesson plan would be the observation tool. Another tool would be a seating chart to record interactions of student groups and/or other templates that help focus on specific aspects of the lessons (Fernandez et al., 2002). Even though the lesson was videotaped, the goal was to have all group members observe and collect data from different vantage points and with different eyes. The data collection would focus on how students respond

and interact in the pilot and what impact the pilot had on their understanding. It would be important that the observers not interfere with the flow of the lesson by interacting with students because that would skew the data obtained during the observations. This step and the next one would be the most important steps in this collaborative process because evidence was collected and analyzed to investigate if the research questions could be answered and if learning goals for instructors and students had been achieved.

The fourth step, reflection, would occurr shortly after the pilot was observed and involved a debriefing in which partcipants shared and discussed data. A discussion protocol would help make this part of the cycle more constructive and efficient. In addition, it would help particpants have a more honest and productive discussion because it would reduce the nervousness and potential for hurt feelings (Fernandez et al., 2002). It would also be helpful to pick a moderator for the reflection discussion to keep the discussion on track, manage the main shifts in the discussion and remind participants to support their arguments with evidence from their observations. Team members would draw implications for redesign, for teaching and learning more broadly, and for understanding of students and subject matter. Ideally after the revision, another team member in a different section of the class would teach the pilot lesson again. In the end a summary report would be written so that other instructors could review and learn from the team's work. The report also helps the team consolidate their learning and is something that can be revisited as the team proceeds to the next research lesson and repeats the cycle.

The above outline was my intended plan for the professional learning activities at the beginning of the study. But in reality, the group proceeded more slowly than I had anticipated. We met every week for the academic year, but did not delegate the planning of the pilot to

subgroups who met in between. Individual group members worked on components of the pilot and we discussed it as a whole group in our weekly meetings. After we did one pilot for a lab in the early spring semester, we repeated the cycle by doing another pilot with a subgroup during March and April 2014. Then during summer 2014 the same subgroup did another pilot. The subgroup planned and implemented three labs that made up the Unit "Scientific Processes" for General Biology labs. This Unit was then implemented in all 14 General Biology lab sections in the fall of 2014. The idea was to repeat more Lesson Study cycles so we would have one pilot for each of the four units for the entire General Biology class, but we ran out of time. Ideally the group would have written a report in the end about the process and what they learned from each pilot. This write-up would also have been a contribution to the professional knowledge base for other instructors in the same field in teaching and learning. But it did not happen in this project.

Month Fall 2013	**Duration and dates**	**Activity**	**Goal**	**Resources needed**
August 20	1 (3 hour meeting)	Seminar	Introduction to Lesson Study for the biology department	video camera, materials e.g. videos on Lesson Study, poster paper, sticky notes, markers
August 21 Sept. 9	1 (2 hour meeting) 1 (50 min meeting)	1. Group meeting Second group meeting	Expectations, norms and logistics Finish group norms and logistics and "wishes and hopes" (big ideas) for our students	
September	3 (50 min-meetings) (16, 23, 30)	Goal-Setting	Goal setting: overall and specific to instruction and student experiences	Curricular material, general education goals, Biology student learning goals

Month Fall 2013	**Duration and dates**	**Activity**	**Goal**	**Resources needed**
October	4 (50 min meetings) (7, 14, 21, 28)	Goal-Setting	Worked on student learning outcomes	
November	4 (50 min meetings) (4, 11, 18, 25)	Goal-Setting Planning	From the student learning outcomes to deciding a research theme (goal of investigation) Started with planning by brainstorming ideas for class (11/11) Started to talk about planning first pilot lab, evolution (11/18; 11/25)	
December	3 (50 min meetings) (2, 9, 16)	Planning	Deciding what to include in evolution lab Summary of natural selection	Lesson plan template Four-column lesson plan template Other curricula, research articles
Month Spring 2014	**Duration and dates**	**Activity**	**Goal**	**Resources needed**
January	2 (2 hour meetings) (9 & 15) 2 (50 min meetings) (22 & 29)	Finalize Pilot Lab (research lesson)	Finish details of lesson plan, documents for students and material	Lesson plan template Four-column lesson plan template Other curricula, research articles
February	1 (50 min meeting) (5) 4 (50 min meetings) (7, 12, 19, 26)	Prepare for observations of pilot lab Debriefing – first one with specific agenda	Collection of data and Reflection of observation Examine (dialogue and Discussion) what happened, what we liked and what needs to change and where we go from here	Whole group, observation tool (guidelines and template) clip boards, video camera Observation notes, reflection notes, goal documents, discussion protocol

Month Spring 2014	**Duration and dates**	**Activity**	**Goal**	**Resources needed**
March	3 (50 min meetings) (5, 12, 26)	Reflection: Dialogue and Discussion	What are goals and next steps? Last meeting: what do we want to change and where we go from here? Discussion of article	Data as evidence, Other documents we produced, university student learning outcome goals
	2 (30 min meetings) (3 & 10) – **Sub group**	2. Pilot in lecture: Writing to learn in Energy Transformation	Create examples that can be used for pilot	Lesson plan, concept of writing to learn, examples
	March 28 (52 min)	Observation of 2. Pilot in lecture	Collection of data and reflection notes	Observation template, PowerPoint of lesson/unit
	March 31 (1 meeting for 30 min)	1. Debriefing of observation	Dialogue and Discussion on data we collected	Observation notes, reflections
April	1 debriefing meeting (30 min) (7)	2. Debriefing	Dialogue and Discussion and what to share with whole group	Observation notes, reflections and other documents
April	5 (50 min meetings) (2, 9, 16, 23, 30)	Reflection cont.	Dialogue and discussion of short-term and long-term goals What others are doing?	Goal documents, Other relevant documents Webinar on teaching strategies; Oregon Biology Workshop
	April 16		Decision on what we want to do the last 4 weeks	

Month Spring 2014	**Duration and dates**	**Activity**	**Goal**	**Resources needed**
May	1 (50 min meeting) (7) 1 (3 hour meeting) (13)	Reflection Wrap up (documentation)	Decision how group proceeds; (department chair was present to touch base) Decision on how to proceed: Subgroup formed to work on Fall 2014 Pilot by having pilot during summer class; Reflective report from whole group on experiences (missing)	
Summer 2014	1 (2 hour meeting) Exchanges via emails	Planning and implementing Pilot for 1. Unit: Scientific Processes	Finish details on lesson plans, split it up within subgroup, communicated via email, observation (1 in person, 2 via video)	Lesson plan for unit, observation template, video
Fall 2014 August September October - December	1 (90 min meeting with whole group) (26) Meetings every week Meetings every other week	Planning: Final changes for Pilot unit	Implementation of 1. Unit "Scientific Processes" (duration: 3 labs in September) in all lab sections	Material, lab manual, lesson plan for unit,
Spring 2015 March	Meetings every other week	Planning 2. Pilot Unit: Genetics	Implementation of 2. Pilot in all lab sections	

Table 4.1: Professional Learning Activities for General Biology Project – Fall 2013 until Fall 2014

Chapter 5: Study Design & Methodology

Study Overview

The purpose of this qualitative case study is to examine the micro-processes of a collaborative process with a group of biology instructors in higher education. I investigate how these micro-processes shed light on the details of practice important for the initial social, cultural, and pedagogical shifts needed for meaningful professional learning within a newly forming community of practice. Ultimately, these small shifts could determine if instructors continue or discontinue their participation in professional learning activities, such as the activities that are part of a Lesson Study group, and therefore determine if the instructors continue or discontinue their efforts to change their teaching practices. The goal is to understand how educators begin to collaborate and learn together about problems of science teaching and learning, in this case biology, in higher education.

I use a case study approach because I want to construct a general understanding of a phenomenon by examining a specific case. I view this study as an instrumental case study in which Stake (2000) explains "a particular case is examined mainly to provide insight into an issue or to redraw generalization" (p. 437). Furthermore, this case study approach allows me to provide a *thick description* (Stake, 2000, p. 43) by looking deeply into the micro-processes of this collaboration and how it supports instructors' professional learning in higher education. I use a "communities of practice" point of view because it allows me to attend to what is actually happening in the micro-processes when Wenger's (1998) concept of "communities of practice" is enacted. The communities of practice conceptual framework guided my analysis of the qualitative data collected over one year of engagement with biology instructors during their initial efforts to build a Lesson Study group together. In this chapter, I describe the research

questions, study design, participants and context, and data analyses used to make sense of the data set and to generate findings from this study.

Research Questions

This qualitative case study analyzes the participation of a group of higher education biology instructors as they engage in a collaborative process to refine their teaching practices and ultimately enhance student learning. The study examines the following questions:

Primary Research Question: How do educators begin to collaborate and learn together about problems in biology teaching and learning in higher education?

(a) What are the micro-processes of this collaborative process in higher education?

(b) How do these micro-processes afford and limit the small shifts in social, cultural, and pedagogical practice that are the beginning of meaningful professional learning?

By *micro-processes*, I mean the fine-grained, internal details of the social interactions that make up a community's mutual engagement in joint work. According to Little (2012), a micro-process is a systematic way "in which interaction is meaningfully situated, shaped by and constitutive of organizational structures, norms, and resources...as well as broader institutional and societal structures, processes, and logics (common arrangements for and ideas about education)." (p. 145). Therefore, micro-processes might help us understand more about the macro-processes, meaning larger grain-size concepts of professional learning, in activities like Lesson Study that otherwise would not be exposed. As Little (2012) states, micro-process research "accounts for the ways in which local practice both instantiates and constructs more

macro-level organizational and institutional structures, processes, and logics" (p. 145). Studies of micro-processes shed light not just on what people do in their workplace communities in their day-to-day practice but also on how interactions within communities contribute to negotiation of meaning including the sense of struggle felt by group members, especially when they are beginning their efforts to collaborate.

The concept of micro-processes allows me to zoom in on my data to understand the details of instructors' professional interactions in a collaborative group that might enhance or hinder teacher learning and instructional changes. Little (2012) points out that to understand practice one needs "to capture the detail, nuance, and patterning of social interaction" (p. 146). This view helps me make inferences about how the collaborative process for professional learning might be influenced by the macro-level of the higher education setting.

Participants and Setting

Seven instructors working within a biology department at a small undergraduate public university in the Midwestern U.S. spent one year focusing on refining general biology teaching practices and learning experiences using a Lesson Study process. In the following, I first provide information on the participants, including how they were selected, their teaching experience, and classes they teach. Secondly, I describe the setting of the study.

Participants

All seven participants were from the same small undergraduate public university in the Midwest and had been identified as people who taught a general biology class. All participants had been teaching this class at least one year prior to the beginning of the study. The biology instructor group worked together using a Lesson Study process (Fernandez et al., 2002; Lewis et al., 2009) to identify improvement goals and to start refining the general biology curriculum and

pedagogy over two semesters (mid-August 2013 to mid-May 2014) at a weekly 50-minute general biology instructor's meeting. This weekly meeting was already part of the instructors' work practice and was a space where instructors could address logistical needs (such as dates for lecture and lab exams, lab equipment needs, etc.) and curricular or pedagogical needs arising as the instructors attempted to coordinate their activities across multiple sections of general biology coursework.

At the beginning of the study, the group consisted of eight instructors, but one instructor withdrew consent during the second semester of the study and stopped participating in group meetings in March 2014. I, as the author, assumed many roles: participant observer (Creswell, 2007), facilitator for the Lesson Study process, and an educational researcher conducting the study. At the onset of the study none of the participants, apart from me as the facilitator, had experience with the Lesson Study process. Table 5.1 provides a summary of study participants.

Pseudonym	**Degree/ Position**	**Years of Teaching Experience**	**Other Experiences**	**Other Classes taught**	**General Biology**	
					Lecture (3hrs/ week)	**Lab (3hrs/ week)**
Anuschka (not a pseudonym)	Masters/ Lecturer/ (50%)	3 years		Anatomy & Physiology Labs (for majors); CVA (for majors)	Yes	Yes
Jenny	Masters/ Lecturer	5 years	Clinical Lab Technician	Essential Anatomy & Physiology (lecture and lab); Unity lecture and lab, CVA (for majors)	Yes	Yes

Pseudonym	Degree/ Position	Years of Teaching Experience	Other Experiences	Other Classes taught	General Biology	
					Lecture (3hrs/ week)	Lab (3hrs/ week)
Paul	Ph.D./ Lecturer	5 years	Researcher in Biotech Industry for 9 years	Unity labs (for majors); Cell Tissue Culture (for majors)	Yes	Yes
Peter	Ph.D./ Lecturer/ (50%)	4 years	Researcher, Project Manager, Director of Research in Medical Diagnostic industry 20 years	Genetics, Unity lab, Molecular Biology, FBI	No	Yes
Sam	Masters/ Lecturer/ Assistant Lab Manager	1.5 years	Wild Life Biologist/Technician for 10 years	Diversity lab (for majors), FBI	None	Yes
Sarah	Masters/ Senior Lecturer	10 years		Diversity of Life labs; Bioquest (both for majors)	Yes	Yes
Tom	Ph.D./ Lecturer	1 year	Botanical Field Researcher	General Botany (lecture and labs), Unity, Plants & society	Yes	Yes

Table 5.1: Information on Participants

I, **Anuschka,** am a Teaching Fellow at the university and had worked three years as an academic staff member in the biology department prior to the beginning of the study. I taught Anatomy & Physiology labs (for majors), Cell Biology (lecture and lab for majors), Comparative Vertebrate Anatomy (CVA) for majors, and General Biology (lecture and lab). My expertise is as a generalist with an emphasis on vertebrate anatomy, evolution and science education.

Jenny is an academic staff member who worked for five years in the biology department prior to the beginning of the study. Before teaching, she worked as a medical lab technician. Her

Master's thesis investigated an online class in the field of kinesiology. She taught Essential Anatomy & Physiology (lecture and lab), Unity labs (for majors), CVA for majors, Fundamental of Biological Investigations (FBI) for majors and General Biology (lecture and lab). Her expertise is Anatomy & Physiology and medical-related topics.

Paul is an academic staff member who worked in the biology department for five years prior to the beginning of the study. Before he decided to teach, he worked for nine years in the biotechnology industry. He taught Unity labs (for majors), Tissue Culture (lecture and lab for majors), and General Biology (lecture and lab). His expertise is microbiology.

Peter is an academic staff member (50%) who worked in the biology department for four years prior to the beginning of the study. Before starting to teach, he had a career in the medical diagnostic industry for about 20 years as a researcher, project manager, and director of research. He was teaching genetics (lecture for majors), Unity lab (for majors), FBI for majors, molecular biology, and is now teaching General Biology labs. His expertise is in genetics, conservation biology, biochemistry, immunochemistry, nanobiology and environmental chemistry.

Sam is one of the academic staff members who was hired one and a half years prior to the beginning of the study. He had some teaching experience while he was pursuing his Master's degree in Ecology and Conservation. Before deciding to teach, he was working for ten years as a wildlife biologist/technician. He is teaching FBI for majors, General Biology labs, Diversity labs and is the Assistant to the Lab Manager (50%). His expertise is ecology and wildlife management.

Sarah is a senior lecturer who had worked in the biology department for 10 years prior to the beginning of the study. For her Master's thesis, she investigated invasive species at Lake

Michigan. She is teaching Diversity of Life labs (for majors), Bioquest (for majors), and General Biology (lecture and lab). Her expertise is as a generalist with an emphasis on ecology, with a focus more specifically on invasive species and evolution.

Tom is an academic staff member who was hired one year prior to the beginning of the study. While he pursued his Ph.D. in Botany, he worked as a Teaching Assistant. He is teaching General Botany (lecture and labs for non-majors), Unity, Plants & Society and General Biology (lecture and lab). His expertise is field research, botany and evolution.

Setting

The study took place at a small undergraduate public university in the Midwest. The university is in a small town of about 10,000 of which about half the population is students. The university has an enrollment of about 7,000 students that has continuously increased over the last couple years. The university is primarily an undergraduate teaching institution with a variety of majors and with only a few graduate students in master's programs. The most common majors are in Agriculture, Biology, Business, Criminal Justice, Education, and Engineering.

The staff in the biology department teach a general education biology class to about 250-300 students per semester. One of these general education classes is the General Biology class that was picked for this study. One reason for choosing this class is that the researcher was also teaching the class and had good rapport with her colleagues. The researcher also knew the university well and understood how things were run. A second reason for choosing this class was that it is a multiple-section class, meaning on average the department offers five to six lecture sections (capped at about 60 students per lecture) and around 14 lab sections (capped at 24 students per lab). Additionally, the biology department expectation is that the various instructors for the class meet once a week to talk about logistics and other issues concerning the class. Thus,

there was already a group-structure present that could be utilized for an investigation of a collaborative process. Another reason for choosing this class was that the researcher was dissatisfied with the course curriculum and student learning outcomes and through ongoing conversations, gained insight that many of her colleagues felt the same way. The reason for lower student achievement might be that students who enroll in this class are, on average, non-Biology majors who simply want to fulfill a general education requirement. Furthermore, the traditional approach of a survey class might not suit this student population. It seemed like a fruitful ground for experimenting with whether the Lesson Study process could be a helpful support structure for instructors to modify the class and help focus efforts on student learning by refining their teaching practices.

Data Collection

To understand the conditions needed to support a collaborative process in higher education, and to understand how the micro-processes unfold and what participants learn collaboratively, data collection focused on interactions between individual participants, within the group, on interactions with students in teaching situations, and on participants' reflections about different parts of the process.

