Bridging Social Annotation Practice with Perspectives from the Learning Sciences and CSCL

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Abstract: Social annotation has emerged as an important approach to supporting students' social interaction and collaborative knowledge building in the classroom. Despite great interest among practitioners and a growing body of literature, social annotation activities are often guided by practical intuitions rather than informed by theories of learning and technology-supported collaboration. To strengthen social annotation practice, more work is needed to explore the systematic application of rich theories of learning and collaboration in this context. The proposed hybrid symposium aims to engage learning scientists, CSCL researchers, and stakeholders in productive dialogues to explore the integration of social annotation as a complex practice that can benefit from meaningful application of theories, explicit consideration of learning constructs, and careful design of technological and analytical support. The symposium will both contribute to social annotation practice in the classroom and help learning scientists and CSCL researchers in achieving broader impacts in the education system.

Introduction

> Annotation covers a broad territory. It has been construed in many ways: as link making, as path building, as commentary, as marking in or around existing text, as a decentering of authority, as a record of reading and interpretation, or as community memory. (Marshall, 1998, p.40)

Annotation, the practice of adding notes, comments, and other representations of ideas to text, is an important part of human cognition that supports reading, writing, and scholarship (Marshall, 1997). For example, readers actively engage with textual content by annotating printed books, with their annotations serving a multitude of functions such as procedural signals, recall cues, and attention traces (Marshall, 1997; O'hara & Sellen, 1997). Annotation can be dynamic—it evolves as readers interact with texts by adding new meanings, which reflects the evolving thinking processes and cultural contexts of its different readers (Liu, 2005; Marshall, 1998). *Web annotation* is a genre of information technology that offers an interactive way for users to engage with digital content, allowing them to add, share, and collaborate on annotations directly over web resources (W3C Web Annotation Working Group, 2016). Since the pioneering Annotea project (Kahan & Koivunen, 2001), various tools, such as NB (Zyto et al., 2012), Hypothesis, and Perusall, have emerged to support web annotation and its application across varied fields. More recently, these tools have undergone notable improvement with the development of more adaptable forms such as public web versions, browser plugins, and Learning Management System (LMS) integrations, further broadening their application in education.

Social annotation in this symposium refers to the application of web annotation technologies in educational settings to support student interaction around course materials and with each other. In higher education, social annotation has been widely adopted as an online discussion activity where students collaboratively read and annotate course readings (Sun et al., 2023). Unlike a post in a traditional discussion forum, a student annotation anchors a discussion to their original context, making the discussion more specific and focused (Sun & Gao, 2017). A growing body of research has investigated the design and implementation of social annotation activities in classrooms (Andrews et al., 2019; Chen, 2019; Hollett & Kalir, 2017; Zhu et al., 2023). Studies suggest that social annotation, utilized across education levels, could help in processing domain-specific

knowledge, promoting argumentation and literacy skills development, supporting assessment, and connecting online learning spaces (Zhu et al., 2020).

Despite growing interest in both research and practice, many existing social annotation activities remain generic and not clearly driven by theories of learning or collaboration. For instance, instructors may routinely mandate students to annotate and reply for a certain number of times during a week. This approach appears to insufficiently align the affordances of web annotation with possible scenarios of productive student engagement with course content and with each other. A recent literature review indicates that the majority of current studies in social annotation do not explicitly state learning theories they employ and are only implicitly informed by theories mentioned in literature review or activity design (Sun et al., 2023). The lack of theoretical grounding in the design of social annotation activities may lead to a misalignment between the design activity and target learning outcomes, limited understanding of the mechanisms that drive effective learning in social annotation, and inconsistent implementation of social annotation activities across different contexts.

