# Using Cultural Historical Activity Theory to Characterize Different Enactments of the LA Model

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## Abstract

Characterizing different enactments of instructional reform approaches is key to improving science education. The Learning Assistant (LA) model leads to many positive student outcomes in a wide range of STEM courses. However, discrepancies in outcomes in different introductory STEM courses have led to a call for more work investigating how the LA model is implemented. This multiple-case study seeks to bridge that gap by providing a high-resolution comparison of three LA-facilitated physics and chemistry courses at two institutions. We used cultural historical activity theory (CHAT) to characterize the activity systems of LA-facilitated interactions and the whole class discussion immediately following these interactions, to understand how instructors leveraged these interactions in their instruction and the roles LAs played in that integration. We found that integrating small group interactions lies on a spectrum based on the extent to which the instructors used student ideas (developed during small group discussion) as mediating artifacts in the whole class discussion, enabled by different divisions of labor and driven by instructors' different goals. Furthermore, we found that LAs provided both conceptual and emotional support to students to support the integration. Implications for teaching with LAs, and for research on instructional reform more broadly will be discussed.

**Problem.** Conscious, reflexive, and deliberate reflection on science education reform efforts is vital to ensure that we as a community are continually striving toward best practices. There exists an inherent tension in reform efforts: on the one hand, it is important for reform to maintain the essential elements that support the fidelity of implementation and to ensure that critical features intended by the designers are maintained (Stains & Vickrey, 2017). On the other hand, reform efforts are locally contingent and should be sensitive to the needs of a particular context (e.g., Lund & Stains, 2015). One reform effort that has been widely adopted over the past decade is the learning assistant (LA) model (Otero et al., 2010). Learning assistants are advanced undergraduate students who facilitate student learning in a course they previously did well in, e.g., by circling around during class and supporting student problem solving, and who also take a pedagogy course and attend weekly prep meetings. The LA model has been implemented in a wide variety of subject and course contexts, including laboratory, discussion, and interactive lectures across multiple science and non-science disciplines (Barrasso & Spilios, 2021). Part of the success of the LA model can be attributed to the wide range of positive outcomes for both students and LAs, including cognitive and conceptual gains (e.g., Herrera et al., 2018; Miller et al., 2013; Sellami et al., 2017; Van Dusen & Nissen, 2020; White et al., 2016; Talbot et al., 2015), and affective outcomes such as science identity and sense of belonging (e.g., Kornreich-Leshem et al., 2022; Sellami et al., 2017; Close, Conn, & Close, 2016). However, it has also been found that there are discrepancies in outcomes for different introductory STEM courses, which has been hypothesized to be connected to differences in implementation (Alzen, Langdon, & Otero, 2018). Thus, there has been a call for more work investigating *how* the LA model is implemented.

In general, it has been found that how instructors enact evidence-based reform practices ranges from didactic (lecture-based) to interactive lecture to fully student-centered (Stains et al., 2018), and that instructors' adoption of these practices depends on personal, contextual, and institutional characteristics

(Landrum et al, 2017; Apkarian et al, 2021). However, to our knowledge, no work has directly compared different enactments of the LA model to understand the different ways in which LA-facilitated problem-solving sessions are leveraged as a part of a course. To fill this gap, we present a high-resolution, multiple case study of three lecture-based science classrooms from two institutions (Yin, 2018). On the surface, each course enacted the model in a very similar way, e.g., each was a partially flipped lecture-based science class, in which the course was an interactive or student-centered lecture format with several problem-solving sessions interspersed during class time. The LAs' formal roles during these sessions were to work with students toward solving disciplinary problems. However, each instructor had their own distinct beliefs about learning that led them to guide and utilize these LA-facilitated problem-solving sessions in different ways, which manifested as different rules that governed these interactions, different roles for the LAs, and different goals. To characterize these elements, we turn to cultural historical activity theory.