One of the main data sources for this study was videotaped weekly group meetings. After each group meeting, the participants wrote reflections, which I collected. I wrote weekly researcher memos after I had summarized the participants' reflections during the data collection phase. The pilot lessons, carried out in one participant's biology classroom, were videotaped. Additionally, I collected observation notes of teaching, field notes, and other artifacts such as debriefing notes, lesson plans, student artifacts, other written documentation, and tools used throughout the duration of the study. Data collection started in August 2013 and ended in August

2014. Table 5.2 below provides an overview of the data collection timeline including the data sources.

Month Fall 2013	**Duration and Frequency of Meetings**	**Activity**	**Goal**	**Data source(s)**
August 20	1 (3 hour meeting)	Seminar	Introduction to lesson study to the whole biology department	Video recording; Reflections
August 21 September 9	1 (2 hour meeting) 1 (50 min meeting)	1. Group meeting Second group meeting	Expectations, norms and logistics Finish group norms and logistics and "wishes and hopes" (big ideas) for our students	Video recording; Reflections; Participant artifacts
September	3 (50 min meeting) (16, 23, 30	Goal-Setting	Goal setting: overall and specific to instruction and student experiences	Video recording; Reflection; Researcher memo; Participants artifacts
October	4 (50 min meetings) (7, 14, 21, 28)	Goal-Setting	Worked on student learning outcomes	Video recording; Reflections; Researcher memo; Participant artifacts
November	4 (50 min meetings) (4, 11, 18, 25)	Goal-Setting Planning	From the student learning outcomes to deciding a research theme (goal of investigation) Started with planning by brainstorming ideas for class (11/11) Started to talk about planning first pilot lab: evolution (11/18; 11/25)	Video recording; Reflections; Researcher memo; Participant artifacts
December	3 (50 min meetings) (2, 9, 16)	Planning	Decide what to include in evolution lab Summary of natural selection	Video recording; Reflections; Researcher memo; Participant artifacts

Month Spring 2014	**Duration and dates of meeting**	**Activity**	**Goal**	**Data source(s)**
January	2 (2 hour meetings) (9 & 15) 2 (50 min meetings) (22 & 29)	Finalize Pilot Lab ("research lesson")	Finish details of lesson plan, documents for students and material	Video recording; Reflections; Researcher memo; Participant artifacts
February	1 (50 min meeting) (5) 4 (50 min meetings) (7, 12, 19, 26)	Prepare for observations of pilot lab Debriefing – first one with specific agenda	Collection of data and reflection of observation Examine (dialogue and discussion) what happened, what we liked and what needs to change and where we go from here	Video recording; Observation notes; Field notes; Researcher memo; Participant and student artifacts
March	3 (50 min meetings) (5, 12 ,26) 2 (30 min meetings) (3&10) – **Sub group** **March 28** (52 min) **March 31** 1 (30 min meeting)	Reflection: Dialogue and Discussion 2. Pilot in lecture: Writing to learn Observation of 2. Pilot in lecture 1. Debriefing of observation	What are goals and next steps? Last meeting: what do we want to change and where we go from here? Discussion of article Create examples that can be used for pilot of writing to learn in Energy Transformation Collection of data and reflection notes Dialogue and discussion on data we collected	Video recording; Reflections; Researcher memo; Participant and student artifacts Audio recording; Researcher memo; Student artifacts Observation notes; Field notes Audio recording; Researcher memo
April	1 (30 min meeting) (7) 5 (50 min meetings) (2, 9, 16, 23, 30) April 16	2. Debriefing Reflection cont.	Dialogue and discussion and what to share with whole group Dialogue and discussion of short-term and long-term goals What are others doing? Decision what to do last 4 weeks	Audio recording; Researcher memo Video recording; Reflections; Researcher memo; Participant artifacts

Month Spring 2014 cont.	**Duration and dates of meeting**	**Activity**	**Goal**	**Data source(s)**
May	1 (50 min meeting) (7) 1 (3 hour meeting) (13)	Reflection cont.	Decision how group proceeds; (department chair was present to touch base) Decision on how to proceed: Subgroup formed to work on Fall 2014 1. Unit for labs by having pilot during summer class	Video recording; Reflections; Researcher memo; Participant artifacts
May	Interviews (45 min)	2. Semi-structured interviews with participants	To learn about their ideas on the lesson study process and how that might have effected their views on teaching and learning	Audio recording and transcription of interview
Summer 2014	1 (2 hour meeting) Exchanges via emails	Planning/ Observation Pilot for 1. Unit: Scientific Processes	Finish details on lesson plans, split it up within subgroup, communicated via email, observation (1 in person, 2 via video)	Audio recording; Researcher memo; Participants and student artifacts
Fall 2014 August	1 (90 min meeting with whole group) (26)	Planning: Final changes for 1. Unit: Scientific Processes		Video recording; Reflections; Researcher memo; Participant artifacts
End of data collection				
September October - December	Meetings every week Meetings every other week		Implementation of 1. Unit "Scientific Processes" (duration: 3 labs in September) in all lab sections	
Spring 2015 March	Meetings every other week	Planning 2. Pilot Unit: Genetics	Implementation of 2. Pilot in all lab sections	

Table 5.2: Overview Data Collection Timeline Including Data Sources

Meetings. The weekly group meetings were video recorded and serve as a main data source used to learn about how the group interacts while working through the collaborative process. I facilitated the meetings and engaged in the meetings as an instructor participant because at the time of the study I was actively teaching one lecture section and two lab sections

of the general biology course alongside my colleagues in the other sections. The video recordings allowed me to gather data about meeting activities while also participating in and facilitating these meetings. The video recordings are a digital audio/visual record of what occurred in each meeting. I transformed the digital record into a text record by transcribing the interactions word for word from the recording. As I was doing the transcription, I also added comment boxes, a Microsoft Word feature, on the side of the transcription text. Miles et al. (2014) call these "jottings" that "hold the researcher's fleeting and emergent reflections and commentaries on issues that emerge during data analysis" (p. 73). In these comment boxes I included, for example, a personal reaction to some participant's remarks or action, a mental note to pursue an issue further, or a clarification of an action (Miles et al., 2014) After I finished each transcription, I wrote memos about the meetings. For example, I would include things such as short summaries about what happened in each meeting, whether I had picked up a theme or pattern, whether I had questions, and other things I noticed.

Reflections. At the end of each weekly meeting each of us wrote our reflective thoughts about the current meeting in a template I created [see Appendix A]. These weekly written reflections were collected by me and summarized in a word document as a primary data source to provide insight into participants' thinking.

Observation. The purpose of using observational data was it was part of the collaborative process and served as a tool to collect evidence on the pilot lesson, especially to learn about how the lesson facilitated students' learning. Furthermore, the evidence was used later in the debriefing and reflection phase of the collaborative process. After the group planned its pilot lesson, one participant agreed to teach the lesson while the other participants observed in

the classroom. The main goal was to observe classroom interactions and take field notes, but not to participate in the class. Appendix B contains the observation protocol for the pilot lesson.

Field notes. Field notes were used to collect data during classroom observations. I utilized two kinds of field notes. The first type is descriptive field notes in which I focused on capturing activities and interactions between instructor and students or student to student verbatim (Creswell, 2007). The second type is reflective field notes where I recorded observers' personal thoughts that related to their insights, hunches and themes that emerged during the observation (Creswell, 2007). I was also the facilitator of the collaborative process and could not write field notes during the meetings; therefore I also wrote a mix of descriptive and reflective field notes after each weekly group meeting.

Researcher memos. I wrote weekly *reflective memos* (Creswell, 2007) to reflect on how I as a researcher experienced first-hand the weekly group meetings during the time of the data collection. I wrote emerging ideas, themes or categories that were part of my preliminary analysis. Additionally, I took notes on potential analytical themes or questions to pursue in future meetings. I wrote another round of memos after I had transcribed each video recording of the weekly meetings. This time it was an analytical memo, which Miles et al. (2014) explain "documents the researcher's reflections and thinking process about the data... [and] attempts to synthesize them into higher level analytical meanings" (p. 84). In those reflections I noted emerging ideas, patterns, concepts, themes, or categories that were part of my analysis. After I did a round of coding of each meeting, I again wrote analytical memos to summarize whatI noticed in each meeting in relation to my coding, and added relevant quotes from each transcript to use the quotes as evidence for identifying emerging ideas and themes. These analytical memos were "powerful sense making tools" (Miles et al., 2014, p. 85).

Participant and student artifacts. Participants generated artifacts during group meetings and observations. These artifacts were collected as additional data to further understand how participants engaged in the collaborative process. Students generated artifacts that were collected as data during the participant-observed pilots to help understand how the pilots helped facilitate student learning.

Participant-generated documents were collected in paper form or electronically. Other artifacts generated on the board by participants were captured with my iPhone camera. Students' artifacts were collected in paper form after the pilots and copies were made of quizzes or exam questions related to the pilot lesson.

Data Analysis

To understand the fine-grained, internal details of the micro-processes in the collaborative process, I analyzed the interactions between participants in our weekly instructor meetings. The goal was to understand how educators begin to collaborate and learn together about problems in science teaching and learning, in this case biology, in higher education. I started my initial data analysis during data collection when I wrote weekly researcher memos to help capture ideas on how participants engaged in and viewed the collaborative process. I wrote these memos when I had summarized their reflections after each meeting. The *memoing* either reflective or analytical (Creswell, 2007; Miles et al., 2014), helped me identify emerging themes and ideas about the micro-processes of this collaborative approach, learning for instructors and students, and teaching practices. I adjusted the data analysis as I immersed myself in the data and pursued potentially important emergent findings and areas of focus throughout the analysis to help me answer my research questions. Additionally, I used instructor- and student-generated

artifacts to help better understand the primary data sources throughout the analytical process. In the following I outline and explain my three phases of data analysis.

First Phase. Once the data collection was completed, I started my first phase of data analysis with a round of open coding (Miles, Huberman, and Saldaña, 2014). I read through my research memos from the data collection and transcribed all the weekly biology instructor group meetings. After I transcribed a meeting, I wrote a researcher memo to capture what I noticed on emergent ideas and themes, and through this process, I developed emic codes for emerging patterns. For example, one such code was to label a role that some of my colleagues took on during our meetings: QUESTIONER. The questioner role was not a formally assigned role but was instead a way that some of my colleagues participated in conversations during our group's meetings. This was not my initial contact with the data as I had facilitated all the group meetings, personally conducted all the data collection, and was engaged as a colleague in relationships with my study participants. This role provided me with an opportunity to view the collaborative process as an insider and outsider at the same time (Trainor, A. & Bouchard, K.A., 2013).

Second phase. After I transcribed my thirty-five meetings, I started a subsequent round of analysis. I used a set of theoretical codes derived from my conceptual framework (Spillane, 2006; Wenger, 1998) and participants' generated codes on my transcribed weekly group meetings. Some examples of theoretical codes are *collaborative process*, meaning either what was the focus of the group, or what was the group doing as part of the *process*. Another is *social learning and interaction* as a way of participating, meaning what roles people take. For example, as I reviewed our group's social interactions during our meetings, I looked for the different roles people played during the meetings and characterized those roles as possible ways of participating in the group. These codes often connected back to codes from the first phase such as seeing that

some people played the role of questioner during meetings while others played the role of someone who is good at summing up what group members talked about. To characterize more about the social nature of our group's learning, I also coded for different patterns of interactions. For example, interactions can either build on what somebody else talks about [coded as: BUILDING ONTO] or just "putting in your two cents" [coded as: TWO CENTS]. In addition, I characterized how interactions contributed to or detracted from the overall flow of our group's conversation such as determining if the interaction was "derailing," meaning it did not productively contribute to the conversation to move the group forward [coded as: DERAILING or PRODUCTIVE]. Another code I used was for *collective agency and authority*, for example, where I coded if there was agreement or disagreement and then traced back through the group's conversations to examine how consensus or disagreements were built over time among participants. Based on instructors' conversations during group meetings, the coding families developed during this second round of coding became recurring themes used to trace what was happening in the collaborative micro-processes of our group (Creswell, 2007).

Last phase. In the third phase I employed selective coding (Saldaña, 2013) to further describe and interpret a set of patterns. Selective coding refers to a process of revisiting previous phases of coding (where the number of codes has grown and the coding framework has branched) to develop coherence by connecting and collapsing sub-codes into "umbrella" codes that aim to theorize about patterns in the data (Saldaña, 2013). For example, I created umbrella codes to figure out why there was a back and forth pattern to productive talk and derailing talk during the processes of negotiation. I also created umbrella codes to investigate why the group grappled with finding consensus and struggled to determine who had authority to make decisions.

During this last phase of coding, I also did more focused coding to both analyze what happened in each of the phases of the collaborative process and to describe the details of the micro-processes. For example, the process of creating umbrella codes to examine the back-and-forth movement of consensus and disagreement caused me to return to focused coding to make note of times when frustrations or concerns occurred in this collaborative process. I also looked for connections between initial themes to understand different relationships within this collaboration. For example, when the group increased their deliberation about finding a consensus, it led to an increase in talk about what the shared goals were for our joint work. Throughout this phase, I checked my patterns against all data sources to verify the outcomes of the collaborative micro-processes in this higher education setting. Throughout the coding process I wrote research memos to keep track of emerging ideas, themes, patterns, and important aspects, as well as how I made inferences from the data. As a result, I had a rich description of what happened in the micro-processes of this collaborative process.

Researcher Positionality Challenges

I faced challenges in this study because I am in a complicated position wearing different hats throughout the study. My roles were threefold in that I was a group participant, the facilitator for the Lesson Study process, and the educational researcher conducting the study. On one hand, I am a biology instructor like my colleagues and we are all trained as biologists. That means I share in who and what my colleagues are and am part of the group because I had been working with them for several years before I took on the other roles.

In addition, I was the facilitator of the professional learning activities as the group engaged in a collaborative process to refine their teaching practices. As a facilitator, I planned the timeline of the collaborative process with its different phases and adjusted it according to our

pace, meaning many times things took the group longer than had been anticipated. I was also responsible for creating the agendas and keeping the communication going via email or in-person about changes, questions or concerns before and after our weekly meetings. When I was wearing my facilitator hat, I was sometimes reserved in sharing my ideas about a specific topic because I wanted other group members to first share their ideas. I did not want to take up too much of the talking time as our meeting always seemed too short for everybody to participate. As a facilitator, I also often stepped into the role of questioner to move the conversation along or summed up what the group had just discussed to make sure I heard them correctly.

Lastly, I am the educational researcher trying to understand the micro-processes of a collaborative process of change in higher education. Because of these different roles, I was sometimes part of the group because my goal is to figure out how to best teach biology. Sometimes as the facilitator I felt as if I were trying to lead the group through the process, but sometimes they went in a different direction than where I was trying to go. Then, as the educational researcher, I was both interested in and confused by how the group's interaction unfolded. My colleagues, who were also study participants, had a hard time figuring out who I was and what role I was holding at certain moments during the study. Even though they followed, I could tell they were also skeptical because of their confusion about my research and the questions they asked about the collaborative process. One reason for this confusion might have been that they had not previously conducted educational research on their own. This reflection underlines how complicated it is at times to be an embedded educational researcher (Trainor, A. & Bouchard, K.A., 2013).

At the same time, assuming all these roles might have been an advantage because it allowed me to be an insider. Being an insider may have provided me insights and credibility

becuase I had worked with the participants before the study. Furthermore, my experiences both with the participants in biology and in science education made me an ideal candidate to wear these different hats during the study. Thus, the study was approached from deep institutional relationships as I had known my colleagues for years and had a deep understanding of how things are done at the study site. This insider stance was also an advantage becuase my colleagues were open and honest with me. Yet, my stance might also have been a disadvantage because the different roles might have spread me too thin, and I also had to be aware as a researcher to try and avoid biasing the data analysis and interpretations of my findings becuase I might hve been too close to and invested in this case.

I intend to stay honest by directly addressing the perspective I am coming from. This qualitative study is based on how I make sense of the events I participated in. Other people might interpret the data differently. My focus in this study was on our group as a whole, but other researchers might have focused more specifically on each of the individual instructors. Thus, an additional limitation of my perspective might be that by purposely focusing on and trying to understand the collective group, I may have a "blind spot" toward noticing aspects of the individuals in the group. That means if the explanation ends up being an individual one, I might not easily see it if it is in my "blind spot."

As with other forms of professional learning activities, it is possible that the self-reported reflections are not true representations of learning, and that the learning reported would have no effect on subsequent lessons the teachers develop. Furthermore, the collaborative process of Lesson Study is not just a PD, but also a development of professional culture through collective participation. It takes time and effort to create this kind of professional culture and a year might be too short for noticing changes in the working culture and development of a community of

practice (Watanabe, 2002; Wenger, 1998). In the same vein, according to Chokshi et al. (2004), the Lesson Study practitioner inquiry model is easy to learn but difficult to master if one does not develop a deep understanding of the principles by focusing on research and reflection. Therefore, I am interested in studying the micro-processes – the small details of interaction and practice that are the first small steps toward building (or derailing) a professional culture through long-term engagement in a collaborative process such as Lesson Study.

