Developing Historical Thinking in Large Lecture Classrooms Through PBL Inquiry Supported

with Synergistic Scaffolding

Abstract

As PBL has gained popularity across disciplines, its move from small medical-school inquiry groups into large-class undergraduate inquiry has led to an increasing need to understand the elements of successful PBL implementations in large classrooms. In this study, we investigated how PBL was appropriated among students to develop historical thinking skills in a 96-person introductory undergraduate history survey course. The video analysis demonstrated that it was initially challenging for students to appropriate the routines and norms of PBL, but instructor interaction with both the students and representational tools in a large classroom provided multiple co-occurring and dynamic supports. This synergistic scaffolding structured around representational tools was instrumental in a semester-long intervention in which we supported student learning of historical thinking skills by encouraging appropriation of the activities that govern PBL.

Introduction

Problem-based learning (PBL) situates collaborative learning in an inquiry task focused on self-directed research. A PBL activity assumes that students should engage in: analyzing an ill-structured question, identifying and resolving knowledge deficiencies; searching for evidence related to the question; developing evidence-based argumentation; and evaluating and justifying their proposed arguments (Hmelo-Silver, 2004). In PBL, one type of authentic problem has clear real-world applications; for example, students might engage in a STEM inquiry about whether a community should permit genetically modified food to be sold (Belland, Glazewski, & Richardson, 2008). The other is less commonly observed in the PBL literature and orients toward

authentic disciplinary questions that might not be practical but are nonetheless ill-structured and raise issues that scholars in a discipline find important (e.g., Hmelo-Silver, Duncan, & Chinn, 2007). Social studies and humanities share the systematic weighing of evidence as part of a logical problem-solving approach (Barton & Levstik, 2004; VanSledright, 2002), but the instructional model of PBL in higher education humanities environments, and particularly in the large lecture classrooms that dominate introductory higher-ed humanities courses, has been less well studied.

In teaching their students, most academic historians describe the disciplinary norms that contribute to the production of historical monographs as inquiry. Broadly held epistemological assumptions about history as a discipline, on the other hand, tend toward a pre-existing construct of history as a settled linear stream of events described simply and famously as "one damn thing after another." (Staff, 1968). The large lecture format that dominates most undergraduate students' experience with the discipline of history, a model that Saye and Brush (2002) label "expository", compounds the gap between an expert view of history as negotiated and a novice view of history as concrete knowledge about a linear timeline passed from expert to novice with little inquiry. Undergraduate students thus tend to see both history teachers and historical primary sources as serving up established facts that exist to be received and not questioned (Wineburg, Smith, & Breakstone, 2018). As a consequence, students undertaking traditional assessments like essay tests, which include ill-structured problems with more than one possible solution, struggle to identify their own role in crafting a more or less suitable answer to an open-ended historical question that accommodates many expert opinions (Saye & Brush, 2002; Hung, Jonassen, & Liu, 2008; Jonassen, 2000). Compounding novice impressions of history as a "settled" discipline is a tendency in early-career undergraduates to see knowledge formation as

simplistic, in line with Perry (1970) and Baxter Magolda's (1992) dualism. This developmental model of knowledge construction aligns with social-studies-specific developmental stages (Kuhn, 1999; Newmann, 1991).

However, PBL's inquiry cycle and systematic approach to handling the complexity of ill-structured questions can help bridge the novice-expert historian gap by supporting a progression from simple to complex stages of knowledge formation, a path through which students move as they gain expertise in historical disciplinary practices. As research on higher education historical thinking has developed, a variety of competing standards and approaches have been developed to define the self-regulated inquiry processes that describe historical disciplinary norms (Poitras & Lajoie, 2013). Generally speaking, the literature on history higher education broadly sketches a process in which students produce historical arguments about change over time by drawing on corroborating and competing accounts in historical texts (or primary sources), and then navigating those accounts by placing them into a historical context drawn from the arguments made by other historians (Craig, Mahoney, & Danish, 2017; Shopkow, Díaz, Middendorf, & Pace, 2012; Grim, Pace, & Shopkow, 2004; Saye & Brush, 2002; Wineburg, 1991, 2001). The governing body of academic historians, the American Historical Association (AHA), developed its 2016 History Discipline Core (HDC) lays out six core competencies for students that was drawn from its constituents, which we have adopted as a middle ground between the educational research and the practical guides on which history professors draw for their own teaching practice. The most relevant core for our study notes that crafting historical narratives in answer to substantive open-ended questions requires historians to develop research strategies, including adopting the lens of a particular historical methodology (e.g. social, cultural, economic,

intellectual history) through which they understand history as a way of honing their research strategies (Sewell, 2005).

Our study thus focuses on two parallel but related structures that extend our understanding of practices in these low student-to-teacher-ratio, large-classroom environments (Puntambekar & Hubscher, 2005). The first asks whether it is possible to effectively scaffold students in the writing and revision of college-level historical argumentation, in which students are responsible for structuring their own arguments and evidentiary claims with instructor support that is generally provided one-on-one, by using PBL (Saye & Brush, 2002). The second addresses the gap between well-understood small-classroom PBL practices and the large classroom environment with an eye to the physical features of the classroom in which our intervention was situated and its role in supporting the implementation.

To understand these questions, we focused on investigating interactions between the instructor and students as they used shared representational tools to regulate their interactions during PBL activities designed to support historical thinking in a large classroom setting. We examined how multiple forms of scaffolding function in a synergistic and contingent way to support teaching and learning concurrently. The scaffolding designs that supported the PBL activity enactment in this context were rooted in disciplinary norms like building and contextualizing historical knowledge in support of an argument about causality in order to encourage student appropriation of those historical disciplinary norms through the use of PBL. Our goal was to explore the necessary balance between arms-length instructional practices with the one-on-one interactions in which the scaffolding is usually provided as we adapted PBL practices to the development of argumentation skills in a large humanities classroom.

Instructional Framework: Problem Based Learning for Large History Classrooms (PBL-LHC)