**Theoretical Framing.** Cultural Historical Activity Theory (CHAT) is a sociocultural framework that provides a structured approach to studying complex systems. Based on Vygotsky's (1934/1987) idea that human activities develop as a process of mediation, CHAT attends to how a subject's work on an object is mediated by cognitive and physical tools within the sociocultural context of a particular community and governed by rules and a given division of labor (Engeström, 1987, 2001). For example, when conceptualizing an LA-supported science lecture as an activity system, students (subjects) may work on developing scientific knowledge (object), which is mediated by their use of tools such as demonstrations and discourse with peers (mediating artifacts). The classroom includes students, LAs, possibly graduate TAs, and a professor (community), who are expected to behave in particular ways, such as starting class on time and doing the pre-reading (rules), and to play particular roles, e.g., that students listen to each other and the professor, and the LA facilitates their conversation (division of labor). Within a single course there may be multiple smaller activity systems that are characterized by different rules and divisions of labor (Patchen & Smithenry, 2013). For example, when students work collectively on a group activity, they may share the work differently (collaboratively, more student-centered) than when the instructor lectures (more teacher-centered, less collaborative).

Our study explores the relationship between small group interactions and whole class discussion within three case study classrooms. Our a priori assumption is that the small group interactions and whole class discussion represent interacting but separate activity systems, governed e.g., by different rules and divisions of labor and working on separate objects (Patchen & Smithenry, 2013). Figure 1 represents one possible way these two activity systems may interact. The goal of this study is thus to characterize the activity systems present in each of these classrooms to understand the ways in which small group interactions facilitated by LAs are integrated into the broader activity system. We seek to answer the following research question: *How are LA-facilitated interactions integrated into introductory STEM lectures, and in what ways (if any) do learning assistants play a role in mediating between the different activity systems of the course?*

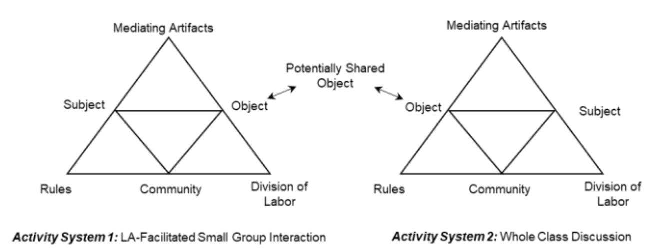


*Figure 1. Representation of the two activity systems focused on in our study.*

**Study Design and Context of Cases.** Several forms of data were triangulated for this multiple-case study (Yin, 2018), i.e., recordings of small group interactions and whole class discussion, instructors' slides and/or lecture notes, informal observation notes, and semi-structured video-stimulated recall interviews with the instructors, LAs, and student groups. During interviews, participants watched back clips of small group interactions they had been involved in (or in the case of the instructor, clips from selected LAs) and answered a series of questions about their understanding of what happened, e.g., what they learned, expectations, and the rules that governed what they were and were not allowed to do. Participants also watched clips of the whole class immediately following the small group interaction and were asked about how the two clips related to each other. Data were collected at two institutions from 3 instructors, 11 learning assistants, and 88 student groups of 1-5 students each.

***Chemistry A***, taught by Prof. Colorful, was a General Chemistry II (GC2) class at a highly diverse public R2 institution in the northeastern United States with approximately 175 students and 2 LAs. The curriculum used in Classroom A was a reformed curriculum that emphasizes developing chemistry ways of thinking over memorizing and applying facts and equations (Talanquer & Pollard, 2010). ***Chemistry B***, taught by Prof. Lemur, was a GC2 class taught at an R1, primarily white private institution in the northeastern United States with approximately 135 students and 5 participating LAs. Classroom B used the same reform curriculum as Classroom A. ***Physics***, taught by Prof. Vishnu, was a Physics 1 class taught at the same institution as Chemistry B. Data were collected from 2 sections of this course, the data from which were collapsed into one for the sake of data analysis, as they were set up and taught in the same way. Each section served approximately 90 students, and 2 LAs per section participated in the study. Although Prof. Vishnu did not use a particular reformed curriculum, his instructional model was based on responsive teaching (Hammer et al., 2012). All courses primarily served non-major students. Additionally, all courses had other LAs and/or graduate TAs who did not participate in the study.