Trustworthiness

To ensure my study is trustworthy and valid, I have constantly reflected critically on the different roles I had throughout the study by writing field notes and research memos to avoid unintentionally biasing my findings and interpretations. To study the collective approach to learning and how it influences teaching practices, I engaged in prolonged and intensive data collection as suggested by qualitative research methodologists (Creswell, 2007). I was able to write a detailed and rich description (Creswell, 2007) of the collaborative process and how it influenced participants' social learning and interactions because of the various data sources I collected such as video recordings of weekly meetings, written weekly reflections of participants, field notes, and researcher memos. I also used verbatim quotes from the participants to substantiate my claims. Furthermore, I triangulated across multiple data sources and data collection methods to ensure the validity and trustworthiness of the data from which I drew my findings and interpretations. Additionally, I engaged in critical debriefs with my advisor and objective friends to discuss my data analysis, questions and concerns that arose as a way to externally check on the research process (Creswell, 2007).

Chapter 6: Findings

Are We Getting Anywhere?: Struggling to Negotiate Shared Goals through Collaboration

Negotiation of meaning – an on-going effort to make sense of workplace activities – is a normal part of collaborative group work. As Wenger (1998) states, mutual engagement "exists because people are engaged in actions whose meanings they negotiate with one another" (p. 73). This process of negotiation results in a joint enterprise as a reflection of "the full complexity of mutual engagement…[and] is defined by the participants in the very process of pursuing it [the joint enterprise] … [and] creates relations of mutual accountability among participants that become part of the practice" (p. 77). As the participants pursue the joint enterprise, a shared repertoire is developed as "a set of shared resources created for negotiating meaning" (p. 82). These three dimensions—mutual engagement, joint enterprise, and the negotiation of meaning —are interrelated and influence each other to shape a collaborative process and contribute to the professional learning of those involved in the community.

The story emerging from the current study is one about the struggle to negotiate a shared goal for instructors and students through a collaborative process of designing and studying new approaches to undergraduate biology teaching through a Lesson Study-type group. In this chapter, I describe how our group of seven biology instructors tried to negotiate meanings for a set of professional goals that were "moving targets" for our group during this first year of collaboration. These moving targets include: coming to consensus about student learning goals for non-majors in a general biology course; sharing a common rationale for why this student learning goal is worthwhile; and refining a shared set of pedagogical practices necessary for working toward this student learning goal. I characterize this work as a *struggle* and these

professional goals as *moving targets* because throughout the year of collaborative work, group members, including myself, frequently wondered: Are we getting anywhere?

In the analysis presented here, I am trying to understand the micro-processes of our collaborative process of inquiry-based professional learning through the design of new approaches to undergraduate general biology coursework. By *micro-processes*, I mean the study of fine-grained, internal details of the social interactions that make up a communities' mutual engagement in joint work. Studies of micro-processes shed light not just on what people *do* in their workplace communities but also on how interactions within communities *contribute to the negotiation of meaning*, including the sense of struggle felt by group members.

Are We Getting Anywhere? An Overview of Collaborative Negotiation of Meaning

At the beginning of the study, the group was in the goal-setting phase of our Lesson Study cycle which entailed nine meetings druing which we treid to come to a shared, public agreement on the central problem of practice in teaching and learning in general biology for non-majors. In our initial meeting, group members shared "wishes and hopes" for their students and tried to redefine these wishes and hopes as goals to anchor our work together. The quote below is an illustration of how the group proposed tentative visions for how goals could be used to anchor our collaborative process of refining general biology.

> Peter: Did you want to review the – um - group definitions or how do you …?
>
> Anuschka: "I really picked up your idea [meaning Peter's idea] and we had worked on a few and a few are missing. So, I wasn't sure how we're gonna go about that.
>
> Sam: So, I guess … before I dive in to the next place … can you kind of refresh my memory on like … cause it feels the resting place of these definitions. What are these … the definitions targeted for?

Tom: That's … I'm unclear about that too. Are these for us?

Anuschka: They're for us.

Tom: … what we're coming up with…? Okay.

Anuschka: They're for us and the idea is really that's kind of our goals.

In this exchange, Sam seeks clarification about the "resting place" for the group's potential definitions of goals and about who or what these goals are "for"; Tom also wonders what a set of shared goals might be used for in our work to revise general biology. This wonderment could be based on different assumptions in the group about how the goals might be incorporated, either into a syllabus or lab manual meaning that these goals are "for" students and "for" a concrete artifact like a lab manual. But others in the group, like myself, held a different image of what the goals are "for", seeing them as revisable anchor points for our own on-going professional inquires for the upcoming year. To come to public agreement about student learning goals, our group also needed to negotiate what those goals could be used for, and we needed to negotiate an audience for our goals.

After further discussion spanning nine meetings, the group prioritized their growing list of student learning goals and picked one high-priority goal for guiding our work together. Our group chose how and why biology is important to the lives of our students because we felt other goals easily fit under this umbrella such as interconnectedness, appreciation of the complex and dynamic nature of biology, and engagement. Initially, we thought this goal marked the end of the goal-setting phase of our collaborative activity. However, as the group moved through the collaborative process of inquiring into our general biology courses for the remainder of the year, the group was still negotiating decisions about the goal for our group's work. In the quotation below, which illustrates an example of our on-going negotiations, it is not only the goal that is

again up for discussion, but also the use and audience for our work as Sam returns to earlier questions about where our work will "rest" and what our work will "look like."

> Sam: I'm a bit ... confused ... and I guess I just need some clarification on ... – you know –our ... our ultimate product or ... – you know - what ... what that should look like.
>
> Paul: Yeah, I don't know where the focus is.

One group member offers her explanation:

> Sarah: I think we have...several goals and different ranges is my interpretation.
>
> Anuschka: You wanna ... elaborate a little bit ... on the different ...?
>
> Sarah: ... there are some very short-term goals and some very long-term goals – um – I ... I think - um – that our "research theme" is ... the one thing that we want to connect everything that we're doing to ... to make...any changes we ... may have ... apply to the lives of our students - um – a big long-term goal I think is ... to redesign the course in such a way that happens.

Negotiating goals occurred and reoccurred throughout the year along with negotiating the related ideas of how goals could be used during our group's work and what sort of final form our group's work could eventually take in practice. One major theme emerging from the analysis of micro-processes is that negotiation of meaning forms a type of rhythm in our group's collaborative process. The exchange between group members highlighted above points to another major theme – timing matters for our group's collaborative process – the theme of short-term versus long-term goals resurfaces again and again and underlines the rhythm of negotiation.

A final major theme emerging from this analysis is that negotiation of meanings within the group is intimately connected to their negotiation of roles and uncertainty about their agency, authority, and capacity for redesigning general biology coursework. Often this theme emerged

as group members took on the role of questioner by raising concerns and expressing uncertainties in the form of questions posed to the whole group. Sometimes questions were explicitly about the on-going struggle to negotiate shared goals and meanings for the group's work. For example, when Sam asks: "It's really just redesigning ... the course? So ... what do we want that to look like?" he seems to reorient the group's discussion towardsarticulating the goal of our overall collaborative process of redesigning general biology. A bit later Jenny adds "...which is why when we started talking about this last week ... I mean we have that list ... but then ... what are doing with that list?" In this instance, she is looking for a shared vision and goal for the class.

At other times, however, group member's questions point to issues of uncertainty about collective agency, authority, and capacity to accomplish the daunting task of redesigning general biology together through our collaborative process.

> Sarah: For me with ... I keep coming back to another ... just trying to ignore it ... to continue – um – is the fact that ... what we need to do is ... big and we have an hour a week...and how do we actually do this big ... big? In an hour a week with eight people?"

These examples show that group members participate in the negotiation by stepping into the role of questioner. The role of questioner was shared consistently throughout the whole year of the study by each of the group participants as they repeatedly revisited questions about the shared goal and vision for the group's work as well as questions about the group's agency, authority, and capacity for this work. Toward the end of the year, the group was still negotiating for a shared goal and vision. Thus, a major finding of my study is how common it was in every phase of the collaborative process to negotiate the purpose of our shared work on teaching and learning in general biology courses. This finding raises some important questions both in terms of my role

as a participant in these collaborative processes and as a researcher interested in how teachers learn together through mutual engagement in joint work:

- Why is it so hard to come to a consensus about a goal for teaching and learning?
- Why is setting a goal that focuses on student experiences in biology not easy or straightforward even though this was an issue all group members initially valued?
- Why didn't the collaborative process arrive at a focus on student ideas and experiences in biology? What might be getting in the way?

The answers to these questions might be found in the small micro-processes that made up our group's work which often felt as though we were taking two steps forward and in the next meeting, three steps back. This story is about the slow work of deliberating with colleagues about teaching and learning in biology. It illustrates how hard it is to work on pedagogical changes in teaching practices in higher education settings.

My analysis of data from the group of seven biology instructors, including a year's worth of transcriptions of the weekly group meetings, artifacts created by the group, and researcher memos, pointed to three specific themes that tell part of the story of the struggle to negotiate meaning in a collaborative process. The first theme is that there is a rhythm to how negotiation occurs, flowing productively forward in some interactions, only to later ebb backward in other interactions. A second theme highlighted how much timing mattered for our group's work, revealing how in higher education settings, structures such as the academic calendar place pressures on instructors. A final theme emerged as group members took on key roles during our group's interactions. Through these roles group members expressed uncertainty and a sense of struggle with collective agency, authority, and capacity for accomplishing the group's work. Even though I will discuss each of these three themes in the following subsections separately, I

do not suggest these themes operate independently from each other. In fact, these three themes are interwoven and influence each other. To describe the micro-processes that make up each theme, I will follow a chronological order through the different phases of the collaborative process: Goal Setting, Planning, Observation/Debriefing, and Reflection.

Theme 1: Rhythmic Ebb and Flow in the Negotiation of Meaning

Our group's collaborative process included a rhythm – a pattern in which our group was continually going back and forth as we deliberated about what the shared goal of our work should be and struggled to come to a consensus. After analyzing the micro-processes of our group's activities, it seems our collaborative process was following the rhythm of a dance, moving two steps forward and three steps backward. In the following section, I will describe how certain activities moved the group forward two steps (e.g. talking about wishes and hopes for our students in the goal setting phase and talking about big science ideas in the planning phase). Then, I will describe how other activities provoked us to move backward three steps, (e.g. prioritizing goals, struggling to define them, and wrestling with different visions for how to teach science ideas). This forward and backward movement happened frequently throughout the study in a kind of rhythm and I will describe it in a chronological sequence of the phases of the collaborative process.

Goal-Setting phase. My data show that the process of genuinely setting a shared goal about the specific problems of learning and teaching general biology is uneven. Goal-setting was more complicated and involved more time spent on negotiating and renegotiating the goal than I had anticipated given the existing literature on Lesson Study and other inquiry-group professional development activities (Allen et al ., 2015; Fernandez, 2010; Lewis et al., 2009; Severance et al., 2016; van Es, 2009).

The first point of negotiation occurred when I started to work with my colleagues as we attempted to come to some public agreement about norms for our collaborative work. The group developed two different foci: one discussion focused on the interactions within the group and the other centered on the structure of the collaborative process, (e.g. the timeline, goals, and how Lesson Study activities would work during semester-long general biology courses).

Sarah summarized these two foci after one of our first meetings:

And I think that the two separate groups took it … in two different directions.

Anuschka: Okay. So what do you mean with that Sarah?

Sarah: Jenny, Tom, Anuschka and I came up with things as to how we would interact and deal with each other on a personal level. Whereas the other group seemed to focus more on how we would proceed with the project rather than with people.

Even though the group of general biology instructors had worked together before, this meeting was the beginning of our efforts to work together in a new collaborative process using Lesson Study-style activities and interactions. In this meeting, I explicitly discussed group norms as a way to signal the start of something new and how to make group norms visible because often shared norms are implied in the higher education culture and it is assumed that colleagues already know how to work together. The group was able to come to consensus through deliberation and agree upon shared norms.

After sharing the different ideas, the group decided on the following five group norms:

1. Be an "active" listener, meaning you pause and try first to hear what the other person has to say before you react.
2. Be open-minded, meaning being non-judgmental about what others are suggesting.

3. Ask questions for clarification and support arguments with ideas, meaning make sure you understand what others' contributions mean.
4. Trust the support of your group members, meaning do not fear what others are thinking because we are in a safe environment.
5. Fulfill your individual role, meaning complete a task or participate in the group discussions.

Peter added that "the establishment of the group norms and having clarity that we feel clear about what our group norms are is a great way to start." This comment shows that the deliberation about group norms for collaboration is an example of a group interaction that allowed us to take a step forward toward a shared purpose for our group activity.

Later in this same meeting, group members engaged in a brainstorming activity about "wishes and hopes" for our students. This brainstorming activity highlights the kinds of problems in teaching and learning biology that group members were initially interested in addressing. For example, Tom wants students "to develop curiosity. Hopefully they are more curious at the end of the semester than they were in the beginning" or Sam states that "I hope that they know how and why biology impascts their everyday life."

Sarah want the students "to see the connections throughout .... that top view...to understand that biology is more than just this part and this part and this part but they are all connected... [and] recognize interconnectedness." Peter added to this idea because "my hope would be that there would be a growth in the students' perception of what biology is and so ... I think that kind of dovetails with – uh – interconnectedness." When Paul added the idea that students should "learn enough basics so that five or ten years from now when some public issue comes up, they can teach themselves about it and understand it better than otherwise", the other

group members agreed with him. Furthermore, they added that they want students to appreciate the complexity and dynamic nature of biology. These last examples illustrate agreements at this phase of the group's deliberation. The "wishes and hopes" discussion was an easy entry-point for group members because every participant has previous experience teaching the general biology class and has ideas about what they want their students to learn. This is another example of an interaction that moved us forward one step toward a shared goal for our group's activity.

However, coming to public agreement about the problem of practice – a problem of teaching and learning in general biology that we all could agree on as a focus of our work – and about potential ways of working on that problem did not materialize in this meeting. Negotiation processes seemed to move the group forward a bit and then backward a bit as we tried discussing different possible problem-of-practice goals derived from our "wishes and hopes" and as we tried prioritizing them. In November after eight meetings, the group did publicly decide on a specific problem of practice – how and why biology is important to lives of our students – and agreed on some strategies for working on this problem: use a topic-based approach with units, employ active learning strategies, and engage students in a variety of science practices such as the use of data. However, analysis of our group's year-long activities now indicates this problem may have been disingenuous consensus as we will see later in the collaborative process.

Planning Phase. The transition into the planning phase of our Lesson Study collaborative process was another easy entry-point for group members' participation. This phase started with an activity in which every group member publicly shared the big science ideas that make up the introductory general biology course. We were able to advance one step forward toward the shared goal of redesigning the general biology course by building on four big ideas provided by one group member. Sarah started us out by noting:

> Four big things I think are important throughout the semester: evolution… the central dogma [gene expression], maybe not even necessarily the specifics steps, but the concept..., biodiversity and energy flow, once again not necessarily the steps of photosynthesis and respiration but energy flow kind of larger context.

For Sarah, the bigger concepts situated in a larger context are important. Paul added "the need to get the concept of the cell across because that's one of the paradigms of biology." But Sarah suggested "instead of having the cell ... talk about the cell when we're talking about gene expression [central dogma], biodiversity, energy flow or dynamics ... make it a component rather than its own separate section." This quote illustrates that Sarah might be thinking about the big science ideas (e.g. evolution, central dogma, biodiversity and energy flow) as well as about a topic-approach to class so that within each topic the larger concepts can be integrated rather than approached as a survey course. Tom added there should be "more of an environmental component ... in this class" and Sam agreed with him. Additionally, Jenny brought up the human connection when she contends, "I think we can connect to all those things ... too." Sam and Tom agreed with Jenny and underline that the human connection relates to the student learning goal of how biology impact the students' lives.

In addition, the planning phase was an easier conversation for the group because it involves working with comfortable, familiar parts of the general biology course design – the science ideas themselves – where everyone in the group feels competent and prepared for participation. As the above quotes show, each group member is able to contribute because they are all trained scientists and have experience in teaching a general biology class. Furthermore, in their reflections after the meeting some colleagues shared they felt we had a good start of ideas for the class and seemed to be on the same page about the big science ideas. Nevertheless, the

reflections revealed that some colleagues were wondering how we should decide which ideas should stay or be removed and whether any of the group members had a vision for the class. This was still a step forward as the group moved toward deciding on a topic for the pilot lesson. But when the group's conversation changed focus and particpants started discussing how to teach the big science ideas, in this case evolution for our pilot lab, the group's interactions and progress became much more convoluted.

One possible reason why this conversation is challenging is that planning how to teach is usually an individual, private practice in higher education (Demir et al., 2013; Sunal et al., 2001; Tagg, 2012). It is unfamiliar for group members to participate in kind of decision-making where there is a new expectation that the group would come to a consensus about how to teach biology. For some group members, this may have been the first time that pedagogical practices were part of a public deliberation and where articulating pedagogies was the focus of shared work. One group member, Sarah, shared how she teaches evolution and notes:

> [there was] one spot where I first started to do the 'writing-to-learn' and I find it quite valuable because I was really frustrated we talked about the process of natural selection ... and at exam time [we went from] like ten percent of the class could explain it ... to like a good seventy percent of the students getting it, to be able to explain how it works.

Sarah offered another example of a pedagogical practice:

> one of the first assignments I give my students is to come in with a definition of evolutionary adaptation…and groups work together on that and half of them still get it wrong – um – but then we come back in okay ... okay so what's the definition of acclimation?