Our instructional framework for PBL in large history classrooms, Problem Based Learning for Large History Classrooms (PBL-LHC) (See Figure 1), demonstrates how PBL scaffolding can shepherd students from one phase of the Baxter-Magolda-Perry expertise spectrum to the next within the framework of one or more historical schools of thought and taking into account the disciplinary norms that govern the complex, ambiguous nature of historical research.
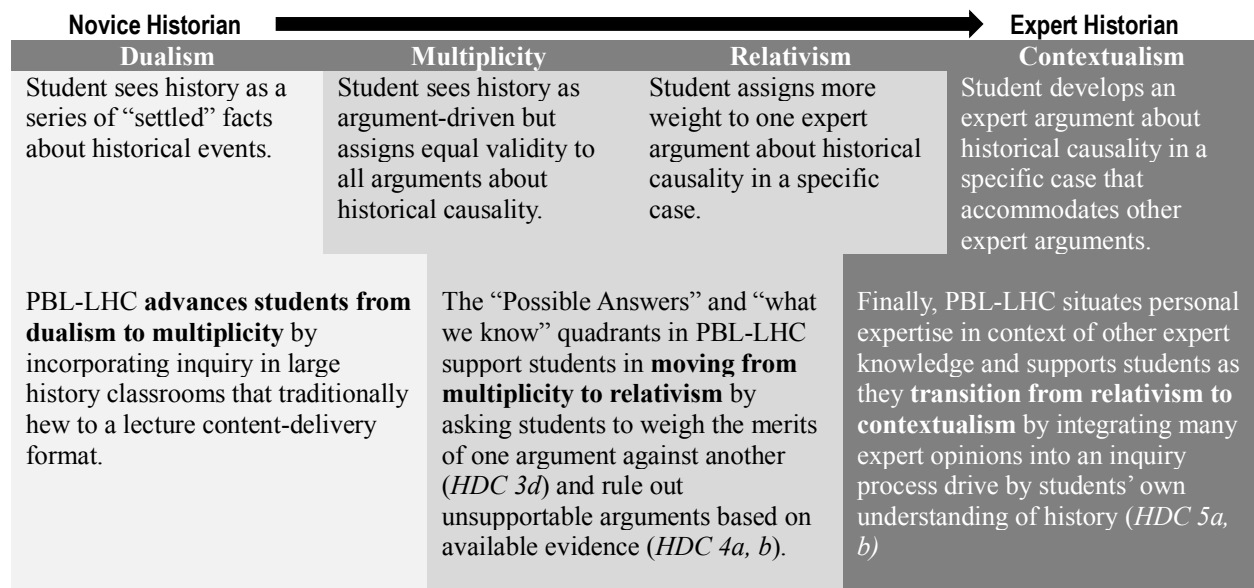
Novice Historian ➝			**Expert Historian**
Dualism	**Multiplicity**	**Relativism**	**Contextualism**
Student sees history as a series of "settled" facts about historical events.	Student sees history as argument-driven but assigns equal validity to all arguments about historical causality.	Student assigns more weight to one expert argument about historical causality in a specific case.	Student develops an expert argument about historical causality in a specific case that accommodates other expert arguments.
PBL-LHC **advances students from dualism to multiplicity** by incorporating inquiry in large history classrooms that traditionally hew to a lecture content-delivery format.	The "Possible Answers" and "what we know" quadrants in PBL-LHC support students in **moving from multiplicity to relativism** by asking students to weigh the merits of one argument against another (*HDC 3d*) and rule out unsupportable arguments based on available evidence (*HDC 4a, b*).		Finally, PBL-LHC situates personal expertise in context of other expert knowledge and supports students as they **transition from relativism to contextualism** by integrating many expert opinions into an inquiry process drive by students' own understanding of history (*HDC 5a, b*)

Figure 1. PBL-LHC Framework. Adopted from Baxter-Magolda-Perry expertise spectrum (1970)

Several affordances in the PBL-LHC process support the progression from the dualism of a novice historian to the contextualism of an expert historian particularly well. First, many PBL activities are centered around a common shared visual representation element divided into four columns labeled Facts, Ideas, Learning Issues, and Action Plan (Hmelo-Silver & Eberbach, 2012). The labels on these columns communicate an epistemological shift from dualism and settled-narrative history toward history as a blend of ill-structured problem solving, collaborative knowledge-building through inquiry, and explicit harnessing of concrete details to support

evidence-based opinion for the discipline of history. The technical affordances of these shared representations require minimal expertise on the part of the instructor, minimal training for students, and classrooms with limited technology, which lowers the barrier to entry for their use in large classroom environments.

Second, each of the columns, and the interplay between information in the columns, have been adapted to provide several affordances that guide novice historians away from dualism and toward contextualism. Our title adaptations in each quadrant represent specific elements of history problem solving drawn from the AHA's 2016 History Discipline Core and were designed to help the collaborative groups organize and manage their ideas in a representational space that walk students through the stages of expertise documented in our PBL-LHC. Each element is parsed from either specific course content or argumentation elements from their own inquiry process and placed into each of these quadrants. Similarly, the change from a columnar PBL visual representation to a quadrant-based visual representation puts all of the quadrants in visual proximity to each other. Data visualization researchers note that relative proximity has a semantic distance effect: viewers assume that relative visual closeness or distance also means relative relationships or lack thereof (Iliinsky & Steele, 2011). The linear structure of columnar organization in PBL semantically distanced the last "next steps" column from the first "potential hypotheses" column. This distance has value in a clinical medical setting, in which a researcher might need to physically enact treatment before revising their hypotheses. In historical research, items in the "Research Agenda" quadrant might help immediately identify elements that are easily moved from "what we don't know" to "what we know"—and which therefore change the potential value of one or more hypotheses--without students needing to undertake that research on the spot.

The structure of the quadrants then scaffolds students as they brainstorm, divide the results of that brainstorming discussion into meaningful categories, and apply the information in those categories in a more systematic way to the ill-structured question. Additionally, the PBL-LHC shared representation becomes a space in which students can build their socially shared regulation (SSRL) (Järvelä et al., 2015; Poitras & Lajoie, 2013) as they develop an agreed-upon set of norms and categories to assess and rank their answers to an ill-structured problem (Poitras & Lajoie, 2013).

Finally, PBL-LHC quadrants support novice historians as they lay claim to their own expertise by providing a format in which their own expertise is reformulated within the context of a community of history practitioners, both novice and expert. In many large lecture-based history classrooms, students are assigned argumentative evidence-driven essays, but the dialogue around argument restructuring and evidence bases is only with the instructor. The collaborative elements of PBL in general broaden the audience of a history argument from instructor-only to a community of students and instructors whose expertise plays a role in the construction of knowledge. In the initial stages of PBL, students negotiate the interplay between the PBL columns with each other; their interactions in this shared representational space require them to evaluate other student-contributed hypotheses, evidence and gaps in evidence. The evaluation of this collaboratively generated information for its application to their ill-structured question helps students move quickly past the "multiplicity" stage of knowledge formation, in which any argument is equally valid. Progression through the PBL activity further requires students to simultaneously examine the underlying factors that shape their ill-structured problems, identify gaps in their own knowledge based on the information provided by expert historians (their instructor and other historians' secondary-source research), and negotiate an answer with their

classmates using the resources they draw from a larger collection of historical primary and

secondary sources to which they have access (Saye & Brush, 2002, 2007). Finally, the

collaborative nature of PBL with its shared visual representation and instructor scaffolding, helps

students evaluate the relative merit of *their* arguments in the context of their instructor, their

classmates and many other expert arguments (Hmelo-Silver & Eberbach, 2012).

