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Understanding the Collaborative Learning Implementation Cycle (CLIC) for a Teacher Learning to Promote Computationally Rich Communication in a Remote STEM Classroom

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Abstract: Promoting productive student talk and computational collaboration in small group work is challenging, especially during COVID-19 induced remote learning. This paper describes a case study of one middle school teacher's participation in a professional learning community and implementations of a physical computing unit where students created data displays to collect and analyze environmental data. The focal teacher implemented the unit twice with astonishingly better results in the second iteration. We discuss lessons from how she participated in a professional learning cycle that used reflection, adaptive support and co-designed tools that helped achieve her vision for student collaboration.

Introduction

Modern research on learning has demonstrated the effectiveness and fairness of perspectives that view learning as collaborative and socially mediated (NASEM, 2018). The COVID-19 pandemic and subsequent remote learning introduced novel and substantial challenges, complicating the way that students interact with one another in formal learning spaces. In collaborative learning, students mediate their understandings with others and situate their experiences in the contexts of their collaboration as well as the tasks they undertake. Collaboration has also been shown to afford more equitable classroom experiences, enabling all learners to better thrive since collaboration helps attend to status and treat diversity as an asset (Langer-Osuna, 2017).

A lever for equity in STEM classrooms is phenomenon-based instruction where students drive the generation of questions and iteratively develop models of their understandings (Biddy et al., 2020). This paper details attempts to promote collaborative learning during remote instruction necessitated by the COVID-19 pandemic in a middle school STEM unit called Sensor Immersion (SI) that uses the Data Sensor Hub (DaSH), a programmable sensor system (Gendreau et al., 2021). This study highlights potential synergy between collaborative learning and phenomenon-based instruction while exploring one facet of how the COVID-19 pandemic unsettled schooling, surfacing different ways to support learning computing collaboratively.

The focal teacher, Lauren, participated in a Research Practice Partnership (RPP) with the University of Colorado's SchoolWide Labs (SWL) group. In the focal year, she iterated her implementation of the SI unit to better support collaborative learning in her quarter-long, required STEM class, conducted in a synchronous remote setting. SI is a co-designed two week long unit where students investigate a sensor system and learn how to program and wire the DaSH to collect data and answer personally relevant questions (Biddy et al., 2020).

This inquiry began when a member of the research team observed an outstandingly productive group work breakout room session at the start of Lauren's second implementation of SI. This student collaboration pushed our vision of what computationally rich communication can be and led us to explore the changes across iterative implementations of SI that seeded such productive collaborative interactions.

We view both student learning and the development of teacher practice as socially constructed and mediated. This motivates us to study how teachers can support integrating productive socio-collaborative learning in their classrooms. We sought to better understand two components of Lauren's professional learning (PL). First, we investigated how she engaged with these practices during PL experiences. Second, we analyzed her implementation to better understand the dynamic between PL and instructional practice. Collaborative learning is one of many important pedagogies shown to support the participation and engagement of all students (Graesser et al., 2020) as well as deep conceptual understanding (Jeong & Hmelo-Silver, 2016).

Facilitating experiences of collaboration with computationally rich learning activities (CT-rich communication) create opportunities to facilitate consequential learning which "changes one's relation to conceptual practice, creating access to and valued possibilities for participation in practices at a broader scale" (Hall & Jurow, 2015, p. 1). We focused on teacher practices that facilitated transitions by developing collaboration protocols for students to develop relational and CT-rich practices.

We use a case study methodology (Stake, 2006) with triangulated data sources to answer the following research questions: 1) How does a middle school STEM teacher adapt her teaching to better support CT-rich communication in a remote synchronous classroom unit? 2) What learning experiences enabled this teacher to develop ideas about supporting students in their use of CT-rich communication during remote learning?