Jenny shared that what she was currently doing "is .... like some history [of evolution] to let them know it's not a new thing, which they kind of actually get into ... they've only ever heard of Darwin ... and then I throw other names in there." Tom shared, "I start by having them spew out everything that comes to mind when they hear the word evolution," which is a practice Sarah and Jenny have used as well.

The pedagogical turn in our group's discussion marks the beginning of an ebb in the rhythm of our negotiations because this discussion renewed deliberations about the goals and purposes of our group's work. For example, in the second meeting of the planning phase I summarized:

> some … of the comments even from two weeks of the reflections like 'you lost me, what is the end product gonna look like, what's this process all about' – you know – and I'm trying to just … give maybe something more concrete. But keeping this in mind because the goal is really to think about … if we try to accomplish that can we really cover all this? Or what … what is really the vision of the class?

Sarah summarized the purpose of our work as "so we're zooming in and then zooming back out." But in the same meeting Paul expressed his concerns about the purpose of our work in questioning:

> So, my two cents is … that – um – that sounds good from the lesson study standpoint. But suppose we feel that a major negative for the class is – uh – say one or two labs or one or two topics in lecture … do we ever at some point in the future get to that … in terms of improving the class?

Paul continued "I think it would be too bad if we didn't ever have time to do something about lab … because I think that's the easier fix and – um - … if it just stops there." Sarah and I disagreed

with Paul because we envision not a "fixing" but rather a rethinking of the class overall and Sarah summed it up as "yah, that's what I am thinking is ... kind of rethinking overall [the class] instead of just tweaking...there was a lot of tweaking over the last ten years." This discussion illustrates that before we even reached deliberation aimed at finding consensus about how to teach the general biology course, renewed deliberation about orienting toward a shared purpose slowed our progress. Talk focused on goal-setting increased before the group could move one step forward again, slowing our progress toward planning for the pilot lesson.

In the rest of the Planning Phase the group worked through these difficulties and decided on a topic for a pilot lesson to serve as the focal point for our Lesson Study-style work. The group again showed an increased deliberation when they discussed the goals of the evolution pilot lab and tried to connect these goals to the overall group's goals. For example, when the group shared ideas about how to teach evolution, Sam brought up "yah, I think we're going in the right direction definitely – uh – but then I see this umbrella of our research theme [goal of group work] ... how it's important to the lives of our students" and a discussion started how we can connect to this overall goal. This conversation is one way the ebb and flow rhythm of our group's interactions governed the on-going struggle to negotiate meaning and shared goals, connecting the overall goal with the goals for the evolution pilot lab. In the end the group members were able to co-plan the pilot lesson. Later I will explain how this lesson-planning activity unfolded when I talk about the third theme of grappling with collective agency and authority.

Observation/Debriefing. Recall that during the Observation Phase, group members observed one instructor's enactment of the pilot lesson. They collected data by taking notes about how the students and the instructor participated during the lesson. These field notes are

then discussed in the Debriefing Phase. This phase functions as more than data collection. While debriefing observations from the pilot lesson, the group started talking about pedagogical practice, which marked forward progress in the rhythm of negotiation of meaning within our group. Group members shared what they had noticed during the observation. For example, some group members noted there was no deep thinking by the students, while other group members noted the pilot lesson may have involved too much reading and remarked that sometimes the students had a hard time following instructions. Group members described how students struggled with analyzing data. Observers noted students' group dynamics seemed problematic because often students worked alone through the reading and then just checked their answers with other group members rather than working collaboratively to make sense of ideas together. These observations from the pilot lesson sparked the beginning of an inquiry into our teaching practices. This inquiry was a step forward toward negotiating shared meaning among biology instructors as we began to focus on relationships between teaching and learning anchored by specific observations from the pilot lesson.

Even when our conversations were not oriented toward inquiry into practice, observing and debriefing the pilot lesson afforded other small steps forward for our group of biology instructors. Tom's question, "So maybe a good place to start is if we were gonna do this again, what would we keep? What would we change?" did not orient the group toward deeper inquiry into problems of practice but instead focused on fine-tuning aspects of the pilot lesson itself. Nevertheless, this move represented a small step forward in the group's negotiation of meaning because it was rooted in shared observations from the pilot lesson. Additionally, Peter shared detailed evidence from his observation about the first component of the pilot lesson. He speculated that components of the pilot lesson likely needed to be redesigned because he

suspected students explained what they thought we as instructors wanted to hear, rather than thinking through their conclusions for themselves. He pointed to discrepancies between students' conclusions and the data they had collected during the lab. Both Tom's and Peter's contributions were oriented toward "fixing" components of the pilot lesson rather than taking a broader inquiry oriented toward larger problems of practice. Nevertheless, the debriefing phase offered a way in to mutual engagement with our group's work.

The "fixing" orientation was evident in the last debriefing meeting as Peter wondered about how the productive work and conversations during the Observation and Debriefing Phase might connect back with what he perceived as the larger goal for our group's collaborative process:

> [What if we] come up with ... a mechanism for how to incorporate some of the ... – you know - the great ideas that are coming out ...and the work that has gone into these module ... into our work product, which is our lab manual ... and I think that it is this ... in my mind as simple as saying that we can make anybody ... can make a proposal for some modification and we simply vote on it and it goes ... in based on how we vote. I mean we haven't really talked about a mechanism for how we make change here.

From Peter's point of view, implementing a change in the lab manual might be a step forward in our joint work because, for him, the larger goal of our work is to improve the tangible instructional materials in the lab manual for the course. For those group members who saw the goal of our joint work as one of updating the lab manual and other instructional materials, this turn in our conversation represented a step forward. But for group members who saw the goal of our joint work as one of sustained inquiry into problems of teaching and learning in the general biology course, this turn in conversation might have been a step backward because it does not

illustrate a deep inquiry into our practice. This opposition foreshadows an ebb in our rhythm of negotiation of meaning as group members spoke up in an effort to refocus on larger questions about our goals.

For example, Paul reoriented the group toward larger goals for improvement of general biology:

> We spent a lot of time this semester and last ... getting to doing the Lesson Study in the lab and we really kind of put on the back burner these larger issue discussions of what should be in the course how ... say just the lab part but how should we organize it? What topics should we include? What should we exclude based on ... what we do and don't like about this distinct format of the [class]?

Later Sarah referred the group back to the list of goals we created in the fall, "But I think it might be a good time to revisit what we've thought about already." Sarah invited the group to zoom out and refocus on larger goals after the pilot lesson, "I'm glad we did the lab because it did point out where we need to change some things." Tom followed Sarah's lead:

> maybe there we ... we kind of figure ... out ... our priorities whether we want to go on with this ... writing-to-learn pilot on energy or do we wanna take a step back and ... have these big discussions? ... and I think we need to ... do one or the other.

Sam built on this idea and proposed:

> setting our ... ultimate goal. We ... have something to strive for... if we have that ultimate goal in mind. Whether that's in ... being we – you know – we have multi-unit ... multi-week system ... okay, if that's our goal, then we can figure out the strategies to do that.

The conversations during the Observation and Debriefing phase were anchored in specific details of the pilot lesson derived from shared observations. Our negotiation of goals or

purposes for our group's work was marked by a rhythm of ebbs and flows in our group's effort to figure out our purpose. Group members ultimately tried to build a bridge suggesting that the group can do both: embark on redesigning another pilot lesson to make specific adjustments to the lab manual while also tackling the big questions about problems of teaching and learning in general biology. An excellent illustration of bridging is seen in Sam's reflection at the end of the debriefing phase:

> I really think we need to step back and evaluate … set our larger goals of Gen Bio; however, I still think it's good that we did … are planning other pilot lessons to gather data on what could work in the future.

The bridging stance taken by Sam and other group members marked a transition into the last phase of our lesson study activities – the Reflection Phase.

Reflection Phase. During the Reflection Phase I noticed a pattern in the participation of the group members that signaled something different was happening in the way the group was trying to negotiate the shared purpose and goals of the lesson study meetings. When the object of the group's activity shifted toward working on a more short-term, tangible task, such as building a new lab manual activity out of two previous lab activities, I saw more participation from people who otherwise were not always very vocal participants. For example, Tom agreed to merge two plant labs into one and also was more vocal about other ideas "maybe we could decide if we wanted ... [to] focus on lecture or lab in the next four weeks' and he suggested "I guess if I had to vote that what I would vote for [is to work on labs]." In some respects, this change in participation represents a change in rhythm as mutual engagement in joint work propelled the group toward some aspects of our goal to redesign general biology. However, this

increase in participation focused on the short-term, tangible task of developing a new lab manual activity was not a complete consensus shared among all the group members.

Instead, the focus on short-term, tangible tasks provoked one group member to speak up and make an effort to negotiate a different route for conversation in the group by asking the group to revisit the longer-term, less tangible purposes of the group's activity, such as creating an overarching outline or map for the course vision. Sarah, for example, advocated again for considering the bigger picture of goals for the entire general biology course and notes "so, it would be nice if everybody like by the end of finals week, could get some sort of idea put together over the quarter [whole semester]." This pattern in participation and in the negotiation of the shared purpose for the lesson study group is a kind of rhythm that was part of the group's activity moving back and forth between smaller goals associated with designing concrete materials like the lab manual and lab activities toward the larger goals of designing a larger-scale vision document guiding the whole course.

The back-and-forth rhythm might be an essential part of how groups negotiate meaning and joint activity (Wenger, 1998). But the uneven progress toward shared goals was also frustrating and sometimes confusing for participants. Participants who were excited about the smaller goals became frustrated when the group focused on larger goals and moved away from tangible planning for short-term tasks. Participants who were excited about larger goals became frustrated when the group strayed from the larger vision to focus on immediate, short-term planning.

Two participants again tried to build a bridge by communicating how the short-term work could eventually build up to the longer-term or larger-scale vision work. Sarah stated "that's why I mentioned the long-term thing... just have it in the folder by the end of next week [finals week]

... so it acts as a focus on the short-term." Jenny added, "I mean kind of like we've been doing where we implemented little pieces into what's already existing while we're planning the bigger ... picture for the future," suggesting that by doing short-term work the group might also be reaching the long-term goal. The ebb and flow rhythm of negotiations among group members may be one factor that slows down collaborative processes of professional learning and creates frustration and confusion among participants.

Researchers that are focused on collaborative design and collaborative workplaces point to this confusion, disjuncture, and dissonance as a central component of negotiating meaning to drive mutual engagement and joint work, but note that participants may not derive a sense of agency or authority from such efforts (e.g., Engestrom, 2011; Sannino, 2010; Severance, Penuel, Summer, and Leary, 2016). I will discuss this idea further when I describe the third theme from the findings that illustrates how group members grappled with collective agency, authority and capacity as a source of uncertainty within their efforts to collaboratively redesign the general biology course. Next, I turn to the second theme from the findings by focusing on how the academic calendar and timing structures of the higher education culture shape the micro-processes and rhythm of negotiation of meaning within our group.

Theme 2: Calendar and Timing Structures of Academic Culture Shape the Micro-Processes of Negotiation

The second theme in the findings centers on structures of higher education – specifically the roles that academic calendars and timing play in structuring the work of teaching in higher education. In our group, concerns about time were brought up frequently. Furthermore, group members often noted they felt accountable to an expectation of having a tangible outcome in one or two semesters. This theme in the findings may play a role in influencing the micro-processes

of the negotiation of goals and purposes within the group because dilemmas or pressures of time create an urgency for the negotiation of purpose, accelerate the ebb and flow rhythm, and prevent extended deliberation about problems of practice. The group could not get comfortable with deliberation and instead felt rushed to produce an outcome that meshed with the academic calendar and perceived expectations for tangible results in a short time frame.

Goal-Setting Phase. During the goal-setting phase of our group's activities, the process of discussing goals and prioritizing them took longer than had been anticipated based on other research into Lesson Study and practitioner inquiry groups (Allen et al., 2015; Fernandez, 2010; Lewis et al., 2009; Severance et al., 2016; van Es, 2009). Setting and prioritizing shared goals for our group's work was not straightforward and was more complicated than anticipated, which caused frustration and friction for group members. Pressure to time our work to mesh with academic calendars and perceived expectations about delivering a final product within a short timeline amplified these frustrations and shaped the way our group struggled to negotiate shared meanings for our goals and purposes.

In our first meeting of the semester when we were discussing the group norms, Paul raised the issue of time as he notes, "I think the timeline part means – at least it meant to me – that we have a goal that is small enough that it is achievable in one semester of the meetings." After five additional meetings dedicated to generating a set of potential goals for our improvement efforts, Peter explicitly addressed the time issue again:

> …[I] realize it all takes time but we haven't had a discussion about – uh – examining those drafts to see if we all agree with those drafts. I think we're actually some distance away from saying these drafts are... are ready – you know- any inclusion into a syllabus

> or anything like that. They require another round. I think they all require another round of discussion.

Afterwards, the group needed another full meeting to discuss the definitions of our goals before we moved forward with prioritizing our goals.

After a month of discussion, I sensed some frustration and encouraged my group members by saying, "It's hard work but keep up with it. So we really need to work a little bit about how we as a group define our four goals we've talked about before we really look at the other ones." When the group finally prioritized the goals, Paul seemed very frustrated with the collaborative process and states, "So how biology impacts their daily life – yah, number one [goal] ...student engagement I think I might put second. But you could put several second. But I'm supposed to choose. So ... that's it." Paul continued "well, those are the two specifics for this ...what I wanna change...like a month or two from now probably...she [Anuschka] asked to keep in mind what we would like to change as we go through this." Paul's comments highlight his frustration with the slow pace of the process of genuinely negotiating shared purposes for our joint work to improve the general biology course.

Planning Phase. The academic calendar and pressure from expectations about the timing of our work shaped the way the group worked on planning the pilot lesson. In the second meeting of the planning phase, I brought up the topic of logistics by saying, "including today we have like four meetings left." I continued:

> I mean we could spend four meetings just talking about – you know – what's more important [from the big science ideas], how ... should we do that? ...so I thought maybe it's a good ... way to think about to really shift it and say like 'Okay, let's dialogue about a topic and really think about our first target or 'research lesson' we're gonna plan

> together. We gonna observe ... one teaching and the others observing and collecting evidence to look at it.

I tried to move the group along in the Lesson Study-type activities by keeping the timeline of the study in mind with hopes that by moving ahead to plan the pilot lesson we might also be able to make progress together on developing shared goals for our work. Peter asked for clarification "what's the time frame? Um – or is it actually... is it not the end of this ... is it not a December – aah – class you're thinking of?" Peter's question hints at the expectation of the academic culture to complete projects within a one-semester time frame and to show tangible products or results quickly. I replied:

> From my understanding of the process, December is not really the time frame. I was rather thinking...maybe to find ... something to start with very early next semester to have one [pilot lesson] right away and then ideally have maybe ... a second or third one the next semester [too].

This dialogue illustrates that the collaborative process takes a lot of time and is a practice the group members are not used to doing. Even as I was trying to move our group's work toward long, iterative cycles of pilot lesson studies, group members like Peter were envisioning more linear trajectories toward completing our work with tangible outcomes within a short academic timeline of one or two semesters. In the following I will describe how planning of the first pilot unfolded with the group and highlight how the theme of time played a consistent role in shaping our group's work.

The first task for the group when planning ahead for a pilot lesson that we could all study together was to decide on a topic for the pilot and then decide on whether we would do the pilot lesson in the lecture component of general biology or in the lab component of the course. It took

the group three meetings over a time span of three weeks to decide on doing a pilot lesson in a lab session focused on evolution. I will discuss in more detail exactly how this decision was reached when I discuss the third theme of the findings that details how our group grappled with collective agency, authority, and capacity.

The next task – actually planning the components of the pilot lesson and re-designing the instructional materials used in this lesson – lasted for another eight meetings that spanned two months. This phase seemed to take even longer as it stretched over winter break, which made it harder to keep the group momentum. For example, three weeks before the end of the semester I stated:

> We have never done it to plan a lesson together and as well have like a research ... like what we wanna get at. So it's all new to us...but I thought it would be a good way to end the semester and take us over to the next and kind of come back and that's what we wanna do.

The group needed two additional meetings lasting two hours each before the beginning of the spring semester and three more meetings in the spring semester before the pilot lab was fully planned. Collaborative planning as a group took longer than anticipated and seemed harder and slower than planning individually. Furthermore, during the planning phase, it seemed as if the group was running out of time to be ready for the pilot. But setting a deadline created an urgency for deliberation and pressure to come to a consensus. Thus the group met its deadline and made the pilot lab happen. I will discuss in detail how the group ultimately came to some consensus as a result of this pressure when I discuss the final theme of the findings.

Frustration and confusion continuously bubbled to the surface during the planning phase. For example, Paul expressed his frustration as such:

> I'm not saying, being critical about Lesson Study, but – uh – I think it's a good idea and it's an interesting thing and – you know – I have been kind of waiting all semester to see where it ends and we've done lots of other things which are fine. But – you know - I don't know. I'll stop there.

Paul's comments implied that the slow, deliberative process of redesigning and studying general biology lessons as an instructor collective was taking too long for him. In addition, Paul's comments point to his concerns about tangible outcomes; he is not sure where the Lesson Study process will get us. Jenny responds with a more long-range vision of how slow and collaborative work would ultimately pay off for the group:

> Jenny: I think all these things are getting us ...
>
> Paul: Yah.
>
> Jenny: ... to where we need to go ...
>
> Paul: Okay. I appreciate that.
>
> Jenny: ... and then once we take those steps ... at least I'm hoping ... especially looking at it [our high-priority goal] through that vision we can ... if we do one thing, it'll be easier to do the next things.