Accommodating Large Classroom Issues in of PBL for History Classrooms

Regardless of the nature of the problems, the crucial element of the PBL is an instructor's

timely and contingent support (Puntambekar, 2015), an element which is generally only possible

in classrooms with a small instructor-to-student ratio. At the same time, instructors employ

multiple forms of scaffolds to support teacher-student interactions in the problem-solving

process. However, because typical PBL activities are organized around small, collaborative

groups, scaling up this learning activity to a large and heterogeneous imposes difficulties in

providing appropriate support for learners (Hmelo-Silver, Derry, Bitterman, & Hatrak, 2009).

While PBL provides a well-structured foundation on which to engage with historical

argumentation, the large lecture classroom norm in history creates its own set of challenges for

using the PBL approach in higher-education history classrooms. Most PBL relevant studies

originated from observations in a tutor-led and small group setting, usually involving five to nine

students in medical and dental schools (Savery, 2006). As class size increases, it is challenging

for an instructor to monitor the progress and interactions of multiple groups (Shipman & Duch,

2001). Thus, instead of serving as a dedicated facilitator for each group, the instructor who acts

as a "floating" facilitator is required to have a more finely-honed ability to assess the current

state of multiple groups' inquiry progress and provide adjusted feedback (Hmelo-Silver, 2000;

Nicholl & Lou, 2012). This role of a floating facilitator is often more demanding than that of the

dedicated facilitator who works with only one group (Allen & White, 2001). Though this challenge has been recognized, few studies investigate how to support instructors in the "floating" facilitator role, which is the most feasible for large-enrollment classes.

Student lack of experience with the inquiry approach without direct facilitation in their small groups (Pastirik, 2006) compounds the difficulty inherent in the floating facilitator role. The transition from a traditional lecture-based learning format to a collaborative inquiry format creates significant tension for students, requiring the instructor to reiterate the process and norms of the problem-solving activity in order to help students adjust to new teaching and learning paradigms (Biley, 1999). An instructor managing a PBL-LHC activity with multiple groups of students therefore faces two challenges: students who are transitioning from traditional lecture-based history classrooms into PBL history classrooms lack familiarity with both general principles of PBL and the specifics of the disciplinary norms of history.

A few studies have demonstrated the beneficial effects of using the PBL approach in large classrooms, mostly oriented toward the role of student engagement (e.g., Klegeris, Bahniwal, & Hurren, 2012; Pastirik, 2006; Woods, 1996). These active learning environments provide an alternative to lecture-based instruction, in which students work on a problem or task (Andrews, Leonard, Colgrove, Kalinowski, & Klionsky, 2011). For example, Klegeris and Hurren (2011) demonstrated high levels of engagement and attendance during undergraduate PBL biochemistry class ranging from 45-85 students. Moreover, Klegeris et al. (2012) demonstrated statistically significant improvement in the generic problem-solving skills in large classrooms ranging from 32-77 students. These results combined with their previous study indicated that the PBL approach not only leads to increased student engagement and attendance but could also improve students' discipline-specific and generic problem-solving skills. These

studies demonstrate that it is feasible to provide the facilitation necessary for successful PBL in large classroom settings (Klegeris et al., 2012).

However, PBL learning effects were more pronounced in higher-level classes with smaller class sizes. Ahlfeldt, Mehta and Sellnow (2005) studied the relationship between student engagement and understanding based on a student survey. The data came from 56 classrooms at a mid-western university in the US, in which each faculty member was trained to use innovative teaching methods such as PBL. Even though the results revealed that students who participated more in the PBL activities reported a better understanding of the course concepts, higher-level courses with smaller class sizes demonstrated higher learning gains.

Besides, Marshall, Nykamp, & Momary (2014) reported that the PBL class was less enjoyable for students than the lecture class. They compared the impact of two different teaching styles on student mastery of learning objectives in a pharmacotherapy module in large classroom settings. The class enrollment was 136 and 141 for the two years of the study. Even though the students showed higher immediate mastery of learning objectives in the PBL course, students reported that they enjoyed the traditional lecture more, which the authors attribute to the nature of the classroom space itself. They argued that student group work with fixed seating and no extra space in the classroom made a PBL approach more difficult to implement. The authors claimed that a physically spacious classroom that allows group work would encourage these small group break-outs activities, increasing the likelihood that PBL would provide a route to increased student engagement and satisfaction in large lecture halls.

Shifting away from lecture toward PBL approach without productive supports from an instructor and physically appropriate classroom environments can disrupt collaboration processes in a small group collaboration context. These results indicated that there are various factors in

successfully implementing PBL, such as students' level, class size, participation, and instructor's

contingent support. Especially when the class is large and in a survey course level, instructors

play a crucial role in facilitating the multiple collaborating groups while providing sophisticated

scaffolding to successfully support complex problem-solving process.

Synergistic Scaffolding Using Shared Representation

Scaffolding refers to temporary supports that allow students to complete a task that they

would be unable to perform unaided (Wood, Bruner, & Ross, 1976). For instance, scaffolding is

important in helping learners manage the complexity of an ill-structured problem and the

relevant disciplinary practices, such as sense-making and articulating their argument (Quintana et

al, 2002). To support these challenges around inquiry, scaffolding needs to be based on an

ongoing diagnosis of the learner's current level of understanding (Puntambekar & Hubscher,

2005). In turn, this ongoing diagnosis will lead to contingent support done in a timely fashion

with a careful calibration of the support and approach to the learner's needs (Van de Pol,

Volman, & Beishuizen, 2010). Different learners not only have different levels of prior

knowledge but also develop their own understanding at different speeds, thus, contingent

scaffolding that is responsive, tailored, and dynamic is critical in the inquiry environment.

However, the notion of scaffolding must be extended beyond individual interactions

between instructor and students to artifacts, resources, and other elements of the classroom

environment to maintain ongoing diagnosis of student learning and inquiry processes in a large

classroom (Puntambekar & Hubscher, 2005). Some researchers suggest embedding hard

scaffolding (pre-designed instructional materials; Saye & Brush, 2002) or distributed scaffolding

(incorporating multiple forms of scaffolding that are provided through various means; Tabak,

2004) into problem-solving activities to meet students' different needs (Snir & Smith, 1995).

Such scaffolding includes various forms of additional tools, such as written prompts, visualization tools, and computer software and can be used for promoting peer interactions, making the inquiry process visible and supporting teacher awareness in a classroom (Belland et al., 2008; Puntambekar & Hubscher, 2005). In this study specifically, we scaffolded the inquiry process with shared visual representations that effectively promote collaborative learning discourses and lead to a productive problem-solving behavior (Suthers, 1999). In addition, a PBL-LHC representation provides support for floating facilitators as they facilitate across multiple learning activities occurring at multiple groups at the same time because it makes the group process and progress visible. In turn, this support advances instructional capacity by providing formative assessments as facilitators interact both with students and the visual representation tools the students have produced. This parallels the embedded hard scaffolding with soft scaffolding from Saye and Brush (2002), but the main premise is a low-tech environment with much less guidance than in some of the computer-based collaborative environments that often support PBL (Pea, 2004).