Approach and Method

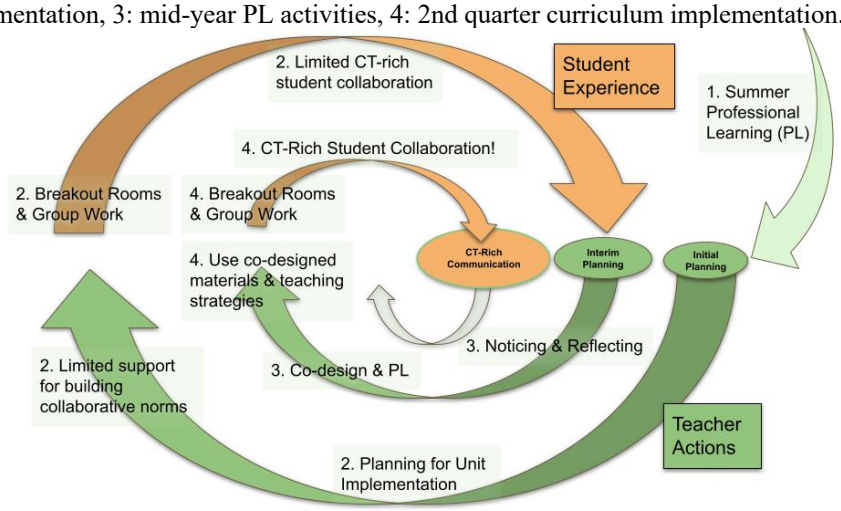
We present a case study of Lauren, an 8th grade STEM teacher in a large, urban school district in the western United States. All students in the school took the quarter long class over the course of one year so Lauren was able to iterate on her implementation. This study was conducted when class was being held remotely and synchronously due to the COVID-19 pandemic. Lauren had 8 years of teaching experience, yet it was her first year in the RPP and first year at that school. Using an intrinsic case study approach (Stake, 2006), we analyze Lauren's unique experiences in PL and classroom implementations of SI.

Data for our analysis were triangulated across classroom recordings, PL data and interviews with Lauren after her final SI implementation. Thematic and open coding were used for analysis (Gibbs, 2018) where we reviewed the various data (fieldnotes, class recordings, PL recordings, written reflections) that characterized Lauren's two implementations. We delineated decisions Lauren made during each implementation, looking for differences in how she supported collaboration and relevant PL experiences.

Results

Lauren joined the SWL team in the summer of 2020. During the four-day remote PL workshop, data were collected relating to her participation in discussions and artifacts submitted during the PL including a video of her classroom data display and end-of-day written reflections.

Figure 1
Collaborative Learning Implementation Cycle (CLIC). Flow of teacher (green) actions and student (orange) experiences. 1: summer PL activities, 2: 1st quarter planning and implementation, 3: mid-year PL activities, 4: 2nd quarter curriculum implementation.



Developing as part of a Professional Learning Community

The collaborative Learning Implementation Cycle (CLIC), described in Figure 1, models Lauren's implementation and subsequent revisions of SI in response to personal reflection and learning experiences with the research team relating to collaborative learning.

As a response to a reading based on different types of classroom discussion during the PL workshop, Lauren shared that she wanted students to be able to engage in sense making discussions within a small group. She commented that she liked "the idea of students being able to move through the discussion types independently because it seems like when they're working with their sensors, they should be sharing initial ideas. They're building consensus as a tiny team." Thinking further about the move to whole class discussion she remarked that, "I'd love to be able to have a student facilitator or even have the group have these kinds of discussions and ask each other the questions to move the conversation forward without necessarily the teacher being the one driving all of that." Before her first implementation, Lauren expressed clear goals for her students to have productive collaborative interactions during remote learning.

First Sensor Immersion Implementation

Lauren's first implementation of SI was challenging for her and her students. They were attempting to use the curriculum in a remote setting using video conferencing software. It was also Lauren's first year at the school. She did not have any established rapport or set of norms, and despite her attempts to facilitate collaboration, "[b]reakout rooms were usually silent with occasional student-to-student interaction [typed] over the chat" (Fieldnote, 12/2/20). Collaboration was limited in the first quarter. Most student participation was individually driven, or teacher led. This limited the ability for students to develop collaboration, which Lauren reflected on.

Redesigning Participation Structures for Remote Collaborations

During her first quarter implementation, Lauren identified a need to better support her students in collaborating in breakout rooms. She told the research team that a video showing students how to collaborate while programming in breakout rooms would help show her students tangible examples of the norms of participation.

In response to this request, the research team collaborated with teachers in the RPP to create an exemplar video that demonstrated collaborative and equitable breakout room participation. For the recording, the researcher played the role of teacher, and the teachers played the role of students. The "students" were asked to enact any of the following: ask a probing question, suggest an alternate solution/strategy, provide an explanation of why you agree with a peer, ask for help or assistance from your group, and think out loud.