This discussion excerpt shows that not all group members were frustrated with the pace of our work; instead, some viewed the time it takes as necessary to move us forward toward a larger vision for improvements in general biology. Nevertheless, the underlying concern shared by group members like Paul was that it was getting closer to the end of the semester and Paul wondered what we would accomplish in the rest of the semester.

One possible reason why this process was challenging is that this new focus of planning how to teach evolution for the group provoked dilemmas that previously might have been under

the surface, but now people were saying things out loud and expressing concerns. On the surface, the concerns sounded like concerns about not having enough time to complete the tasks, but as group members continued to talk, it seemed as though there was more to the concern than just a worry about timelines. Group members were also struggling with uncertainty about their collective agency, authority, and capacity to redesign and systematically experiment with teaching general biology. I will discuss this idea further in the final theme of the findings by highlighting how all three themes of the findings are closely intertwined.

Observation/Debriefing Phase. During this phase, our group spent four meetings trying to make sense of observation data gathered by notetaking during one instructor's enactment of the pilot lab lesson on evolution. These discussions were grounded in the observational data from the pilot lesson and quickly led the group back to big questions about the goal of our joint work. Time pressures of the academic calendar and perceived expectations that our group needed to deliver a product (e.g., a new general biology lab manual) within the semester time frame also contributed to raising discussions about vision, goals, and purpose. This pressure was a site of friction between the slow, deliberative norms of lesson study activities and the higher education norms and expectations for quick results within semester-long courses.

The friction between differing expectations for pace and outcomes created obvious frustration with our joint work. For example, preparing instructional materials for use during the pilot lab lesson was a time-consuming process. It took the group nearly an entire meeting to work on structuring a concept mapping activity that students would do to wrap up our pilot lab lesson. Such work moves more quickly when completed individually by instructors, as is typically done in higher education, but in the norm of collaborative lesson study, redesigning and remaking instructional materials is a shared activity necessary for capturing consensus ideas

from instructors even if this means the work will move more slowly. This difference in norms and expectations for pace and outcomes was especially salient for one group member who noted a conflict between the collaborative norms of Lesson Study and his own expectations for how to improve the class. Paul shared, "I think to some extent... the Lesson Study format is in a little bit of conflict with the time available to us." Timing really mattered to our group members and the collaborative processes of Lesson Study-style practitioner inquiry may take so long that the process is not viewed as helping improve the general biology course.

Reflection Phase. At the end of the Observation/Debriefing phase the group began talking about overall goals of our joint work, which marks the beginning of the Reflection phase. These renegotiations of meaning – reiterations of our goals in light of the pilot lesson – were also influenced by the theme of the academic calendar and timing pressures exerted by the perceived expectations for tangible results within a short timeline.

Discussions about timing of our group's work in relation to the academic calendar and timelines expected by academic departments were prominent in group members' reflective talk. For example, Sarah explained her expectations for "rolling out" our group's work by saying, "I don't see a ... full roll out for next year at all personally. I think it would be awesome if we have it by Fall 2015... [at the] absolute earliest and that's still...[a] very fast scenario." Paul was also focused on the timeline for our work and expresses his concerns about trade-offs that would have to be made:

> It seems like in here with our time ... we could either do one or the other. In other words we can...kind of reconfigure ... [the] lab a bit for next fall. Or we can reconfigure lecture, but probably not both.

Tom agreed saying, "We can do probably one or the other. I don't think we can do both."

Group members proposed a strategy for dealing with time constraints by focusing on a small part of the class that the group could change as a small but tangible step toward our larger goals for improving general biology. I summarized this sentiment and connected it to the larger, more long-term goal of improving the entire general biology course in the next meeting:

> We all came to [the agreement] that we feel like it takes time ... to really change the whole class or to think about what it would be. But I felt like everybody felt inspired ... if we had more time, we would really ... rethink what ... the class could look like.

Later, Paul reemphasized he thought "we can get more efficient and accomplish something" if we would not use a collaborative process for redesigning and studying the general biology course because it seemed just too slow for him and "sometimes when we tried to plan what actually we wanted to decide for the future, it sort of got in the way."

> A sense of urgency became more pronounced as the group reconvened after spring break. The group focused on how they could work on renegotiating short-term goals – tangible outcomes of what we could implement for the upcoming Fall semester – while moving the focus on long-term goals and less tangible outcomes into the background. For example, Sam thought:
>
> in stepping back we would need to add some kind of broader, structured goals like just establishing a timeline and when is some of the stuff going to get done. I think that's important so that we stay on task.

Paul agreed with Sam and added "maybe first we should do the timeline what we wanna accomplish the rest of the semester. That's coming up sooner than 2015." This illustrates that for some group members, the short-term more tangible outcomes are preferable than the long-term, less tangible outcomes considering the time available to the group.

Other group members also expressed this sense of urgency as Tom stated "I think if we're going to make any changes for the Fall [2014] ... we'll probably be prepared and work on those on Tuesday [last meeting for the Spring semester] .. because if we don't ... do it then, it's just ... been Fall." Peter agreed with him:

> I love the idea to take the long-term view but ... Tuesday is ... is really our last formal meeting that we plan before next Fall ... and if we're gonna to something for next Fall, we gotta focus on what we gonna do ... for next Fall.

All these examples above clearly point to a point of friction where the expectations in higher education to produce an outcome within a semester timeframe stand in contrast to the extended time it takes the group to reach a consensus on the shared goal for our work when using the collective, deliberative processes of Lesson Study-type practitioner inquiry.

Furthermore, the urgency created by the higher education structure of working within a semester time frame led the group into a rapid mode of work with the short-term goal of producing a tangible outcome – concrete changes in the lab manual that could be used for the next fall semester. Peter pressed the group to pin down short-term goals and concrete tasks that could be completed within the remaining four weeks of meetings as hw suggests, "Let's actually think about in terms of if we wanna establish a timeline, how about if we come together and say here is what I would like to accomplish in meeting one, meeting two, meeting three, meeting four. Tom added onto Peter's suggestion when he pointed out that:

> We're probably not in a position to reinvent the wheel at this point... with the time we have left in this ... if we're wanting to make changes to the upcoming semester ... a couple of pieces here and there might be far more doable that shuffling everything around.

Paul agreed with him as he states, “If we wanna accomplish anything in the next four weeks for next fall [we have] to figure out what things we could limit or not deal with.”

As seen already in earlier findings, such discussions about short-term goals and tangible outcomes spark confusion and frustration by some group members who then reorient the group’s focus back onto further clarification about long-term goals and renegotiation of the shared purposes for the group’s activity. Sam expresses confusion about the focus of our joint group work when he states, “I guess I need some clarification on...our ultimate product or ... what should that look like.” Paul agreed, “Yah, I don’t know where the focus is” and he went on to connect this concern to his concern about timelines, “Maybe once in a while I got the impression in our meetings that we were trying to change something for the fall and now I hear ... a *year later* than the fall.” Paul continued by describing how the shifting focus of the group’s goals was a source of frustration, “Let me tell you that I think what it is [the main focus or goal], the next week it changes.” As facilitator of the group, I acknowledged the frustration and stated, “but I know as well it seems frustrating for different people on different levels. You feel like ‘okay, we made progress’. Now we step back again like ...‘where did we get to…?’ It takes longer.” Paul again pressed the group to work on short-term, tangible goals:

> If we don’t try to do some simple things for next fall ...to kind of see why we can’t really get anything done ... it’s good to plan for 2015. But ...a lot can happen between now and then ... so it would be too bad to miss the opportunity.

Findings from this Reflection Phase show that the micro-processes and the norms of slow, deliberative, and collaborative processes of practitioner inquiry are not always in sync with norms and expectations in higher education to produce a product quickly. Also one year,

especially when college courses tend to have semester-long life cycles, may not be enough time for the degree of deliberation and negotiation needed for genuine goal-setting among instructors.

Thus, I discuss my third and final theme of how group members grappled with collective agency, authority and capacity as a source of uncertainty within their efforts to collaboratively redesign the general biology course. This theme emerged in the findings as group members raise questions about what authority the group has to decide what the class is going to be about and grapple with questions about the collective agency and capacity of group members to determine how we could get to our shared goals by changing our teaching practices.

Theme 3: Grappling with Collective Agency, Authority, and Capacity

The third theme that characterized our group's struggle to negotiate shared meaning for our joint work is how the group was grappling with collective agency, authority, and capacity for accomplishing our goals. Over the year of working together to redesign general biology, our group faced increasing challenges when trying to figure out how and when we were ready to make a decision. The group also grappled with whether we had the authority to make decisions as instructors. Even when we did make decisions, group members expressed uncertainties about our collective capacity to successfully carry out our decisions. Small moments of uncertainty about collective agency, authority, and capacity existed throughout the year, but this theme became more pronounced toward the end of the study. In the following section, I explain how this pattern unfolded over the chronological sequence of phases of our group's collaborative process of redesigning general biology.

Goal-Setting Phase. At the beginning of the year as we entered into the Goal-Setting phase of our work, group members never talked about how we would make decisions and whether we would have the authority to make decisions about curriculum and instructional

practices for the general biology course. Instead, group members began the year by making a few decisions through a consensus-building process. The group's first decision was to come to a consensus about group norms. After the group discussed group norms, Sam initiated a move toward consensus by saying:

> I am on board with the group norms. That's the dynamic I would like to work in is –those four or five things that are up there [on the chart paper]. I am comfortable with that relative to how we interact.

In this example, decision-making entailed one group member endorsing or agreeing with what the group discussed about the group norms and other group members nodding their heads or making a sound like "m-hm" to indicate agreements. These tacit consensus-building processes later provoked questions. Paul asked "Can you define that too? Our individual roles?" Group members like Paul may have tacitly agreed at the beginning of the Goal-Setting phase and later questioned those tacit agreements.

As the group moved through the micro-processes of the Goal-Setting phase, we developed other areas of consensus. For example, Paul suggested the merging of some goals:

> One thing our group came up with in discussion that probably shouldn't be lost is that ... you could almost merge our connections and critical thinking into one.... you could use critical thinking to get connections and – you know - vice versa.

Again, group members endorsed this idea:

> Anuschka: Yeah.
>
> [Jenny nods her head in agreement]
>
> Paul: So it doesn't mean picking one necessarily, in our case you could also merge them.
>
> Sarah: It may connect...directly with the other two.

Paul: M-hm. Sure.

The group agreed that although the student learning goal of how and why biology is important to students' lives is a big goal of our joint work, it is also hard to define more precisely in a few sentences. Tom suggested:

> If you're looking for a couple of sentences to put into a syllabus ... to me the best way to do that would just be to throw out some questions that ... talk about how biology impacts their daily lives.

The other group members agreed with this idea by nodding and saying "m-hm." Tom continued his thought:

> I'm guessing if we all came in with a list of ten things and we give … would throw them in a big pot and sift them out and come up with … whatever number five or ten …
>
> Sarah: Right.
>
> Jenny: M-hm.
>
> Tom: …five or ten basic step all our ideas would fall under.
>
> Jenny and Sarah: M-hm.

Consensus-building during the Goal-Setting phase seemed, at first, to move forward gradually but productively; however, when our group moved toward connecting our local goals with goals set by other undergraduate educators, questions about agency and authority arose among group members. For example, when the group checked to see if our goals aligned with other experts' goals such as the University's general education student learning goals, the department's student learning goals, and the goals set forth in the Vision and Change report (2011, 2013), Jenny asked the group, "Do we feel comfortable with the fact that we're aligning with these things [expert opinions]?" Sarah tentatively agreed saying, "I think we are." Jenny tentatively continued saying,

"I think we are too. I mean maybe not verbatim – but in terms of some ... it's built in." Alignment with outside experts – with larger authorities – arose as an important consideration for group members and signaled the beginning of some group members' hesitations about whether our group had the authority to make decisions about general biology.

Questions about agency and authority continued as our group members discussed the relationship between our general biology course and the other course offerings in the department. Peter made a bid for communicating confidently to the department that general biology could serve unique learning goals for our students rather than being considered a "light" version of the biology course offered to science majors. He notes, "Maybe if nothing else just [saying] to the department that we're really stressing that it's not unity light! You know – this [General Biology] is ... this is a different course and – uh – this has a different ... agenda." Group members nodded in agreement with this statement; however, the consensus may not have been genuine. Instead, the group may have been operating "as if" there were consensus (Grossman et al., 2001).

Later in the year group members slowly revealed there was not genuine consensus – there were still differences in how group members viewed the problems of teaching and learning that needed attention and differences in how group members viewed the possible strategies for working on the problem. When the "as if" consensus began to dissolve, group members began raising uncertainties about whether we had the collective agency, authority, and capacity to truly redesign and study the general biology course.

Planning Phase. At the start of the Planning phase the group came to a consensus on four overarching science ideas that anchor the redesign of the general biology course as detailed earlier in the Findings. But when the group's conversation changed focus and tried to determine

how to teach the big science ideas, the group's interactions and progress became much more difficult.

Initially, group members deliberated about what the pilot lesson should be about and discussed the specific biology content and focused on examples of case studies, laboratory activities, and instructional resources used in the past to engage students with different biology content. For example, Jenny shares examples from her previous semesters teaching the course:

> Two other things that...I do like is that on the sound clip of PBS's website I think of a guy talking science versus religion … and he just kind of lays it out and says this is one thing and this is another thing. …The other thing that I feel like has really made a difference in … some things I do at least I show that – uh – evolution in action video from the web site … from the Phelan website [Fruit fly experiment from the text book] looking at the flies and starvation resistance.

The sharing of ideas and resources continued outside of our meeting times and, surprisingly, a decision was made informally outside of our weekly group meeting through suggestions from group members shared via email. Two group members chatted about designing an evolution lab using real data and scientific methods for deriving conclusions from data. Two group members replied immediately. Paul replies, "Two thumbs up!" and Tom sates, "Agreed! I would really like to see an entire lab on evolution. This might be the great opportunity for us to implement the lesson planning that we have been discussing this semester."

Discussions about *how to teach* presented a challenge for the group, which may signal that the group had not yet developed the collective capacity for sharing pedagogical principles and practices. For example, the group agreed to make a real data set a central feature of the pilot lab, but struggled to figure out how to facilitate a learning experience for students using the data

set, or as Tom said, “But what are we gonna do with it?” Paul continued by asking, “But will that be meaningful for the students?” I picked up this point again in the next meeting by asking, “We can decide on a data set we want to use, but how do we make the lesson out of it?” Although the group was able to come to consensus about the content of the pilot lesson lab, it was harder for us to figure out how to teach it so that it would be meaningful for students.

Toward the end of the Planning phase, the group discussed how to start and wrap up the pilot lab. I asked the group:

> How will we make the connections to the beany bacteria [activity in previous lab]? We don’t know exactly how. But it’s gonna be made. I feel like we need kind of finish it off ... and not just let them go.

Jenny suggested “What about giving them ... I mean kind of like Peter had said ... environment, natural selection, fitness … giving them these words and then they kind of have to spin the words together.” Making pedagogical principles and practices a part of the joint work of our group was difficult because this is typically a private practice and done individually in higher education (Demir et al.,2013; Sunal et al., 2001; Tagg, 2012). This discussion was an early signal that our group may not have developed collective capacity for talking about and building a shared repertoire of pedagogical practices.

Although conversations about how to teach were challenging for our group members, conversations about the biology content of the pilot lab lesson offered an entry point for group members to take ownership and authority for aspects of our group’s work. For example, Sarah’s prior experience teaching about a case study using real data about finch populations on the Galapagos Islands was endorsed by the group who decided to use it in the pilot lab because it was based on real data. Sarah offered to “volunteer to put it together and try to make it flow as

one and see and try to put things to connect them." Peter capitalized on this entry point by offering, "I could certainly – uh – review the lactase persistence papers and send it out looking for a fairly concise version of that." Notably, Peter began to serve as a catalyst for the group's work planning the pilot lesson saying, "you don't intend to have it perfect ... you intend to learn something ... we are not a hundred percent sure is this gonna work or not. Well, let's find out." He encouraged the group to go with the flow and try it out, moving the group slowly but steadily through the planning phase and serving as a leader in ways he had not served before. The following is an illustration of his leader role as he states:

> So we got three modules and we haven't really talked about any of them in full detail as approval. So I think it's kind of important that we do that. And – um – hopefully we consider ... I just dive in and take home and toughen it ... Good idea?

The group agreed with him and discussed the three modules.

Leadership activities during the Planning phase were distributed across multiple group members, especially Sarah, Peter, and Jenny. For example, when the group discussed how many different environmental conditions to include in the pilot lab lesson, Jenny shared "what I was thinking is we could do two or three environments and not even make it too complicated. I need to know what you guys think about it." She wanted a group consensus on the environment. In a later meeting Jenny again wanted input from the group and states, "I did some updating to that [activity] but there are things I want everyone to look at before I ... anybody changes them further." Jenny summarized her thinking about the sequence of the pilot lab by stating:

> So set the stage. Then talk about the specifics of natural selection and go into the example of natural selection. ...if you look at it from a different perspective, gets me in the environment thing. The organisms are dying because of their environment … we look at

> predation or pollination or whatever it is we choose to look something at their situation. Then we have a case study, where it is natural … sort of a model … where we study these finches, we've seen this happen and then do human stuff where we kind of tie it back in ... and look at … how does this affect us? … That's my bottom line.