All of these interactions contribute to synergistic scaffolding, a system of multiple co-occurring and interacting supports that includes a set of possible tools and actions, and communications (Tabak, 2004). This synergistic scaffolding can be achieved via meaningful interactions among any or all possible actions within the set of interacting supports, or through a demonstration of how these actions and tools can be synergistically coordinated in order to produce the activity (Pea, 2004). The challenge in synergistic scaffolding is to support the dynamic, moment-by-moment reasoning process that leads students to appropriate new psychological tools (Vygotsky, 1978). In order to support student analysis of disciplinary best practices in history argumentation (e.g., HDC), students must appropriate PBL, or transform

PBL as a psychological tool from the social plane of mediated interaction to an individual plane (in the mind) (Vygotsky, 1978). Learning via appropriation requires students to use desired tools (i.e., the course principles and history disciplinary norms) until they understand the history disciplinary practices, voluntarily use those tools, and appreciate them (Cole, 1996). In this study, we investigated how synergistic scaffolding allows an instructor to effectively facilitate student appropriation of PBL-LHC to support historical thinking during the interactions among the shared-representation artifacts, PBL activities, students, and an instructor in a large history classroom.

Methods

Participants and Context

This study was conducted with 96 undergraduate students in a large survey level of history classroom at a public Midwestern University. Students were divided into 16 groups of 5-6 students at oblong tables that created a shared learning space to foster collaboration (see Figure 2). This open active learning space allowed instructors to circulate freely and engage frequently with the students. Each table was equipped with whiteboards and large computer monitors to serve as media for shared representational tools, which supported PBL and were designed to promote disciplinary norms in history. Five groups volunteered to participate in the research and agreed to be video-recorded.

The intervention took place over three 75-minutes class sessions spread throughout the semester (weeks 4, 8, and 14 of a 16-week semester). In each of the 3 sessions, one instructor provided mini lectures to the whole class, and the instructor and two teaching assistants facilitated group discussions by circling among groups. The classroom was designed to support an active-learning environment (see Figure 2) to promote student collaboration. We initially

assigned each group to one of several shared representational spaces available in the classroom: whiteboards, poster paper, the shared computer screen with keyboard, and a pencil-enabled iPad projected to the shared monitor. In part, these choices were made based on limited instructional resources for whiteboards and poster paper, but there were no substantial interactional differences between groups using different media for their shared representational space.
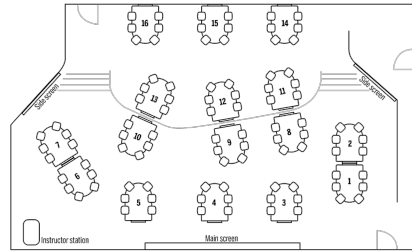

Figure 2. Classroom Layout, including group numbers that are visible to both students and instructor.

PBL Intervention Design and Shared Representations to Support PBL

The driving questions that anchored PBL were provided by the instructor as a subset of historical questions that drove a course focused on historical responses to bubonic plague. In elementary and middle-school social studies, historical encounters centered on bubonic plague mostly focus on the effects of The Black Death in 1345 on medieval Europe's economic and demographic structures. By contrast, academic research on bubonic plague spans social, cultural, religious, and medical-history responses centered on plagues in the sixth, fourteenth, sixteenth, nineteenth and twentieth centuries. These more complicated structures in a post-secondary history literature are indicative of a vast array of sometimes-competing, sometimes-complementary explanations for historical context and causality drawn from many academic perspectives and many different historical sources.

In order to help students narrow their frame of reference within all of the potential arguments about public response, the scope of the question for each of the three interventions started with a fairly narrow focus on a single historical school but became iteratively more

complex over the course of the semester: 1) "What single element was the most significant factor in the responses to plague in the 6th century Justinianic Plague?"; 2) "What two elements interacted to explain responses to plague in the 14th century?"; and 3) "What single element helps explain plague response in three different outbreaks (6th century, 14th century and 20th century)?" These questions increased in complexity for two reasons: first, we wanted to observe students' historical thinking skills as they changed over time and responded to changing course content; and second, we wanted to capture how students appropriated PBL to develop historical thinking skills. Increasing complexity in the historical question allowed us to better differentiate between increasing the problem solving-only skills and historical thinking skills.

In the first two interventions, students were shown an example of history PBL-LHC with adapted titles from a PBL quadrant (Hmelo-Silver & Eberbach, 2012) and asked to copy the quadrant to their local shared representational space. Our PBL-LHC adaptations of these columns and titles are designed to more explicitly communicate the norms of history research within a traditional PBL context are detailed earlier.

Each 75-minute session was divided into specific types of student interaction with the history PBL quadrants, each of which was designed to further emphasize the norms of the historical discipline. The instructor provided an initial mini-lecture on why PBL provides support for students trying to solve an ill-structured problem— "how to answer a question with no right answer". That mini-lecture was accompanied by guidance on how to undertake a 5-minute

Figure 3: PPT scaffolding for PBL, slide 1 Figure 4: PPT scaffolding for PBL, slide 2 Figure 5: PPT scaffolding for PBL, slide 3

structured brainstorming session using the quadrants and a slide with a guide so that students could refer to as they brainstormed (see Figure 3). After 5 minutes of unguided brainstorming, the instructor began to circulate and help students negotiate any questions they had about the PBL activity or the information they wanted to put into the quadrants. After 10 minutes, the instructor presented another 2-minute mini-lecture which directed the students to fill in the PBL quadrants more systematically, using connections between the information they had available and what their next steps were (see Figure 4). Finally, after another 10 minutes of guided work, the instructor used a third 2-minute mini-lecture and reference slide (see Figure 5) that demonstrated how to narrow down the best hypothesis using information from the other PBL quadrants.

In the third intervention, students were allowed to structure their own group collaboration. During all three interventions—with the exception of the first 5 minutes of unsupervised brainstorming—instructors provided support by circulating at will, and students made use of table-mounted microphones to request help if an instructor was not nearby by calling out their group number.

Data Collection

Five of 16 groups volunteered to be video recorded. We then narrowed our focus to the groups that represent the different barriers to their PBL processes: one in which students started with the evidentiary gather process but struggled to articulate and organize their evidence to provide a clear answer (group 8); one in which students came up with an initial but unsupportable answer and had to reorient their inquiry (group 13), to analyze collaborative problem-solving patterns using multiple scaffolds to develop historical thinking skills, such as the quadrants and instructor.

A small tabletop 360-degree camera was set up in each group to capture the whole group interaction. No operator behind camera was needed for this camera set up. Studies show that when people are intensely involved in what they are doing, the presence of a camera tends to quite rapidly fade out of awareness (Jordan & Henderson, 1995). Additionally, students' artifacts including final posters, quadrants, and notes were collected as a digital format after each session and were used to triangulate how students' historical thinking skills were developed across the time.