During rehearsal, the teachers reflected and came to a consensus to focus on "juicy interactions" over completion. "It's a video about norming participation, not how to finish this [programming] tutorial" one said. After this reflection and consensus building, they recorded the final 3-minute-long video (available here).

Second Sensor Immersion Implementation

Second quarter, Lauren implemented SI again with new students and included a few changes to support norms for collaboration during subsequent breakout room work.

One example comes from a lesson early in SI when Lauren had students work in breakout rooms on a programming tutorial. She started this day's lesson with a focus on building a collaborative and supportive classroom culture. After an introduction activity where she took celebrations from students that affirmed their cultural and personal assets, Lauren reviewed the classroom contract about kindness and respect, demonstrating a strong work ethic, listening and respecting one another, and how to resolve conflicts. Lauren discussed what they should do if either she, the teacher, or a student were not holding up to the terms of the contract. She then told a story about how it is better for students to regulate the norms than to have her, as the teacher, be the disciplinarian. This move helped create a supportive community where the students are positioned as upholders of the norms, empowering them to be active participants in their own learning and classroom culture.

After two norm-building activities, Lauren did a whole-class demonstration of a simple programming tutorial. She answered student questions about hardware and software, giving students the chance to turn on the webcam to show their sensor systems, verbalize questions with their microphones on, or type their questions in the chat. This introductory activity provided everyone with common languages and experiences around the micro:bit. When the students went to breakout rooms, they had knowledge capital to share and build off. In this way, they were able to discuss the tutorial activities relative to their past experiences with the demonstration.

Lauren told her students that the goal of breakout room work was not just finishing the tutorial but primarily figuring out how you can work as a team and make sure everyone is participating. She said that she was confident they could write the program without the breakout room, but expected them to use the screen sharing and collaboration as practice on how to work together. This focus on the process of learning means less time is spent focusing on the products that students make in the classroom. Yet, through improving their process, students gain skills and tools to improve subsequent productions.

The last 25 minutes of class, students worked in breakout rooms to collaboratively program the micro:bit. Students asked questions of one another, upheld group norms, used one another's names, asked and answered questions, and aided the screen sharer as they worked through the programming tutorial. There were subsequent instances in later lessons of students helping explain the programs to one another and thinking out loud as they talked through their programming process.

Lauren's Reflections on both implementations

Reflecting on her implementation, Lauren discussed how she saw student collaboration develop in the remote breakout rooms and how changes she made provided opportunities for students to work together in a remote setting. "[When] they were in a breakout room where they were given specific roles for that coding collaboration, one person would be sharing their screen, one person would be looking at the tutorial, one person would be actually pushing it to their micro:bit to test it out." This new facilitation tactic came after Lauren helped create a

video to support student-student collaboration. “We put together an exemplar video with teachers showing what an effective [breakout] room looks like to help … encourage students to ask each other questions throughout the process to check in with each other, to use each other's names and make sure that everybody feels like they belong in the group.” Lauren reflected on the successes of her promotion of these collaborative roles through the CLIC, improving her practice with reflection and interaction with the research team. When she reflected on how her students were working together remotely, she thought getting students to work in teams was worth the extra effort on her part so students could have a mix of independent and collaborative work.

Discussion

As Lauren participated in the CLIC, she planned for instruction, reflected on her practice, sought support from the research team and then implemented new practices informed by her reflection and participation in the professional learning community. Her process of learning to support her students in collaborating with one another during remote learning has implications for teachers, researchers and RPPs in their work to help support more authentic and productive student to student CT-rich communication. Specifically, RPP practices such as (1) routines to promote ongoing communication, (2) informal professional support to deepen trust and provide responsive PL and (3) using and co-creating shared tools, helped Lauren to develop during this CLIC. Lauren’s pedagogical alterations and developments offered structure to support and enable opportunities for students to collaborate while engaging in computing tasks during the unit on programmable sensor technology.

Conclusion

Lessons learned from how teacher engagement with the CLIC can increase collaboration during remote learning will be invaluable for future classrooms, regardless of format. Successes promoting collaborative computing learning in a remote classroom will be easily transferred to in-person settings that lack many of the logistical barriers for collaboration. As researchers work to support teachers in professional learning communities, they should note the benefits of intentional teacher reflection, responsive research team support and adapting the focus of a professional learning community to address the unique and situational needs that arise.

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