Overall, coming to consensus during the Planning phase seemed challenging because it took longer than anticipated. But, in the end, the group worked through these difficulties thanks to some group members who moved into the role of leaders, propelling the group forward by taking ownership of certain parts of the pilot lab. This new focus for the group provoked dilemmas that might have been under the surface before, but now people were saying things out loud and expressing concerns. These concerns revealed that different group members held different goals for the group's work – planning and preparing for the lesson study activities was seen by some group members as not quite as important as creating new lab instructional materials/handbooks or new course syllabi. Furthermore, group members also revealed that they had different ideas about what it means to work on teaching and learning – some group members saw the planning and goal-setting conversations as important for working on pedagogical practices and setting goals for student learning while other group members saw these activities as low priority compared with working on the instructional materials, lab materials, and syllabi.

Observation/Debriefing Phase. The Observation and Debriefing phase of our group's joint work began with instructors sharing what they were noticing and what they were wondering after having observed Jenny teaching the pilot lab lesson in the previous week. Right away, Tom brought up his suggestion for how our group should focus our work following the pilot lesson saying that the group needed to decide what we should do with the pilot and what we had learned from it. Peter wondered:

> One thought I don't have fully worked out in my own mind is that – you know – one portion worked less well and what happened next and ...perhaps how did they stand independently? But that's something we can certainly talk about – uh – as we go forward.

Tom was "not convinced that the modules fully worked." But after some more discussion, Sarah said "we have a start" and then Jenny and Peter agreed. Sarah said "in one way we did [meet our original target]. We didn't necessarily … at least in my mind the things that I really wanted to, get out of it." The group decided that a subgroup would work on a second pilot lesson – one that could take place in the lecture component of general biology –to move the redesign of the class forward. Jenny expressed support but also made a bid to revisit the bigger picture and the larger goals of the group's work saying:

> I'm also feeling like ... we do need to keep the ... goal of having this 30,000-foot view in mind because ... I think that really is our intent here is... to really find out ...where we want us to go ... and I guess in my mind I feel like ... by making even some of these small changes we can at least begin to figure it out ... where we want to go.

Because the group decided we needed to talk about the big questions again, we went back to the beginning of our Lesson Study cycle and discussed our goals for joint work. Sarah reminded us that the group struggled with finding a consensus in the beginning by saying, "I also think at some point – maybe before we even do – we really have come to some sort of consensus on what we think the course should look like. So we are not wasting our time." Sarah was uncertain about whether our group actually had the capacity to do an overhaul of the whole course if we never successfully decided on a consensus goal or purpose for our work She states, "We started that last fall. I think there is a list some place or two or three something that we began and it was also consulting with the gen ed list [but] we never came to a conclusion." Jenny tried to build a bridge

between doing another pilot and discussing the bigger picture when she suggests, "What if we do the writing-to-learn [second pilot] ... see what comes out of that. See if we gain more information to then see what the whole [course] should look like." However, Sarah remained uncertain about the group's collective capacity to undertake a whole-scale redesign of the general biology course.

Sarah's uncertainty about the group's capacity shifted the conversation once again to a desire for approval from an external authority when Sarah suggested, "Maybe getting on a department meeting agenda to have a discussion with the larger group as to what ... they think the general biology course should look like." She seemed to seek external authority to have our joint work approved. But Peter disagreed and notes:

> It's possible we could ... we could lose... our charter vote then because ... we have been in the driver's seat for the very worst and we have our ideas and it almost ... I would almost propose and –uh – why I would propose that ... this alternative that we come together around what we think the big picture is ... and then propose it ... rather than go ask somebody ... what they would do and then I have to live with it, right?

Jenny and Tom agree with Peter. Tom notes, "but I think Peter is exactly right we should ... have our shit figured out before we do that." Ultimately, Sarah also agrees and Peter addes "they tell us to do that or ask us what our opinion is anyway ... I know we're gonna look a little ... foolish when we say 'Well, we're hoping you can tell us'." Despite the confidence expressed in this meeting, the group did not decide on a plan to present at the department meeting. This theme of grappling with authority will become even more pronounced in the Reflection phase.

Reflection Phase. During the Reflection phase the group again grappled with its sense of collective agency and authority for decision-making about the course. The following examples

show that grappling with collective agency and authority became more pronounced in this last phase toward the end of the study.

On one hand, the group made some visible moves toward making some decisions by voting to move forward on the short-term task of combining two lab activities into one revised activity. This move to combine happened close to the end of the spring semester, when the group talked about the second pilot lesson, and I use it as an opportunity to raise the question about how we should make a decision as a group.

> Jenny: I do think we need to have some sort of common consensus though on how we do make a decision. Because what if I were to say – you know – I wanted do ... this and Peter was like 'Yeah, let's do that' and Sam is like 'Yeah, let's do that' but Sarah was like 'I hate that idea.' It's the random part any of us envisions…
>
> Paul: Yeah.
>
> Tom: I thought we ... talked about that a couple of months ago, right?
>
> Jenny: We probably have … but we have never made a decision.
>
> Tom: ... right we didn't move on it.
>
> Jenny: Yeah.
>
> Anuschka: Yeah.
>
> Tom: And you [Jenny] mentioned simple majority, right?
>
> Anuschka: So ... so what means… slightly more than majority?
>
> Peter: I've been thinking about maybe five of us ... that five of us say ...
>
> Sarah: That's what I was thinking.
>
> Anuschka: So like five out of seven or how is then six out of eight?
>
> Sam: Yeah, five out of seven is good.

Sarah showed leadership by initiating the first official vote of the group by asking, "Who wants to get rid of the Plant 2 lab so we can add something else potentially? [Jenny stretched her arm high as a YES] Whom likely addressed it?" Sarah, Tom, Sam and I all held up our arms to show our vote "yes."

On the other hand, there still seems to be some questions from group members about whether or not they have the authority to make significant changes to the course. I notice the group struggled to decide which content to include. Despite the fact a formal leader from the department publicly stated that the group had authority to decide what the class should be about, group members remained uncertain about their authority to make substantive changes to the content of the general biology course. The department chair spoke frankly to the group saying, "So the big thing again is that you all feel invested in the project and can kind of shape the outcome as well… I would encourage you to have that discussion as a group – um – as the semester trails off and think about where you wanna ... the course you wanna have ... next year."

Toward the end of the year, formal leaders from the department clearly communicated that group members are: a) the experts on this course, b) have been doing meaningful and important work, and 3) have the authority to make changes to the course. These formal leaders also designated some additional authority and leadership to the group by suggesting formal teams with leaders to carry on the work of reflecting on biology courses and redesigning them with one leader specifically stating that reflection should become an official "part of the culture." This may have been an attempt by the department leaders to foster collective agency in the lesson study group, but it also imposed a more formal team/leader structure onto the group rather than a distributed leadership model.

Questions about collective agency and authority may have also emerged because of some friction between group members' efforts to engage in coordinated planning efforts while maintaining some autonomy for their own biology teaching. For example, when the group discussed the second pilot of writing-to-learn and I raised the question "how do others feel about it [writing-to-learn as a good tool]? Is it like all seven or eight ... of us have to agree? Or four out of seven?" Sarah replied cautiously:

> I don't know if this is ... quite the direction I wanna go here ... but – um – then do we even want to say a tool such as writing-to-learn is something that we're all going to do? If we all ... if seven of eight would say yes, we have to then. I ... hesitate to do that.

Paul agreed with her saying, "because that would be a departure from the way we previously worked the lecture part of the course." Also Peter agreed, "we still don't all have to use it [writing-to-learn] because I agree with Paul that's a departure from ... we always maintained – you know –I'm going to do [it] a little different." This example illustrates a friction and group members' understanding that this collaborative practice would deviate from the norm of autonomy in higher education.

Concerns about the group's collective capacity were more pronounced in the Reflection phase. By collective capacity I mean the ability or perceived ability that the group can accomplish the tasks at hand. Two group members tended to bring up the concept of capacity in discussions. For example, Sarah stated that it "is the fact that ... what we need to do is ... big and we have an hour a week ... and how do we actually do this in an hour a week with seven people?" Sarah wants to overhaul the class but recognizes it is hard work and questions whether the group is adequately resourced to carry it out. In the next meeting Peter agrees with Sarah that it would be exciting to redesign the whole class because he thinks we have great ideas, "but it ...

it is a little daunting to think of what just exactly the process and effort in going to think it happens." Sarah adds, "I think the thing … ideally more than two people would have 100% release time almost for a year really to make this happen ..which isn't going to happen." Concerns about collective capacity, especially in light of scarce resources, comes up again when Sarah states:

> The other thing I keep coming back to as I started envisioning what's gonna have to happen over the year and a half ... two years ... I don't think we can do a good job of this ... if we don't look for some external grant money. I mean if all of us were childless and had all the time in the world, we would have ... 80 or 100 hours a week and can get it done. Um – but I don't think we can ... get this done without looking for the external money ... and hopefully we're getting some of that. I don't think it's possible to do a good job.

Peter adds:

> I don't disagree with that... I think what you just said is that ...if we don't get funding which we do not have ... that a year from this fall is probably not realistic…I think that a year from this fall you may be right that ... is that too much to ask if it is all of us kind of meeting once a week ... the end of the afternoon ... and then getting busy again not really ... I think not [having] much time to do that.

These examples exemplify how concerns about capacity influenced the negotiation of shared purpose for our joint work in the last phase of our group's work.

Overall, this study examined how the group of instructors grappled with negotiations of meaning, the pressures for quick outcomes, and collective agency, authority and capacity for instructional decisions. This story is about the slow work and deliberating back and forth with

colleagues about teaching and learning in the sciences. My findings demonstrate that sense-making via negotiation is a normal part of a collaborative groupwork. However, from participants' points of view, the Lesson Study process may have been too slow, too governed by the ebbs and flows of decision-making, and ultimately too difficult to make genuine changes to our teaching practices and the structure of the general biology course. The group members' question, "Are we getting anywhere?" hints at the challenges faced by instructors when trying to use practitioner inquiry practices such as Lesson Study within the culture of higher education where such practices go against most norms and expectations.

Chapter 7: Discussion

The major finding of my study is that negotiation of meaning, characterized by friction and dissonance that can feel frustrating to participants, is an on-going, normal part of the micro-processes of collaborative group work. Nevertheless, one group members' question, "Are we getting anywhere?" should be taken seriously. This is not just an expression of frustration by a complaining colleague; it is a legitimate question about the difficult process of negotiating shared goals for instructional improvement among university instructors. I will discuss how the micro-processes in the beginning of a new practitioner inquiry group can tell us something about larger questions of participation and meaning-making. The key details derived from a newly formed group are what other facilitators of professional learning activities would like to know to help people begin the collaborative processes of practitioner inquiry in other settings. I argue that the small steps are an important foundation to get us started in changing teaching practices.

In the following discussion, I look at each of the three themes of my findings: the rhythmic ebb and flow of the negotiation of meaning, the calendar and timing structure of academic culture in shaping the micro-processes of negotiation, and grappling with collective agency, authority, and capacity. As I discuss these three themes, I identify important *ways in* – entry points serving as possibilities for participation in a newly formed practitioner inquiry group – including roles taken up by colleagues in this study (e.g., taking on the role of questioner). I also discuss how friction points are important analytically, even though they can be frustrating in practice, because they help us understand how the group is working. In each subsection, I will point out the affordances and limitations of these small beginning steps of the micro-processes of negotiation of shared meaning.

Rhythmic Ebb and Flow in the Negotiation of Meaning

This ebb and flow was a necessary but frustrating aspect of our group's collaborations. This process is similar to Severance et al. (2016) who argue that dissonance among participants – disagreements about the purposes, practices, deliberations, and timing of joint work – are necessary features of sense-making that ultimately lead to agreements in group sense making processes. In the same vein, Johnson et al. (2016) argue that tension is a necessary ingredient for groups to make progress in joint instructional improvement efforts, but disagreements and tensions make joint work slow and frustrating for participants. Both groups of scholars agree that this friction is very helpful from a learning standpoint, but from a participation standpoint of view, it is hard to navigate.

In my findings, I saw learning benefits from the ebb and flow rhythm in the interactions of group members in planning the pilot lesson and during observation and debriefing as small steps toward a beginning of finding new ways of doing a practice. This finding matches with the findings of Severance et al. (2016) as they state, "valuable contributions from teachers and other participants did not originate from any one individual but instead occurred through intricate interlocking agentic processes of participants taking up and building on ideas of others" (p. 558). This quote demonstrates that deliberation and negotiation are necessary and beneficial in the collaborative process from the learning standpoint, even though they were coupled with participants' frustration because it made our joint work slower.

Additionally, Johnson et al. (2016) point out that PD is "embedded in wider contexts that should be taken into account" (p. 181). They found these different values were expressed "as different goals, which were discussed but not always adopted, sometimes deflected, and sometimes deferred" (p. 181). This idea was also seen in my findings in the on-going negotiation about the purposes of our joint work, which also was reinforced by norms and expectations of

the higher education setting. However, analyzing the friction point of the rhythmic ebb and flow in the negotiation of meaning can be a way to understand, according to Johnson et al. (2016), "how the choices we made attempted to balance our multiple values and goals." (p. 182). This again means tension is necessary and beneficial from the learning standpoint in terms of moving forward. But this raises the question of whether this kind of practitioner inquiry model might be harder to sustain in higher education over a longer period, which I will discuss later in my implications section. From the learning point of view, facilitators of professional learning activities should find ways to stay with this friction point to make progress.

Challenge of Shared Goals

Wenger (1998) also argues that negotiation of meaning is a normal part of communities of practice as participants are mutually engaged in a collaborative process in which they negotiate meaning that leads to a joined enterprise. My findings support this idea because my group was continuously engaged in a process of negotiating shared meaning throughout the study. But, the focus of our negotiation always returned to disagreements about the goal of our joint work. Wenger's (1998) portrayal of the negotiation of goals seems much more straight forward where a common goal of joint work is easily accomplished in a few meetings. The reason for this finding could be that the group of Wenger's people – dealing with client's medical insurance claims- had structures and norms in place that easily identified their goals for mutual engagement in their joint work. Whereas my group of instructors in a higher education setting was missing these support structures and therefore, the goal-setting was a constant source of disagreement and deliberation.

Furthermore, my findings also seem different from what I expected about Lesson Study-type activities because based on Lesson Study research (Fernandez et al., 2002, Lewis et al.,

2009; Saito, 2012; Takahashi et al., 2016) and other inquiry-based professional activities (Severance et al., 2016, van Es & Sherin, 2010), I assumed the goal setting would only be part of the discussion. But it dominated my group because we came back to the goals over and over and the negotiation was more complicated.

Additionally, Wenger (1998) portrays the goal finding as successful. In my case, however, the goal was agreed upon at one point but then the group questioned our goal and purpose again as we kept going through the collaborative process. This means that my group was partially successful but it was not the easy success story that I might have expected when I started my study. This raises the question of whether professional learning research is more often painted as a success story that gives the impression that when one starts a collaborative process with teachers, one will have success. My findings show that professional learning research is more complicated to do because it takes time, goes slowly, and involves being frustrated with the collaborative process. In this study, there were agreements and growth, but the study resulted in showing just the beginning steps of establishing a community of practice.

Challenge of Shared Pedagogical Vision

Another challenge for our group was negotiating a shared pedagogical vision because it was much more difficult for our group members to talk about *how to teach* big science ideas than it was for our group to agree on the big science ideas themselves. One reason for this ebb in our group's negotiation could be that planning instruction and making decisions about teaching is often an individualized and private practice in higher education (Demir et al., 2013; Sunal et al., 2001; Tagg, 2012). An additional reason could be that in higher education, common modes of professional learning opportunities often consist of brief workshops focused on implementing certain best teaching practices presented by an outside expert with the hope that instructors will

directly implement changes in their teaching practices (van Driel, 2012; Wilson & Berne, 1999). But the collaborative processes of practitioner inquiry counter this direct-implementation practice by placing experimentation and investigation of a pilot lesson at the center of the instructors' cycle of Lesson Study activities. Our group made a small step forward in the Debriefing phase when they began talking about actual teaching and learning practices anchored in the shared experience of planning and observing the pilot lesson.

I view this effort as an affordance to begin moving away from the private practice of planning and teaching that is a norm in higher education settings because my group was able to start (even in just a small way) coming to some productive agreements about teaching and learning biology. This effort agrees with the findings of Cerbin et al. (2006) in that the structure and protocol of Lesson Study activities with opportunities to observe each other teaching, and focusing on student learning over a longer period, are important for fostering productive professional learning in a collaborative process among instructors. Similarly, Kamen et al. (2011) found that Lesson Study-style collaboration was a powerful experience for postsecondary teachers and participants and, therefore, an effective model for instructor's professional learning. Additionally, Cerbin et al. (2006) maintain that, "broad scale teaching improvements in higher education might be possible, if teachers work together to build a professional knowledge base" (p. 256) because the Lesson Study model scaffolds reflective practice among college instructors.