***Analysis and Findings***. To understand how LA-facilitated interactions were integrated into the lecture, we attended to the two smaller activity systems within the class structure shown in Figure 1. We narrowed our focus to these two sub-parts because the small group (SG) activity system encompasses the bulk of the LAs' work in the case study classrooms, and the whole class discussion (WCD) immediately following is the time during which the professor directly leverages those interactions toward the teaching and learning activity.

Interviews with the instructional team (LAs and professors) were used as the primary data source and were analyzed in several stages. First, interview transcripts were deductively coded in NVivo to characterize the CHAT components (subject, mediating artifacts, object, division of labor, community, rules, outcome) of the SG and WCD systems. Next, we considered the interrelation between these components by creating tables that represented how social components (community, rules, and division of labor) supported subjects working on different objects towards specific outcomes. Finally, we generated thick descriptions (Ponterotto, 2006), guided by analytical questions based on our research question, to contextualize these interrelations and understand how the instructional team integrated the SG and WCD, and the roles they and the students played in that integration. We triangulated this analysis with the other data sources. For example, we compared participants' descriptions of their divisions of labor reported in their interviews to what they actually did in whole class and interaction videos. Similarly, we found that informal observations from the days of data collection often showed the same patterns as what was revealed in the more detailed interview analysis. We then compared findings across cases to identify critical pieces of the enactment that were common to all three cases (Corbin & Strauss, 2008). To ensure reliability in our analysis, the first and second authors engaged in consensus coding, where they analyzed data separately and discussed until they came to agreement, because they had different positionalities toward the data and brought different perspectives to bear. They also met weekly with two of the three instructors in the study to engage in member checking as they developed their analytical and theoretical approach (Creswell & Miller, 2000).

Across the three classrooms, we found that SG interactions were integrated into the WCD on a spectrum that relates to the extent to which student ideas generated during the small group interactions (i.e. the *outcome* of the activity system) versus the professor's ideas serve as *mediating artifacts* in the whole class discussion, which was enabled by different divisions of labor, especially the LA's role in the SG, and the professor's perception of the *objects* of the SG and WCD and how they relate. (see Fig. 2).

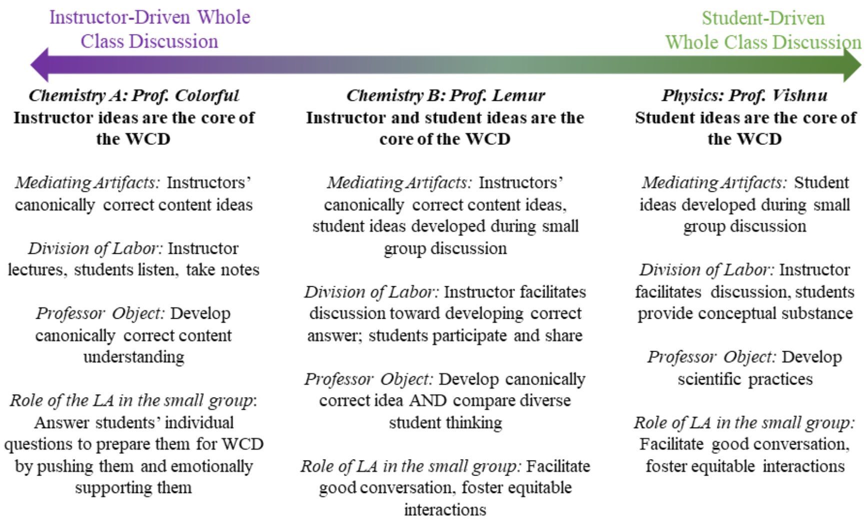


*Figure 2. Spectrum that describes how LA-facilitated small group interactions were integrated into the whole class discussion (WCD).*