Data Analysis

We employed Interaction Analysis (IA) to investigate learning interactions with each other and with objects in their environment through video (Jordan & Henderson, 1995; Powell, Francisco, & Maher, 2003). The video-based IA approach can serve as a powerful tool to understand learning particularly in complex, multi-actor, and tool-mediated learning environments (Jordan & Henderson, 1995). Particularly, providing verifiable observation through video technology has been vital in establishing IA for its primary records and on playback capability for the analysis. This analytical approach allowed the researchers to observe learning as a distributed and ongoing social interaction, in which evidence of learning must be studied in understanding the ways in which occurs moment-to-moment throughout collaboration (Garfinkel, 1967). Thus, the IA approach helped the researchers to gain insights into students' development of historical thinking skills and instructor provision of contingent scaffolding by interacting with the students and the visual representation tool.

Following the video analysis guidance from Jordan and Henderson (1995) and Powell et al. (2003), our analysis effort was performed as collaborative data sessions rather than individual coding sessions. The research team's intersubjective process of analysis contributed to validity in

this qualitative study as data sources are triangulated with the collected artifacts. The researchers analyzed the data through continuous group discussion aiming to construct mutual meanings of the data, as described below. Our first step toward analysis was to generate a video log. The video content listings were indexed by five-minute time stamps, consisting of identifying information and rough summaries of events. It was useful for the researchers to grasp a quick overview of the data corpus, and to locate particular scenes and interactions. At this stage, no attempt was made to provide evenness or consistency in coverage. Then, we identified critical events related to PBL processes, such as development of historical thinking, use of representational tools, and interactions with the instructor. For instance, we looked for observable behaviors that demonstrated any confusion in the PBL process when student groups were discussing about what to write under the potential hypothesis section, closely reading their primary sources, asking questions, and explaining to the instructor. These clips were transcribed verbatim and analyzed during the multiple data sessions. The transcripts contained annotations for nonverbal behaviors, such as gaze, student's hand gesture, or document writing/drawing, so that we could better understand references to the shared representational space of the PBL-LHC quadrants. In the following data sessions, the research team noted interesting moments of each interaction and the specific features of synergistic scaffolding including teacher's talk and the usage of representation tools and discussed how each interacted with each other to support historical thinking based on our framework, PBL-LHC. Through the course of multiple replaying of the video segments, our working in groups revealed finer and finer levels of participants' social interaction with using their tools.

Findings

Through synergistic scaffolding rooted in the history PBL quadrants, students in a large-lecture classroom were able to successfully engage in self-regulated historical-argumentation with minimal instructor contact. One representative group, number 8, spent less than 20 minutes engaging in instructor-driven inquiry across the 225 minutes of the 3-session total. Despite minimal instructor contact, students successfully generated multiple hypotheses and narrowed their evidence to provide an answer to an open-ended problem. Here, we present representative interactions in a student group that demonstrated how they drew on minimal instructor support scaffolded by the PBL-LHC representational tool to advance their reasoning.

Connecting PBL Processes to Historical Thinking

The group discussion took place right after timely instructor scaffolding based on a concrete example using the words students actually wrote on the board. As soon as the instructor was able to see where the group was by looking at their whiteboard, she responded to the students' inquiry process by emphasizing that the written word "advancement" could be seen as a judgment about the past from a current perspective, rather than an indication that the students had situated their primary sources in a historically contextualized time and place. Excerpt 1 demonstrates how the scaffolding was taken up by the students after the instructor left while students were trying to connect three different historical plague outbreaks with a single argument. In this interaction, students struggled to find the right vocabulary to describe their argument not using the word advancement.

Excerpt 1 (Group 8 / Week 14)

1. **Michael**: I don't even know how to word it. How you combine the three plagues, I guess. Just like three great plagues? I don't know… Oh my god…
2. **Josh**: (murmuring) *available* medicine… (Michael is typing)
3. **Michael**: (inaudible, but repeating what he is typing into the PBL hypothesis quadrant)
4. **Charlie**: We need to name it
5. **Michael**: Yea, I mean at that point, we name them in the actual…
6. **Josh**: …yeah, opening paragraph.

7. (Students all direct their gaze at the PBL hypothesis quadrant)
8. **Michael**: So.. Medicine during three major plagues…
9. **Josh**: Umm, influenced…or…yeah…
10. **Michael**: social change…? Umm, it could be just like societal change?
11. **Josh**: Influenced the social response to change? I mean we don't have to get it ironed out right now. We just need, I mean, I am pretty sure we all know what we are trying to say.
12. (Everyone is staring at the screen silently)
13. **Michael**: Social response...
14. **Josh**: To outbreaks. I don't know
15. (Michael types what Josh just said)
16. **Josh**: Just put next to it, like, "not real". So she doesn't come and say that doesn't make sense. So like we know. We know. We haven't worded it perfectly. You can put "not exact" or something.
17. **Michael**: Yeah, "not complete." (Everyone laughs)

Michael's initial complaint in Line 1 that he didn't know how to "combine the three plagues" demonstrated that he had appropriated the underlying PBL norms that required them to synthesize three separate historical contexts and narrow their arguments into one argument (lines 1-5) as well as the value of elaborating the argument in a shared PBL quadrant (line 7). More importantly, this interaction showed that the instructor's scaffolding was taken up by the students properly and was effective as demonstrated by Josh's comments in line 2, "available" medicine. Then, they showed that they appropriated the vocabulary of historical argument (lines 9-14) and acknowledged the interaction afforded by boundary objects (lines 16-17). Even though it was challenging, the students appeared to regulate their argumentation process, as evidenced by Josh's statement that they should clearly indicate the draft nature of their statement so the instructor "doesn't come and say that doesn't make sense." Here, students acknowledged that they would receive ongoing feedback based on what was written on the whiteboard. The integration of PBL norms, instructor scaffolding, and representational tool allowed students to advance their reasoning but in a very cautious and mindful way (i.e., using "not complete" wording). This interaction demonstrated how the PBL quadrants supported both instructor evaluation of, and feedback about student selection of the vocabulary that would best

demonstrate their historical thinking skills, as well as the challenge inherent in student

appropriation of discipline norms. (i.e., Michael's frustration "Oh, my god").

Contingent Support Based on Visual Representational Tools

The visual representations of PBL-LHC quadrants on the whiteboard, computer and iPad

surfaced students' reasoning processes, allowing the instructor to assess the current status of the

group's inquiry process and adjust the feedback to be more responsive and contingent. In excerpt

2, the PBL-LHC quadrant made students' thinking immediately visible to the instructor without

the instructor interrupting the discussion or making students repeat themselves. In turn, the

instructor was able to provide contingent and expert guidance to help the students. This excerpt

began with Anna pointing to the whiteboard, and the instructor looking at the whiteboard

following the direction of Anna's finger (Figure 7), while talking about potential hypothesis for

them.