Furthermore, I understand learning as social and situated in experiences and interactions; for example, participants learn how to talk to one another about learning and teaching science in a certain way. Therefore, the pilot lesson was a critical starting point for moving the group forward toward some shared pedagogical vision. This finding is concurrent with the concept that learning happens as "social participation" (Lave & Wenger, 1991; Wenger, 1998) because

learning happens by social involvement and affects participants when they are engaged in a collaborative process that defines common goals and works toward accomplishing these goals. Wenger furthers the idea of learning by focusing his concept of community of practice on "what people do together and the cultural resources they produce" (Wenger, 1998, p. 283). This means the group, during planning and implementing the pilot lesson, started to develop a shared language and shared pedagogical vison for the biology class and began moving away from an individualized private practice of planning and teaching.

Finding Ways Into Participation

Examining micro-processes that make up a group's effort to negotiate meaning allowed me to see different *ways in* or different possibilities for participation in the collaborative process of practitioner inquiry. However, different group members had different "ways in" and these may not have been equally productive forms of participation for everyone. For example, the group's efforts to improve biology instruction allowed people like Peter, who saw the goal of our joint work as making changes to the lab manual, a "way in" when our group focused on refining a component of the lab manual for our pilot lesson. Peter, and others who were focused on refining tangible artifacts like the lab manual, did not find ways of participating when our group was focused on larger, less tangible, vision-oriented or goal-setting conversations.

For other group members, the narrowly focused work of refining a lab manual lesson might have been a step backward because the group did not continue a deep inquiry into our teaching practices. These group members pushed back against spending too much time focusing only on a single lab lesson or on the narrow goals of updating a syllabus or lab manual. Instead, these group members worked to turn the group's conversation back toward broader visions for changing the whole experience of teaching and learning general biology. Although there was

significant dissonance during these friction points where group members pushed and pulled our focus in different directions, the focus on the tangible work of designing and refining a lab lesson for the pilot study opened a *way in* for people who before did not participate as much, but now became more engaged as the group talked about short-term, tangible outcomes. This finding is in line with higher education expectations and norms to produce tangible outcomes in a shorter time frame (Brownell et al., 2012; Sunal et al., 2001, Tagg, 2012).

Additionally, this change in participation represents a change in rhythm since mutual engagement in joint work propelled the group toward some aspects of our goal for redesigning general biology. But at the same time, this back and forth movement slowed down the work, which confirms what scholars (Brainard, 2007; Henderson et al., 2011; Sunal et al., 2001; Umbach, 2007; Wieman et al. 2010) found, in that changes in higher education are very slow. This uneven progress creates frustration and confusion, as Severance et al. (2016) and Johnson et al. (2016) have described as necessary for learning as an organization, but limiting if deliberations do not create a sense of agency and authority in participants.

Overall, micro-processes are useful to understand because viewing up-close the actual practice of practitioner inquiry reveals details that may be portrayed as more straight forward and uniformly successful in studies that examine collaborative processes from a distance. I argue that micro-processes are important for giving us better details about the lived experience of collaborative learning activities.

Calendar and Timing Structure of Academic Culture Shape Micro-processes of Negotiation. Dilemmas about time present another friction point that influences the micro-processes because it creates an urgency for negotiation of purpose accelerating the ebb and flow rhythm, and preventing extended deliberation about problems of practice. This finding is similar

to findings in other studies that point out the higher education culture creates a semester-based way of thinking that structures instructors' work and reinforces the expectations to produce outcomes fast – in one or two semesters (Anderson et al., 2011; Hora et al., 2013). In this case study, semester-based thinking put my group in a sense of urgency that group members described as "four-week-mode" when the Spring semester came to an end. Increased pressure of the academic calendar reinforced the expectation to produce a tangible outcome which may have accelerated some aspects of our joint work, but sacrificed other aspects, such as extended deliberation about problems of teaching and learning. Brownell et al. (2012) found that time put pressure on the work of faculty members, making it harder for instructors to have extended inquiry into problems of teaching practice. Similarly, Anderson et al. (2011) found that "departmental and university culture often do not adequately value, support, and reward effective pedagogy" (p. 152), which takes more time to learn and implement. As a result, our general biology instructor group made progress on a pilot lesson, but did not make significant progress on our larger goals and inquiry questions about improving the entire experience of teaching and learning in general biology. More time is likely needed for such deliberations, and semester-based pressures will likely be limitations for any practitioner inquiry groups in higher education.

The findings also show that collaborative processes of practitioner inquiry take more time than anticipated. For example, in the planning phase when the group planned the pilot lab, they needed long negotiations back and forth to come up with the final product and the self-set deadline created a sense of urgency. This contrasts somewhat with what other research into Lesson Study has found (Fernandez et al., 2002, Lewis et al., 2009; Saito, 2012; Takahashi et al., 2016). These studies, from K-12 educational settings, portray the planning phase as a relatively short, straightforward component of the group's work. The slow, deliberate norms of Lesson

Study activities were counter-cultural to expectations for quick results in higher education. Mitchnek et al. (2016) argue that "many embedded values and expectations for what counts and the timeline for when things count toward advancement have remained fairly static" (p. 149). This may point to an important way Lesson Study in K-12 differs from similar activities in higher education settings where instructional design and shared deliberation about teaching practice is not the norm. Practitioner inquiry models, like Lesson Study, are working against cultural norms and expectations in higher education (Demir et al., 2013; Sunal et al., 2001; Tagg, 2012) because the group never planned together in this way nor observed each other teaching. This friction with the larger cultural models of teaching in higher education may partially explain why our group's collaborative work was slow and often frustrating for group members.

Changes to teaching practices happen slowly (Brainard, 2007, Henderson et al., 2011; Sunal et al., 2001, Umbach, 2007). Findings from this case study seem to match what Wieman, et al. (2010) found. They note, it takes "one or two years" of instructors encountering different teaching approaches and research on learning "before they are comfortable in making changes" (p. 13). Furthermore, this case study underlines what Brownell at al. (2012) identified as one barrier for changing teaching practices: not enough time. The time dilemma is a friction point that creates frustration for the participants and, as the study continues, led to an increased frustration for the participants.

These discussion points highlight this friction point. Time works against this practitioner inquiry model which requires hard work and more time. Additionally, it adds to the frustration of participants and shows how the friction points influence each other. Furthermore, this time dilemma might be a limitation because this inquiry model of professional learning is not in sync with higher education expectations and norms. The last friction point I will discuss is how

grappling with collective agency, authority and capacity also influenced the micro-processes of negotiation.

Grappling with Collective Agency, Authority, and Capacity. For Wenger (1998), collective agency means the joint efforts to move forward and succeed in the enterprise of mutual engagement in joint work toward a common goal. Collective agency embodies how individuals are part of a collaborative decision-making process. My findings echo this idea as the group moved forward in reaching a consensus for our goal and then worked on how we would implement it. There were many occasions where our group reached a consensus, including establishing group norms and identifying four major science ideas the class could cover, and these consensus-building moments were important accomplishments that generated momentum forward in the group's discussions and in the group's sense of collective agency. This finding is similar to how Severance et al. (2016) view collective agency as "the efforts of groups working together to break away from current forms of activity and envision new forms of activity" (p. 533). This finding shows that the group could enact collective agency and tried to change how things had been done.

However, there were also many moments where our group questioned the goal of the enterprise and wanted to go back to deliberate about the purpose of our joint work. It seems the group struggled at times to reach a consensus, what Johnson et al. (2016) identify as a tension necessary to move the group forward toward future agreement through resolving areas of disagreement. In our group, struggles for consensus were not always resolved through deliberation and negotiation. Instead, we sometimes resorted to voting; moving forward on an activity or a decision without genuine agreement to get our work done. While we came to agreement about *how to make decisions* (e.g., by voting), we may not actually have agreed on the

larger goals, visions, or practices needed for improving biology teaching and learning. It is likely that our group needed much more time and support to get used to this practice of negotiation.

The concept of authority also plays a role in the micro-processes of negotiation, and my findings suggest the group grappled with it throughout the study. For example, the group had difficulties building our own pedagogical principles and practices as part of our joint work when they were negotiating how to teach the pilot lab; instead, the group looked to other external authorities for guidance on "best practices" for teaching. This practice shows the group had not yet developed a collective capacity and agency to agree and move toward "new forms of activities" (Severance et al., 2016, p. 533). However, this still opened a *way in* for some group members to take ownership and enact authority because three group members stepped into leadership roles and were authors of different components of the pilot lab. Spillane's concept of "distributed leadership" allows us to see how "members of a group have a sense of themselves as an ensemble of the collective. They don't just think about their individual actions, but think about what they do in terms of other members of the group" (p. 59). Group members who demonstrated some authority by playing roles as designers during the planning phase of our pilot lesson were perhaps making some small, initial moves toward participating as part of a collaborative group rather than as individual instructors. Furthermore, these group members pushed the group for a consensus on the pilot lab. This movement shows collective agency and authority within the interactions of group members. However, our initial efforts to make use of a distributed leadership model (Spillane, 2006) may have been interrupted when formal leaders from the department imposed a formal team leader to spearhead efforts to redesign the class. Formal, administrative leadership structures might also illustrate the influence of the higher education context on the collaborative process (Brint, 2009; Huber et al., 2006, Umbach, 2007).

Furthermore, as three group members moved into leadership roles during certain parts of the micro-processes, they might also be an example that professional learning occurred because they moved from the periphery to the center in the collaborative process. This is what Lave & Wenger (1991) call learning as "legitimate peripheral participation", where participants first are at the periphery of the social interactions, but slowly move toward the center as they learn through their social interactions in the collaborative process. I view this learning as an affordance of the collaborative process because it provides participants the possibilities to become full members of the community of practice. However, there was one group member who was rather skeptical of the collaborative process and stayed at the periphery throughout the study. It is unclear to me what this group member might have learned in these social interactions of negotiations, that Lave & Wenger (1991) propose in their theory of social learning are an important site for learning. It is unclear from this case study how this one, peripheral group member learned during our work together.

Toward the end of the study, active and public grappling with collective agency, authority, and capacity became more prominent. Participants expressed their uncertainty and struggle with the group's agency, authority, and capacity by stepping into the role of questioner. Taking on the role as a questioner during group deliberation served as a *way in* to participation. However, this role might be a limitation of practitioner inquiry in higher education because it is not clear if the group will persist with slow, deliberative work if they cannot also see an answer to their question of, "Are we getting anywhere?"

Overall, this story explains that the three friction points are important in understanding the micro-processes of negotiation in a collaborative process. It underlines how these friction points are intertwined and influence each other. It also illustrates how instructors in higher

education are beginning to grapple with the complexity of what it takes to work together on redesigning a general biology class. It would take hard work and would happen very slowly compared with the expectations reinforced by academic calendars when using collaborative processes that are often counter-cultural to the higher education norm and expectations (Henderson et al., 2011, Sunal et al., 2011; Wiemann et al., 2010). Looking back on our year of working together makes me wonder if I might have asked the group of instructors to make too many cultural changes without also creating time and support for the necessary negotiation processes – the back and forth deliberations needed to build consensus and agreement. I now question whether the whole group or some group members will persist through the collaborative process; I worry that our group may be an example of what Grossman et al. (2001) call a "pseudo-community" where a teacher group abandoned the group process and did not move forward after having spent months working together "as if" group members shared common commitments and interests in improving teaching together.

Furthermore, my findings complicate the demands set forth in reports like "Vision & Change" (2013, 2011) that portray instructional improvement very simply. In short, these reports call for instructors to stop doing ineffective teaching practices and take up effective teaching strategies. Findings from this case study suggest that this might be too simplistic a view of instructional improvement because instructors are not likely to change their teaching practices by employing more active learning activities; nor are they likely to simply drop their pre-existing teaching practices. This case study shed lights on the messiness and hard work of professional learning that is necessary if we are serious about changing teaching practices in higher education. It raises the question of whether professional learning is (and isn't) possible in higher education cultures that may not provide support for developing pedagogical visions and skills.

Additionally, this leads to the question of whether such professional learning activities are sustainable for a long period. This case study shows that genuine instructional improvement is far more complicated and far less straight forward than the vision of underlying change reports like “Vision & Change” (2013, 2011).

Chapter 8: Conclusions and Implications

In my study, I investigate a support structure for professional learning for a group of biology instructors in higher education. The support structure was a collaborative practitioner inquiry model to ideally help change teaching practices in the sciences. The question I tried to answer was whether this was one possible pathway for educators to collaborate and learn together about problems of biology teaching and learning in higher education. The great challenge is that despite efforts to reform undergraduate teaching in higher education (Brainard, 2007; Henderson et al., 2011; Sunal et al., 2001), the transmission model of teaching is still dominant and does not support student learning.

Plenty of reports, like the Vision and Change reports (AAAS, 2013, 2011), call for changes in undergraduate biology education. These reports suggest incorporating more active learning practices, utilizing an inquiry approach, and integrating undergraduate research opportunities into the classroom because these practices have been shown to support student learning (Pelch, 2016; Wieman, 2010). Furthermore, many biology education research publications exist on the subject of changing teaching practices toward evidence-based teaching in STEM as well as awards and grants offered to support these changes (Pelch, 2016; Tagg, 2012). However, little emphasis is placed on developing professional learning experiences for instructors in higher education settings that could support the kinds of pedagogical changes necessary to answer the calls published in these reports. Previous research into undergraduate science education reform efforts has shown changes happen slowly in higher education, especially in connection with teaching practices (Brainard, 2007; Demir et al., 2013; Sunal et al., 2001; Umbach, 2007), and make pedagogical changes challenging for educators to find ways to shift more toward student-centered pedagogy. Therefore, I explored one possible pathway in this

study to learn more about the kinds of professional learning support needed for pedagogical changes among a group of biology instructors dissatisfied with the status quo and interested in making a change.

A group of seven general biology instructors worked together in a practitioner inquiry group with Lesson Study-type activities to redesign a general biology course at a small undergraduate university. This study illustrates the group's first year of trying to incorporate more active learning approaches into the curriculum because we want this for our students in general biology. Through the study of the micro-processes of our group interactions in the collaborative process, I tried to understand what made pedagogical changes slow and hard. Studying the micro-processes is important because it give us better details about the live experiences of collaborative learning activities. Furthermore, this kind of study can shed light on how the micro-processes influence the macro-level elements of the institutional culture and vice versa.

The overall finding of this case study was the on-going negotiation of meaning and struggle to agree on a goal for our joint work in redesigning the general biology class. The question tht was raised as the group was going through the collaborative process for a year and wondering, "Are we getting anywhere?" The answer to this question lies in the three subthemes: the rhythm of negotiation with ebbs and flows, how much timing mattered for our group work, and key roles through which group members expressed uncertainty and a sense of struggle with collective agency, authority and capacity for accomplishing the group's joint work.

Furthermore, these three patterns illustrate small steps in the micro-processes of the collaborative process that explain the slow work of deliberating about teaching and learning in biology and how hard it is to work on pedagogical changes in teaching practices in higher

education. Additionally, these three themes contain friction points that do not exist independently from each other but are interwoven and influence the collaborative process. Also, these micro-processes are influenced by the larger context of the higher education setting. The findings suggest that one year is not enough time for the degree of deliberation and negotiation needed for genuine goal-setting regarding students' learning in biology and goals about the instructor-team's activity and purpose of the Lesson Study group. More work is needed to find out whether this might provide a possible pathway for incorporating active teaching practices.

Implications of this Study

Implications for other University Instructors Interested in Creating a Practitioner Inquiry Group.

The first implication for other instructors interested in creating a practitioner inquiry group to improve teaching and learning is that groups should directly address the question of sustainability over a longer period. The deliberate and slow work of Lesson Study or any kind of practitioner involvement in fine-tuning and changing teaching practice seems unlikely to be supported by the higher education setting in the long-term. Higher education institutions are not set up structurally and culturally to maintain the kind of joint work involved in practitioner inquiry because it is hard to carve out the time that is needed for these collaborative processes. Additionally, institutions are not equipped with providing facilitators or tools for instructors to do this kind of joint work.

University instructors who might play roles as facilitators of this kind of professional learning activity should find ways to work through the friction point of rhythmic ebb and flow of negotiation of meaning because this on-going negotiation is a necessary part for changes to occur in the joint group work. But, this may mean that other instructor groups would need to seek out resources including time, facilitation support, and flexibility for course syllabi and other

instructional materials to help support Lesson Study-type activities in more sustainable ways. Norms and expectations in higher education are not in sync with this kind of collaborative work, so instructor teams may also have to advocate for and work toward building new norms and negotiating new expectations within their academic departments.

The second area of implications addresses an idea important for future practitioners of Lesson Study-style activities and for researchers interested in studying professional learning in these groups. At numerous times during data analysis, the role of the facilitator is central in how the group functions. Becauase I wore different hats in this study by playing the role of both facilitator and researcher, I found I could not study the facilitation practices; my positionality in the project was limiting in this respect. If others want to do this kind of work, they have to be aware of this dilemma. From the researcher side, even though I had video documentation of all the group meetings, I could not separate myself because I was just one person and would have needed another educational researcher to study the role of the facilitator in the micro-processes of the collaborative process. Similiarly, I could not really see how to improve or adjust facilitation during the meetings of our group because I was so deeply immersed in the work. For other instructors interested in doing this work, some external support in learning to facilitate and adjust facilitation of the group might be one way to improve the quality of the group's work during meetings.