***In Chemistry A***, Prof. Colorful saw SG interactions as opportunities for students to "discover for themselves and think about [chemical concepts] for themselves" (Prof. Colorful) in a safe learning environment that would bolster their confidence with chemistry. This was supported by the dual roles of the LAs in these interactions, which were to push students to think in the right (e.g., canonically correct) direction while simultaneously emotionally supporting them to stay engaged even when they feel frustrated. Generally, the LAs approached groups only when they were called over by students, because they experienced a tension between contradicting rules that "hovering over their shoulder […] make[s] the students feel awkward" (LA Mango) and that they should be present when students need help. The object of the WCD was for Prof. Colorful to debrief on the problem and show students the correct answer, in line with how he saw his role as the subject responsible for navigating the material. Student ideas were rarely if ever used as mediating artifacts in the whole class phase; rather, Prof. Colorful demonstrated how to correctly solve the problem. In this way, the SG interaction served as a preparatory period in which students got their specific questions answered by the LA, so that they could better pay attention and match what they understood to the professor's demonstrated solution. Both the SG and the WCD were guided by the same overarching object: develop a canonically correct understanding of chemistry content.

***In Chemistry B,*** Prof. Lemur saw SG interactions as an opportunity for students to refine their own thinking, which they could bring to the WCD, when multiple groups would report out their ideas. LAs would stay with a group during the entire SG period, and their role was to help ensure the students had quality conversations about the content and to help make connections between different students' reasoning. Additionally, because students worked in mostly the same groups all semester, LAs attended to the groups' social dynamics and helped foster equitable interactions between students. During the WCD, Prof. Lemur would rephrase the ideas students shared out not only to make sure she and the rest of the class understood them, but also to make core parts of student thinking more explicit, often with drawings and through comparisons to her own thinking. She sometimes directed the flow of the conversation by strategically calling on students who she thought would contribute diverse ways of thinking including but not limited to the correct perspective, so that she could simultaneously develop the canonically correct solution using student ideas while eliciting and comparing student diverse ways of thinking, which she sees as the dual objects of the WCD. Sometimes this approach contradicted with another of her rules, which is that the WCD should be directed as equitably as possible. She also saw the relationship between SG and WCD as reciprocal, as she believed the WCD guided what happened in the SG interactions over the course of the semester. For example, during WCD, Prof. Lemur modeled how to consider and "give justice to different thoughts" (Prof. Lemur). This modeling then influenced how students interacted and considered others' ideas in SG.

***In Physics,*** Prof. Vishnu saw the SG and the WCD as deeply intertwined. The SG interactions served as a space for the students to grapple with confusions in a safe and comfortable environment, enabled by his rule that students worked with the same group and LA for the whole semester, so they could get to know each other. Similar to Chemistry B, the LA's role during SG was to help facilitate discussion, including jumpstarting it when it died down, and to attend to the social dynamics in the group. Student ideas developed as outcomes of these interactions were the primary mediating artifacts in the WCD. Prof. Vishnu saw his role during this phase to "sort of coordinate what the students are saying as a whole and allow that to shape the learning experience and learning environment" (Prof Vishnu). He often felt challenged by the work of coordinating and making sense of student ideas and worried about "cherry-picking" ideas to develop a story consistent with his way of thinking, because he saw student ideas that were inconsistent with the canon as learning opportunities. This aligned with his object for the WCD, which was primarily to develop scientific practices, while content goals were secondary. He also saw this as the object of the SG, in which students grappled with ideas in a smaller setting toward the end of developing scientific practices.

To mediate the integration of SG into WCD, the LAs in all three courses played two core roles: first, they emotionally supported students to grapple with content and confusions in a safer environment. In Chemistry A, the LAs did so by providing a sense of safety through their presence, e.g., that the students could rely on the LA to direct them as they navigated new understandings. In Chemistry B and Physics, the LAs did so primarily by supporting the student groups to work together in an equitable way, to make sure that feeling of safety came from within the students. Second, the LAs supported the students to feel prepared for learning in the whole class discussion. In Chemistry A, the LAs did so by helping the students resolve their confusions, so they could better follow along with Prof. Colorful's explanation. In Chemistry B and Physics, the LAs did so by helping students to refine their ideas and gain confidence to participate during the WCD.