Excerpt 2 (Group 13 / Week 9)

1. **Anna**: We don't know. We feel like we'd have trouble finding sources.
2. **Instructor**: You will, yes.
3. **Adam**: It sounds like a great idea. But, like, then again is there a lot of evidence to back that up?
4. **Instructor**: There is not. So that's one of the reasons that we talk about the best answer, and not the right answer. This is, it's a fabulous hypothesis, but you would literally have to do, like, tree ring observations, and gerbil population spreads, and a number of other things that are well outside the boundaries of what we do in this class to prove that. Lovely, and I like it a lot, but I would go a different route, ok?
5. **Adam**: Different route as in like, different route for seasons, or different route as in like, social class different route.
6. **Instructor**: I like the social class piece, and you've got plenty to prove that.
7. **Adam**: Ok that's what I thought.
8. **Instructor**: You can already see it over here (pointing "Social class/Jobs" on the whiteboard). Greed. People who take care of the dead earn substantial salaries. You've already got proof that the plague changed people's social status. So what other elements are happening here? Doctors ... service. Right? Is there an element of, you guys had talked about medical response? Is there an element of social status in how doctors treat patients and can you see that shaped in the primary sources?
9. **Bob**: Alright.
10. **Instructor**: So, now you need to hunt down evidence and figure out how to go get more.
11. **Cathy**: Cool, she just told us what to do.

In this excerpt, students verified their assessment of their PBL-LHC process with the instructor by using their whiteboard as a communication tool (see Figure 8). Anna drew instructor attention to the "What We Know" quadrant to indicate difficulty finding sources to support their proposed hypothesis, and Adam restated their problem by asking the instructor "It sounds like a great idea. But, like, then again is there a lot of evidence to back that up?" (line 3). This interaction showed the students drawing their instructor's attention to a pre-existing issue in their inquiry process—a lack of evidence for their argument to make sure they are on the right track. The instructor's responses throughout this excerpt drew on the students' visual representation of their thinking to validate the students' performance in the inquiry process to date. She began by confirming that the students' concern about lack of evidence was correct and then supported their continued use of PBL-LHC by noting, "that's one of the reasons that we talk about the best answer, and not the right answer." (line 4).

Figure 6. Pointing the Whiteboard 1
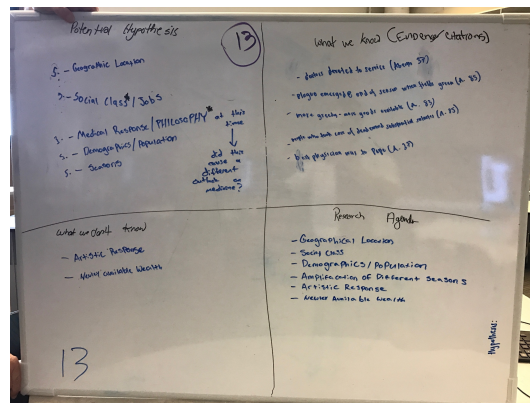
Figure 7. Student's White Board 1

At this point, the instructor shifted focus to what the students had added in their "Potential Hypothesis" quadrant, an example of responsive and contingent scaffolding that emphasized the successful engagement with disciplinary practice that students could build on as they moved forward (line 4). In response, students clarified their understanding of the historical thinking in which they were engaged by elaborating the instructor's feedback, such as "Different route as in like, different route for seasons, or different route as in like, social class different

route." (line 5). Then, the instructor drew student attention to evidence they had already

gathered: "You can already see it over here (pointing "Social class/Jobs" on the whiteboard)."

(line 8).

In this way, contingent scaffolding helped students refine their arguments when they

were not confident about their inquiry process. By grounding her emphasis on social status in the

students' own visual representation, the instructor demonstrated that the students had already

engaged disciplinary practices despite their perception that they were struggling. This kind of

interaction prevailed across the student groups, as demonstrated by a similar interaction at a

group that focused on a very different historical argument. In Excerpt 3, we show another

interaction which highlights the example of synergistic scaffolding among the instructor, a group

of students, and the visual representation to facilitate the problem-solving process.

Excerpt 3 (Group 8 / Week 4)

1. **Instructor**: How are you guys doing?
2. **Josh**: We are doing good. How are you doing?
3. **Julia**: I think we are good.
4. **Instructor**: Ok. The answers are… (looking at the whiteboard and reading) OK, the
   answers are responding to higher power [that's] striking people down with plague
   because of war and murder. OK, so divine punishments because of.. (stops and focuses on one
   corner of the whiteboard)
5. **Tim**: That's our triangle?
6. **Instructor**: WOW! That's so awesome. You guys did a visual version. OK, so divine
   punishment because of inappropriate geopolitical martial interaction. Plague spreads where there
   is…
7. **Julia**: War (laughing)
8. **Josh**: That's what I was thinking (inaudible)

In this excerpt, the instructor initiated the conversation by asking how the group felt to

diagnose their current status of the PBL process (line 1). Then, the instructor immediately

skimmed the whiteboard and quickly assessed the group's status. The exposure of students'

inquiry process written on the whiteboard served as a referent for the instructor in her contingent

support of the group's historical thinking (line 6). Then, she highlighted the norms of historical

argumentation and vocabulary (lines 6). In this group, the students transformed the written

information in their PBL-LHC into a triangle diagram that represented their argument that the

medieval Christian God spread plague as a way of conveying disapproval about constant war in

the Mediterranean (see Figure 8). This is a particularly good example of students integrating

PBL-LHC quadrants with historical thinking and appropriating the results of that integration in

an unexpected way. The use of a student-generated visualization, the triangle, within an

otherwise text-oriented PBL-LHC quadrant to present a historical argument to the instructor

meant two things: the students were able to understand and synthesize the interrelationship
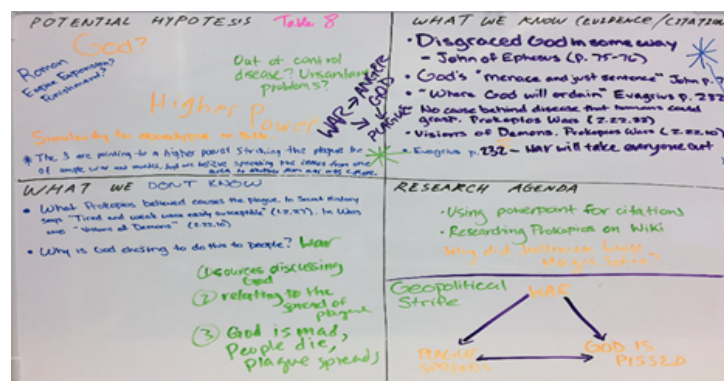

Figure 8. PBL quadrant generated by students at group 8 during PBL encounter 1.

among critical factors and the instructor was able to draw on a very specific representation of

current state of student work without needing to have witnessed the entire inquiry process. The

whiteboard, with its PBL-LHC text plus the triangle, provided a co-constructed reference point

that the group members and the instructor used to jointly facilitate a discussion that ultimately

affirmed the students' historical thinking.