Implications for other Educational Researchers Examining Professional Supports in Higher Education Settings. In framing this study, I hypothesized about the influence of the cultural components of institutions in higher education on the micro-processes of joint group work. This hypothesis is grounded in existing research about the higher education setting and cultural elements. But I could not make strong claims about the specific influence of cultural

models or about the particular institution where this case study took place because my study did not collect that kind of evidence. To make stronger claims about the cultural and institutional contexts of instructors' work during an activity like a practitioner inquiry group, we need more research using different study designs that capture details about cultural models, practices, and institutional settings. For example, a larger ethnography of the department and university where a practitioner inquiry group is trying to change cultural models of teaching could provide stronger evidence about the specific roles played by such contexts. Similarly, a multi-case study of different practitioner inquiry groups in different settings may allow researchers to examine important comparisions that could help us learn more about the role of the larger cultures of higher education.

A larger ethnographic study would be useful because in this case study I tended to make claims about higher education culture by using existing research. But there is a need for a larger ethnographic study that extends beyond the group because this larger study of the university could examine department meetings, investigate what the provost's office is saying about teaching and learning in general or more specifically about science education at the undergraduate level, and could look at the tenure and promotion work done in different science departments. This future research might work out connections and frictions where practitioner inquiry groups are trying to do similar work. So far, we hypothesize that those connections and frictions exist from what we understand in general about the higher education setting based on exisiting scholarship. But follow-up research may investigate the connections between the micro-level and macro-level where those cultural elements come into play. This would mean trying to understand how the micro-processes are influenced by the macro-level and vice versa.

A multi-case study would also be useful in helping us gain an understanding of patterns across different cases. My study was a very close-up study of the micro-processes of one collaborative group, but because I had nothing to compare it with, there is a chance my findings are unique to this particular group of instructors. By suggesting a multi-case study, I am not talking about having a control group, but I rather some variations between groups that might allow researchers to see commonalities and differences when making comparisons between groups. I wonder if the patterns I found are common to my specific group or are these patterns also found in other groups? It would be fascinating if I knew about one or two other practitioner inquiry groups at other state system universities or at institutions outside of my state's university system. In a multi-case study, one might discern whether these patterns are unique to one setting or happen more commonly across different inquiry-based groups. Further study might also inform questions about whether more time would have made a difference by including long-lived practitioner inquiry groups as one of the cases in a multi-case study. For example, would we see different patterns if a university sustained a practitioner inquiry group over a period of ten years?

All these implications show that more work needs to be done if we are serious about providing support structures for science educators in higher education settings to change their teaching practices to ultimately enhance students' learning experiences. Furthermore, the results would provide support structures to help practitioners reevaluate teaching and learning at the undergraduate level in hopes of building a continuum from K-12 to college.

References

Allen, C. D., & Penuel, W. R. (2015). Studying teachers' sensemaking to investigate teachers' responses to professional development focused on new standards. *Journal of Teacher Education*, *66*(2), 136-149.

American Association for the Advancement of Science (2013). Vision and Change in Undergraduate Biology Education: Chronicling Change and Inspiring the Future, Final Report, Washington, DC.

American Association for the Advancement of Science (2011). Vision and Change in Undergraduate Biology Education: A Call to Action, Final Report, Washington, DC.

Anderson, W. A., et al. (2011). Changing the culture of science education at research universities. *Science,* 331(6014), 152–153.

Biesta, G., Priestley, M., & Robinson, S. (2015). The role of beliefs in teacher agency. *Teachers and Teaching*, *21*(6), 624-640.

Brainard, J. (2007). America's science test: The tough road to better science teaching. *Chronicle of Higher Education*, August 3, *53*(48), A16-A18.

Brint, S. (2009). Focus on the classroom. Movements to Reform College Teaching and Learning, 1980-2008. In J. C. Hermanowicz (ed.), *The American Academic Profession. Transformation in Cotemporary Higher Education*, (pp.44-91). Baltimore: John Hopkins University Press.

Brownell, S., & Tanner, K. (2012). Barriers to Faculty Pedagogical Change: Lack of Training, Time, Incentives, and…Tensions with Professional Identity? *CBE-Life Sciences Education*, 11, 339-346.

Cerbin, W., & Kopp, B. (2006). Lesson study as a model for building pedagogical knowledge and improving teaching. *International journal of teaching and learning in higher Education*, *18*(3), 250–257.

Chokshi, S., & Fernandez, C. (2004). Challenges to importing Japanese lesson study: Concerns, misconceptions, and nuances. *Phi Delta Kappan*, *85*(7), 520–525.

Cochran-Smith, M. & Lytle, S. (1999). Relationships of knowledge and practice: Teacher learning in communities. *Review of Research in Education*, 24, 249-305.

Connolly, M.R., Savoy, J.N., Hill, L., Lee, Y.G. & Associates (2016). Building a better future STEM faculty: How doctoral teaching development programs can improve undergraduate education: Executive Summary. *LSFSS Brief Series, No.9*, Madison, Wi: Wisconsin Center for Education Research, University of Wisconsin-Madison.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Thousands Oaks, CA: Sage Publications, Incorporated.

Darling-Hammond, L., & Richardson, N. (2009). Teacher Learning: What matters? *Educational Leadership*, 66(5), 46-53.

Demir, K., Czerniak, C., and Hart, L. (2013). Implementing Japanese Lesson Study in a Higher Education Context. *Journal of College Science Teaching*, 42(4), 22-27.

Demir, K., Sutton-Brown, C., Czerniak, C. (2012). Constraints to Changing Pedagogical Practices in Higher Education: An example from Japanese lesson study. *International Journal of Science Education*, 34(11), 1709–1739.

Desimone, L., Porter, A., Garet, M., Yoon, K. & Birman, B. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis*, 24(2), 81-112.

Doig, B., & Groves, S. (2012). Japanese lesson study: teacher professional development through communities of inquiry. *Mathematics Teacher Education and Development*, *13*(1), 77–93.

Engestrom, Y. (2011). From design experiments to formative interventions. Theory & Psychology, 21(5), 598-628.

Ferrare, J. & Hora, M. (2014). Cultural Models of Teaching and Learning in Math and Science: Exploring the Intersections of Culture, Cognition, and Pedagogical Situations. *The Journal of Higher Education*, *85*(6), 792-825.

Fernández, M. L. (2010). Investigating how and what prospective teachers learn through microteaching lesson study. *Teaching and Teacher Education*, *26*(2), 351–362.

Fernandez, C., Cannon, J., & Chokshi, S. (2003). A US–Japan lesson study collaboration reveals critical lenses for examining practice. *Teaching and Teacher Education*, *19*(2), 171–185.

Fernandez, C. (2002). Learning from Japanese Approaches to Professional Development: The Case of Lesson Study. *Journal of Teacher Education*, *53*(5), 393–405.

Fernandez, C. & Chokshi, S. (2002). A practical guide to translating lesson study for a U.S. setting. *Phi Delta Kappan*, *84*(2), 128–136.

Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., and Wenderoth M.P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of the United States of America*, 11(23), 8410-8415.

Garet, M., & Porter, A. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, *38*(4*)*, 915-945.

Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record*, 103(6), 942-1012.

Hawley, W., & Valli, L. (1999). The essentials of effective professional development: A new consensus. *Teaching as the learning profession: Handbook of policy and practice* (pp. 127–150). San Francisco: Jossey-Bass.

Henderson, C., Beach, A., Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: an analytic review of the literature. *Journal of Research in Science Teaching*, *48*(8), 952-984.

Hiebert, J., Gallimore, R., & Stigler, J. (2002). A knowledge base for the teaching profession: What would it look like and how can we get one? *Educational Researcher*, (July), 3–15.

Hora, M. T., & Ferrare, J. J. (2013). Instructional systems of practice: A multidimensional analysis of math and science undergraduate course planning and classroom teaching. *Journal of the Learning Sciences*, *22*(2), 212–257.

Huber, M.T., Hutchings, P. (2006). Building the Teaching Commons. *Change: The Magazine of Higher Learning*, 38(3), 24-31.

Hutchings, P., Huber, T.M., Circone, A. (2011). *The Scholarship of Teaching and Learning Reconsidered: Institutional Integration and Impact*. San Francisco, Ca: Jossey-Bass.

Johnson, R., Severance, S., Penuel, W.R. & Leary, H. (2016). Teacher, tasks, and tensions: lessons from a research-practice partnership. *Journal of Mathematics Teacher Education*, 19(2-3), 169-185.

Kamen, M., Junk, D. L., Marble, S., Cooper, S., Eddy, C. M., Wilkerson, T. L., & Sawyer, C. (2011). Walking the Talk: Lessons Learned by University Mathematics Methods Instructors Implementing Lesson Study for Their Own Professional Development. In L. C. Hart, A. S. Alston, & A. Murata (eds.), *Lesson Study Research and Practice in Mathematics Education*, (pp. 165-174). New York: Springer.165–174.

Lave, J. & Wenger, E. (1991). *Situated Learning*. New York, NY: Cambridge University Press.

Lewis, C. (2015). What Is Improvement in Science? Do We Need It in Education? *Educational Researcher*, 44(1), 54-61.

Lewis, C. (2000). Lesson study: The core of Japanese professional development. *Annual Meeting of the American Educational Research Association, New Orleans April 28, 2000, Session 47.09*. Retrieved February 23, 2013 from http://www.csudh.edu/math/syoshinobu/107web/aera2000.pdf

Little, J. W. (2012). Understanding Data Use Practice among Teachers: The Contribution of Micro-Process Studies. *American Journal of Education*, 118 (2), 143-166.

Meyer, R. D., & Wilkerson, T. L. (2011). Lesson Study: The Impact on Teachers' Knowledge for Teaching Mathematics. In L. C. Hart, A. S. Alston, & A. Murata (eds.), *Lesson Study Research and Practice in Mathematics Education*, (pp. 15-26). New York: Springer.

Miles, Matthew B., A. Michael Huberman, and Johnny Saldaña (2014). *Qualitative data analysis*. Thousand Oaks: Sage Publications.

Mitchnek, B., Smith, J.L., and Latimer, M. (2016). A recipe for change: Creating a more inclusive academy. *Science* 352(6282), 148-149.

Opfer, V. D., & Pedder, D. (2011). Conceptualizing Teacher Professional Learning. *Review of Educational Research*, *81*(3), 376–407.

Pelch, M.A., McConnell, D.A. (2016). Challenging instructors to change: a mixed methods investigation on the effects of material development on the pedagogical beliefs of geoscience instructors. *International Journal of STEM Education*. Retrieved from https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-016-0039-y

Penuel, W., Fishman, B., Yamaguchi, R., & Gallagher, L. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal*, 44(4), 921-958.

Perry, R. R., & Lewis, C. C. (2008). What is successful adaptation of lesson study in the US? *Journal of Educational Change*, *10*(4), 365–391.

Priestley, M., Edwards, R., Priestley, A., & Miller, K. (2012). Teacher agency in curriculum making: Agents of change and spaces for manoeuvre. *Curriculum Inquiry*, *42*(2), 191 214.

Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, *29*(1), 4–15.

Rock, C., Wilson, C., Rock, B. T. C., & Wilson, C. C. (2005). Improving Teaching through Lesson Study. *Teacher Education Quarterly*, *32*(1), (1999), 77–92.

Saito, E. (2012). Professional Development in Education Key issues of lesson study in Japan and the United States: a Literature Review. *Professional Development in Education*, *38*(5), 777–789.

Saldaña, J. (2013). The Coding Manual for Qualitative Researchers. (2nd Edition). Los Angeles, CA: Sage Publications.

Sannino, A. (2010). Teachers' talk of experiencing: Conflict, resistance and agency. *Teaching and Teacher Education, 26*, 838–844.

Severance, S., Penuel, W. R., Sumner, T., & Leary, H. (2016). Organizing for Teacher Agency in Curricular Co-Design. *Journal of the Learning Sciences*, 25, 531-564.

Stake, R. (2000). Case Studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (2nd ed., pp. 435–454). Thousand Oaks: SAGE Publications.

Spillane, J.P. (2006). *Distributed Leadership*. San Francisco, CA: Jossey-Bass.

Sunal, D. W., Hodges, J., Sunal, C. S., Whitaker, K. W., Freeman, L. M., Edwards, L., Johnston, R. a., et al. (2001). Teaching Science in Higher Education: Faculty Professional Development and Barriers to Change. *School Science and Mathematics*, *101*(5), 246–257.

Tagg, J. (2012). Why does the faculty resist change? *Change*, 44, 6-15.

Takahashi, A., McDougal, T. (2016). Collaborative lesson research: maximizing the impact of lesson study. *Mathematics Education*, 48(4), 513-526.

Trainor, A., & Bouchard, K. A. (2013). Exploring and developing reciprocity in research design. *International Journal of Qualitative Studies in Education*, *26*(8), 986–1003.

Umbach, P. D. (2007). Faculty Cultures and College Teaching. In R.P. Perry and J.C. Smart (eds.), *The Scholarship of Teaching and Learning in Higher Education: An Evidence-based Perspective*, (pp. 263-317). Dordrecht, the Netherlands: Springer.

Van Driel, J.H., Meirink, J.A., van Veen, K. & Zwart, R.C. (2012). Current trends and missing links in studies on teacher professional development in science education: a review of design features and quality of research. *Studies in Science Education*, 48(2), 129-160.

Van Es, E.A. & Sherin, M.G. (2010). The Influence of Video Clubs on Teachers' Thinking and Practice. *Journal of Mathematics Teacher Education*, 13, 155-176.

Van Es, E. A. (2009). Participants' roles in the context of a video club. *the journal of the learning Sciences*, *18*(1), 100-137.

Watanabe, T. (2002). Learning from Japanese Lesson Study. *Educational Leadership*. Retrieved February 25, 2013, from http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ640977

Wenger, E. (1998). *Communities of Practice*. New York, NY: Cambridge University Press.

Wieman, C., Perkins, K., & Gilbert, S. (2010). Transforming science education at large research universities: A case study in progress. *Change: The Magazine of Higher Learning*, *42*(2), 7–14.

Wilson, S. &Berne, J. (1999). Teacher Learning and the acquisition of professional knowledge: An examination of research on contemporary professional development. *Review of Research in Education*, 24, 173-209.

Appendices

Appendix A: Weekly Reflection After Group Meeting

Reflections Group Meeting [isert date]

Name (optional) _____

Goals & Accomplishments	**Personal reflection**
• Goal(s) for the meeting: • Goal(s) accomplished?	• Personal takeaways from today:
Summary of today	**Professional growth**
• Content: • Instruction: • Student learning: • Goal(s) (short & long term):	• I learned: • Ways I might use what I learned today are:

Other comments/notes:

Appendix B: Observation Protocol for Pilot Lesson

Observation Protocol with Student Response Categories for Pilot Lesson

STEPS OF LESSON: learning activities, key questions, time allocation)	STUDENT RESPONSE CATEGORIES							GOALS & METHODS OF EVALUATION -> Which ones make *students' thinking visible*?	COMMENTS/ NOTES
	Prior Knowledge	Relevance/ Connection to life	Scientific processes	Terminology: Scientific vs. everyday language	Students are stuck	Behavior	"Notice what you notice"		
Anna will give quiz (5 min) I. Introduction (5 – 10 min) 1. Shortly introduction of observers 2. Explaining lab goals 3. Make connections to last week's lab: beany bacteria -> word list on board								Think-Pair-Share	
II. NS activity (45 min) 1. Do activity, remind them to read all instructions 1st and then obtain materials 2. Do experiment, 2 rounds	□Reproductive success □ Fitness (respond to questions in predator part) □ Talk about "work"/things they did prior □ From lecture before lab?		□ Not taking time to think through process □ Read each section entirely before starting to do. □ What is each student supposed to do? □ How to do		□Definition of fitness □"explanation of ploidy" w/prior knowledge or lack of knowledge (i.e. my beliefs say…) □Terminology □Environment drives change □Occurs within populations, not individuals	□ Visibly upset □ On task □ Looking around □ On phones □ Asking basic questions □ Asking questions that make it apparent they understand concept and are digging further □ Conversation on or off topic □ Positive affirmation	□ Listen to nearby groups to see if they are confused		

3. Share data from all groups and how they analyzed the raw data 4. Discuss open-ended questions -> question#8 transition to next module	□ Camouflage makes students share story from backyard about white bunnies	□ "So how does that relate to brightly colored birds?" □ Hunting camouflage	□ experiment? □ How to do the math for analysis? □ Using data to support preconceived ideas	□ "survival of the fittest" □ appearance instead of phenotype □ "My theory is…"	□Concept of differential survival & reproduction □ "Population **had to** adapt." □ Populations adapt based on which individuals/traits survive, rather than populations adapt "in order to survive" □ Can they bring things from last week's lab? □ Variation exists within populations, □ Environment changes; "survival of the fittest"	□with eye contact or head nodding □Involvement of all group members □Sharing ideas with group members □Behavior of not getting it: eye rolling, boredom, texting/gaming, not working with peers			
III. FC (45 min) 1. Get them started on finch case study -> highlighting that they look at real data 2. Discuss results with whole class 3. Transition to last module: example of human evolution in action					□ spatial and temporal relationships				

IV. LP (30 min) 1. Show video clip (15 min), hand out questions to fill out while watching 2. Students talk in small groups about what they took away from video & work on questions (10 min) 3. Whole group discussion (5 minutes) 4. Lead into summary									
V. Sum up of lab (25 min) 1. Students make a word map with key terms of lesson (10 min) 2. Talk a bout word map (10 min) 3. Students write reflection based on 4 questions and turn in (5 min)					□ Natural selection: <u>who</u> selects which traits are better?			Students make a word map -> shows their understanding in their small groups □Formative assessment: reflective writing with 4 guiding questions	