**Discussion and Conclusions**. Our work found that in all three classrooms LAs' dual roles could be characterized broadly as socioemotional and cognitive support enacted in different ways in the three classrooms; prior work has suggested that these different roles play a part in how students achieve affective and cognitive outcomes in LA-supported courses (Kornreich-Leshem et al., 2022). Our analysis further shows that LA-facilitated interactions can be integrated into a course in a variety of ways, and that different implementations of the LA model can have different activity structures. One aspect that the three cases differed in were the object of the SG and the WCD and the division of labor that supported these objects. In Chemistry A, both the SG and WCD were directed toward the same object, i.e., developing canonical content knowledge. These were supported by the division of labor of the LA and the instructor, who guided students toward the correct answer—in the SG, by answering student questions, and in the WCD, by delivering the correct solution. In Chemistry B, the SG and WCD were directed toward different objects. The SG was guided by the expectation that students grapple with ideas to share them out during the WCD. The WCD also was geared toward grappling with student ideas, but the instructor directed the learning environment toward a secondary object: developing the correct answer. These different goals were supported by different divisions of labor: in the SG, students discussed with each other, and were supported by the LA; in the WCD, the instructor orchestrated the conversation and brought different ideas into the air, sometimes strategically toward her end. Finally, in Physics, the SG and WCD were directed toward the same object: developing scientific practices. These were supported by more similar divisions of labor: in SG, students discussed with each other, facilitated by the LA. In WCD, the professor called on different students to bring their ideas into direct dialogue, however, he tried to minimize the amount of "cherry picking" of ideas, in order to have student ideas direct the experience. Stains and Vickrey (2017) called for an analysis of how reform efforts are implemented, our work further details the implementation of interactive and student-centered approaches (Stains et al, 2018) by attending to the role correct content knowledge vs. scientific practices play on a spectrum of implementation from instructor-driven to student-driven and how these different objects are realized in practice through the division of labor in SG and WCD. These differences in enactment of reform of interactive and student-centered approaches were connected to differences in the roles the LAs played. The LAs in Chemistry A, enacting the instructor's expectation that students in the SG developed individual content understanding, performed a role of supporting students toward that end, and played the role of an emerging content expert (Close, Conn, & Close, 2016).The LAs in Physics and Chemistry B enacted the instructor's expectations that students spend the SG time exploring their own and each other's ideas and performed a role of facilitating their conversation more as a learning friend. These two roles (emerging content expert and learning friend) align with recent research that has found that LAs' facilitation practices can exist on a spectrum of authoritative to dialogic (Carlos et al., 2023); the present study provides evidence that these facilitation practices are mediated by instructors' classroom rules and expectations. We suggest that the enactment of the LA model as characterized by the instructors' object, how they leverage LA-facilitated interactions into the overall instruction, and their expectations for what LAs do may begin to describe the mechanism of how different student outcomes are achieved from the LA model (Alzen et al, 2018).

**Contributions to Science Teaching and Learning and to NARST**. Our work interrogates the ways in which LA models are enacted in a variety of contexts, and specifically pays attention to how classroom structures and rules are enacted and enforced through interaction. Returning to the theme of this NARST conference, this work makes several contributions to science teaching and learning and to NARST. First, we *reflect on reform* by presenting a comparative multiple case study of multiple classrooms that are guided by the same pedagogical model, but which use it in different ways. This contributes to both the LA literature, which has a dearth of high-resolution studies examining the implementation of the LA model, as well as to the larger science education reform literature, by demonstrating how CHAT can be used to productively compare different implementations of instructional practices. Additionally, this study is valuable to NARST members, including instructors and practitioners, by providing a lens through which they can reflect on what their goals for science instruction are, and how they can achieve those different goals through different ways of course enactment. Overall, our study provides a first step toward shedding light on the mechanism of how what LAs do in the classroom lead to different outcomes, providing the NARST and science education communities a data-driven opportunity to continually and consciously reflect, develop, and improve science education practices and structures.

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