Students' Gradual Appropriation of the PBL Process

Over the course of the three PBL-LHC sessions, students gradually began to appropriate

the norms of PBL-LHC to refine their responses to, and marshal evidence for, increasingly

complex questions. At the beginning of the first PBL-LHC session, students struggled to

understand several elements of PBL-LHC. Despite accepting the necessity of an ill-structured

problems as a foundation for historical thinking, students still struggled with both the ill-structured nature of a historical question and with finding appropriate evidence to support the hypotheses they developed. For example, in the first few minutes of the first encounter with PBL, one student asked, "What are we supposed to do?". This is illustrative of the struggle many students in the classroom faced as they attempted to grapple with the shift from history as a memorization discipline to an inquiry discipline. Another student provided an answer to the first student's query: "5 minutes to be confused." The second student was echoing something the instructor noted in the introduction to PBL as a way to situate students in a "messy" and complex PBL learning environment: that solving ill-structured problems is difficult at first but will lead to productive solutions eventually.

By the second PBL-LHC encounter, procedural questions about the inquiry process were less frequent and the student-instructor interactions began to focus on the historical content of the ill-structured problem. At the close of the third and final PBL-LHC session, most students were comfortable with PBL-LHC as a process through which they could support their historical thinking. The third session positioned students' argumentation for the production of the last major group assignment of the semester. Instructors announced that students could structure their argument using any process with which they were comfortable. Twelve of sixteen student groups voluntarily guided their collaborative historical-argumentation inquiry using the structure of the PBL quadrants to categorize their information and explore how the information in the different quadrants related, either on a whiteboard or in PowerPoint. These choices suggest that students appropriated not only the underlying disciplinary norms that required them to synthesize three separate historical contexts into one argument but also the value of elaborating the argument in a shared PBL quadrant format.

Excerpt 4 (Group 8 / Week 14)

1. **Tim**: So we are calling cultural and politics are the same thing?
2. **Josh**: What?
3. **Tim**: Like we are looking for overlap between cultural and politics?
4. **Josh**: Ah.. I don't think it necessarily overlap? Like
5. **Tim**: One causes the other?
6. **Josh**: Or like political something in a cultural something, both arose because of the plague. Like the plague caused these two things either change or act certain way, respond differently.
7. **Julia**: We can do religion as one of the subpoints
8. **Josh**: Yeah…
9. **Tim**: So what group of people is considered "other" for the first plague? As a result of wars?
10. **Josh**: Would it be, non Roman empire?
11. **Tim**: The Roman empire?
12. **Josh**: NON (emphasized speech) Roman empire.
13. **Tim**: Where is
14. **Josh**: Because it was Roman
15. **Julia**: I think anyone who lived in (inaudible) was like Justinian
16. **Josh**: Yea, right before the plague, slash right before Justinian, the Roman empire was right at their peak, so thriving. Then it starts decreasing a little bit …
17. **Tim**: Who raises the wages in second plague? Was it a government body?
18. **Josh**: Umm, it was just a demand thing. Like there were fewer workers so they had to.
19. **Tim**: Which could be political trade for the second one..
20. **Josh**: So like.. It would be like kings and stuff like that would give land to lords who then pay serfs to work it, and so there is like very structured tier system. But as there weren't enough serfs, the lords kind of had to give up some of ground politically. Because they had to pay more to serfs and it became slightly equal so the tier, monarchal type of system kinda fell apart then.
21. **Tim**: So then the lower class kind of was the target, right?
22. **Josh**: Yep, like yea that's pretty good. I think we can definitely argue that with facts. If we disagree later on, we can tweak it a little.

In this series of utterances, we see three students engaged in a discussion in which more than one student asks a thoughtful historically contextualized question about their argumentation structure and process (lines 1-8); more than one student provides a response rooted in historical evidence in order to narrow the scope of their argumentation (lines 9-15). More importantly for the inquiry process, students acknowledged that they should have evidence to argue something while at the same time expressing an understanding that additional evidence they produce from their historical primary sources might change the argument about historical change and continuity that they are developing (line 22). This is indicative of a general pattern in which students moved from confusion about inquiry in general using PBL to a systematic approach in

which their familiarity with PBL supported negotiation about the historical argumentation process.

Student appropriation of PBL-LHC to support their historical thinking is particularly visible if we compare artifacts from PBL encounters 1 and 3. Figures 9 and 10 are PBL-LHC quadrants from the same group drawn that were developed during, respectively, PBL-LHC encounter 1 in week 4 of the semester and encounter 3 in week 12 of the semester. Although the artifact from encounter 1 in figure 8 made active use of the PBL-LHC process to hone collaborative student thinking at group 8, figure 9 demonstrated the same use of PBL-LHC but with vocabulary and contextual framing that reflected a much more complex historical-thinking approach. In figure 8, we see generic language like "higher power" and "Roman Empire" appearing in the hypothesis section. A narrowing of student discussion ensued, resulting in a final triangle that demonstrated that students used the instructor language of "geopolitical strife," to describe what they worded in a triangle that links a higher power angry about too much war to the outbreak of plague as a punishment.
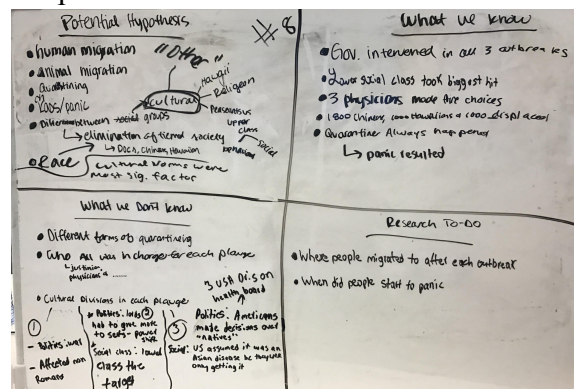
Figure 9. PBL quadrant generated by students at group 8 during PBL encounter 3.

In figure 9, however, the students' language in the hypothesis section of the PBL-LHC quadrant draws on ideas of cultural "otherness" as a connecting point between racial differences, economic class and social status. This "otherness" was drawn from the language from the primary source of history discussing several different plague outbreaks. Group 8's evidence

quadrant from encounter 3's PBL-LHC also reflected a more robust understanding of historical

context. They implicitly acknowledged the very different historical contexts of the outbreaks

they were working with while still highlighting similar patterns in quarantine of lower social

classes. Finally, group 8's more nuanced view of historical patterns with historically

contextualized differences was visible in the "what we don't know" quadrant as they compared

cultural divisions across each of the three plague outbreaks they studied. This complexity did not

have a counterpart in the far simpler thought process in the "what we know" and "what we don't

know" sections from encounter 1 despite the similarity of the instructor's prompt ("one factor

that helps explain plague outbreak"). Group 8's use of PBL-LHC to shape their historical

argument in encounter 3 demonstrated the role PBL-LHC played in supporting historical

thinking across the course. This group voluntarily appropriated PBL-LHC for their own use in

encounter 3 despite a prompt that allowed students to use whatever outlining process they

preferred. Twelve of sixteen student groups, including group 8, in the course used the PBL-LHC

quadrant voluntarily, suggesting that students found this worthwhile.

Discussion

This study demonstrated the promise of implementing PBL in both large classrooms and

in humanities inquiry, provided that care is taken to provide synergistic scaffolding. This system

of scaffolding can effectively support active learning in a large classroom by using appropriate

shared representational tools that do not simply accommodate, but are rooted in and reshaped

around, the disciplinary norms of the classroom in question. By co-constructing the elements of a

PBL quadrant adapted for historical thinking, students in a large classroom were able to engage

in an inquiry-oriented activity by generating multiple hypotheses to answer a central problem.

Beyond the size of the classroom, this is notable because the co-construction of a PBL-LHC

quadrant asked the students to *do* history, moving away from a passive lecture encounter with the discipline of history and toward a more authentic practice of history that involves navigating multiple perspectives, evaluating the reliability of evidences the students built, and experiencing the nature of history which is interpretive and ill-structured (Monte-Sano, 2012).

This series of inquiry activity in the history classroom can be also tied to the process of knowledge construction (Scardamalia & Bereiter, 2003), which consists of a range of cognitive processes including the use of problems and questions, interpreting and evaluating new information, sharing, critiquing, and testing ideas at different levels. Here, the process is a situated and reflective process that can be individual or social effort (Palinscar, 1998) that involves "qualitative changes in the complexity of students' thinking about and conceptualization of context-specific subject matter" (Moore 2002, p. 27). In this study, the PBL-LHC iterations allowed students to experience this knowledge construction process and test their inquiry skills on a set of ill-structured questions that were increasingly complex and supported students as they moved from a narrower single historical school of thought to a more authentic, complex and ambiguous historical narrative that accommodated different perspectives and resources. Thus, throughout the course of the inquiry process, student discourse increasingly demonstrated appropriation of vocabulary that drew on historical disciplinary norms, on historical complexity and ambiguity, and on the synthesis of primary and secondary sources. The iterations also allowed students to connect the historical contexts and events in three different historical plague outbreaks in a single final argument and demonstrate progress toward expertise in historical disciplinary practices. In particular, these disciplinary practices demonstrated one of the recognized characteristics of knowledge construction process that contributes to the evolution

of ideas by citing and referencing others' work and makes that evident by using disciplinary specific discourse in their own right (Scardamalia & Bereiter, 2003).

At the same time, the types of facilitation were different depending on the complexity of the problem. In the first PBL-LHC encounter, students struggled to understand the inquiry process with the ill-structured problem and struggled to find appropriate evidence to support their hypotheses. In these early stages, the inquiry process was driven by the instructor, who modeled and prompted appropriate historical thinking and inquiry skills. For example, in the beginning of the PBL-LHC activity, the instructor started the class by scaffolding students with a mini-lecture on how PBL-LHC provides support for students trying to solve an ill-structured problem— "how to answer a question with no right answer". Then, the mini-lecture was accompanied by other slides on how to use the quadrants with specific guidance for a single historical school of thought so that students could refer to a focused example as they worked on their problems. As the intervention continued and student inquiry began to accommodate more complexity, the contingent support shifted away from the direct guidance that a single PowerPoint slide could support and toward a diagnostic interaction that tailored instructor scaffolding to specific student questions that were inspired by the students' own choice of historical school of thought. Despite increasingly complex questions, the repetition of PBL-LHC with appropriate scaffolding meant that, in the later stages of the class, students demonstrated the ability to craft strong hypotheses, locate effective evidence to support these hypotheses and evaluate the validity of a hypothesis without the instructor's explicit support.

Integrating history disciplinary norms into the PBL-LHC visual representation, in things as fundamental as the shape of the visual representation that anchored the PBL-LHC or the title of the PBL-LHC quadrants, was a critical consideration in supporting student inquiry strategies

as they evolved over time. The representational tools common to PBL served as a boundary object channel for teacher and students to negotiate shared understanding and to mediate the contingent scaffolding that made enacting PBL-LHC in this large learning space achievable for both instructor and students (Hanney & Savin-Baden, 2013). For students, shared visual representation served as a communication channel to involve students to regulate and monitor their learning process as a group. Students were able to expose their inquiry processes and historical thinking simultaneously, and more easily collaborate with other group members as a result.The process of knowledge co-construction is challenging in small group collaboration because it requires multiple actors in a group engaging in SSRL (Järvelä et al., 2015; Poitras & Lajoie, 2013) to support their learning. Here, the mediating function of PBL-LHC visual representation demonstrated how the representational tool supported student groups to regulate their inquiry process by providing a structure with which to exchange ideas, negotiate conflicting thoughts, and construct hypotheses (Miao, Holst, Holmer, Fleschutz, & Zentel, 2000). Moreover, representational tools allowed the instructor to provide more contingent and adaptive scaffolding without interrupting students or asking them to describe their inquiry or historical reasoning in full. We often observed that the instructor stood near, but not at, a student table to read that group's PBL-LHC quadrant before the students and provide scaffolding based on the group's current progress. Frequently, both the instructor and the students pointed to specific student-generated elements of the PBL-LHC quadrant so that everyone in that interaction could focus on the same issue more effectively.

The PBL approach aims to promote knowledge co-construction by advancing student reasoning skills to solve a problem and to use systematic process of gathering information and presenting coherent explanations to justify their rationales (Ertmer & Glazewski, 2015). All of

these behaviors are indicative of supports to promote productive collaborative problem-solving in small groups using representational tools common to PBL in supporting instructor interaction with students in a large classroom. We argue that this study demonstrates the promise of PBL in both large classrooms and in humanities inquiry, provided that care is taken to provide synergistic scaffolding by establishing norms for group work, structuring the task for learning, modeling the desired collaborating behaviors with the whole class and with small groups, and actively monitoring group work with the help of representational tools (Webb, Farivar, & Mastergeorge, 2002).

Conclusion

This study demonstrated ways in which PBL in its PBL-LHC form could be successfully enacted in a large active-learning history classroom. Drawing on inquiry practices to develop historical thinking skills provides a solid foundation for the discipline of history, and PBL-LHC in particular is well suited to support inquiry in the large classrooms that dominate survey courses in college history. Even though adapting PBL for use in large classrooms requires a careful integration of history disciplinary norms with the one-on-one scaffolding interactions, the synergistic scaffolding made possible by visual representation tool of a PBL-LHC quadrant which supported both elements of that question. First, we could transfer tutor-led and small classroom to practices to a large classroom because of the visual representation that helped offer diagnostic and contingent scaffolding among instructor and students. Second, the visual representation of the PBL-LHC quadrant, especially when adapted to specific history disciplinary norms, both signaled to students that history is an inquiry-based discipline and provided a scaffolding process through which they could represent, modify and structure their PBL inquiry over an extended period of time.

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