To strengthen social annotation practice in the classroom, more work is needed to explore the systematic application of rich theories of learning and technology-supported collaboration in the social annotation context. Work in this fertile area is already happening. For example, Andrews et al. (2019) investigated the use of an *expansive framing* framework in an undergraduate course, with the goal of enhancing generative collaborative learning in social annotation activities. Expansive framing encourages students to relate their immediate learning experiences to broader contexts and future applications and offers support for productive conversation and knowledge transfer. In a separate study, Zhu et al. (2023) developed a scaffolding framework with predefined participation roles (including facilitator, synthesizer, and summarizer) for learners to play each week to improve their social interaction and cognitive engagement. These efforts have demonstrated the prospects of infusing theories of learning and collaboration in the design of social annotation activities. However, these studies are only scratching the surface and more work is needed to bridge theories of learning and computer-supported collaborative learning (CSCL) with social annotation as a complex educational practice shaped by a constellation of factors including teachers, learners, technologies, and even the open web. How can we build on theorizations of social annotation as conversation along cognitive, social, cultural, and political dimensions (e.g., Kalir & Dean, 2018; Marshall, 1997) to pursue new ways of conceptualizing social annotation in learning spaces? How can theories that are actively explored in the learning sciences inform this pursuit? At the same time, how may CSCL theories that think carefully about individual minds, small groups, larger communities, digital objects, and collaboration processes (Stahl & Hakkarainen, 2021) shed light on the social processes around annotation artifacts? How could technological affordances offered by web annotation technologies be leveraged to support CSCL practices such as establishing a joint problem space, communicating with each other, and creating a shared knowledge space (Chen & Lin, 2020; Jeong & Hmelo-Silver, 2016)? It is time to expand from prior efforts by engaging learning and CSCL researchers in conversations with designers and participants of social annotation activities to collaboratively explore this rich space. This exploration can generate more theoretically robust and practically impactful designs of social annotation and hereby enhance social annotation experiences in the classrooms. Given the increasingly broader reach of social annotation, this work will be extremely meaningful for learning scientists and CSCL researchers who are interested in achieving tangible change in the education system and large-scale environments (Wise & Schwarz, 2017).

To this end, the symposium aims to delve into the nuanced process of integrating social annotation in authentic learning settings in order to initiate conversations within the learning sciences community to advance social annotation research and practice. Our goals are threefold: (1) Advancing theory use – We seek to encourage a more sophisticated application of learning theories in social annotation, which involves translating abstract theoretical concepts into pedagogical strategies by understanding how theories can be more effectively applied in practical settings; (2) Connecting learning constructs with technology affordances – We aim to precisely map the affordances of social annotation technologies—such as interactivity around artifacts and visibility of student ideas (Hennessey, 2011; Pifarré, 2019)—with specific learning constructs, and thereby create a more targeted and effective learning experience; (3) Exploring design complexity – The symposium will discuss the complexities involved in social annotation practice, including disciplinarily specific learning outcomes, instructor design decisions, learning analytics applications, and new technologies targeting higher-order learning skills.

To achieve these goals, this symposium has involved five teams from multiple institutions who have been actively exploring social annotation from distinct perspectives. Each presentation is charged to respond to the following questions, with the hope of stimulating rich conversations within the learning sciences and CSCL research communities and between the research communities and people who are actively involved in social annotation:

1. What learning theories can productively inform the research and design of social annotation practice?
2. What learning constructs are supported by the affordances provided by social annotation technologies?

3. How can we develop robust methodologies to investigate and assess the learning occurring within social annotation activities?

Personal versus professional authenticity in social annotation
Daniel Hickey and Grant Chartrand

We explore a crucial aspect of annotation that deserves systematic consideration. This concerns how learners *frame* their annotations (i.e., contextualize, as in Goffman, 1974)*.* Social annotation naturally lends itself to "personal" framing where learners are pushed to find connections with individually relevant people, places, topics, and times, beyond the boundaries of the course. In practice, framing is closely related to the more pragmatic principle of *authenticity,* as popularized in the essay by Brown et al. (1989) which introduced many to situated cognition.

Personal authenticity was explored in a 2021 expert consensus study report on computing education from the National Academies of Sciences, Engineering, and Medicine by leading learning scientists (including Barbara Means, Victor Lee, and Mimi Ito). They juxtaposed personal authenticity with *professionally* authentic experiences that are widely used to frame learning in STEM contexts and beyond. The report argued forcefully that professionally authentic experiences often marginalize learners from non-dominant backgrounds and that *all* learners can benefit when *each* learner engages in personally authentic experiences (e.g., Calabrese-Barton & Tan, 2019).

Personal authenticity is entirely consistent with the situative design principles for *expansive framing* in Engle et al. (2012). This is important for at least two reasons. The first is the five compelling explanations that Engle and colleagues presented to explain why expansive framing should support generative learning that transfers readily and widely (c.f., Hickey, 2022). The second reason is that expansive framing and its precursor principles for *productive disciplinary engagement* (Engle & Conant, 2002) are being extended to support equity and inclusion (see especially Agarwal & Sengupta-Irving, 2019, systematically reviewed in Freedman et al., in review).

We are motivated by the fact that the design principles for expansive framing have yet to be widely taken up by others; our own efforts to promote expansive framing in social annotation and beyond (e.g., Hickey et al., 2020) have had limited impact. We suspect that this is because many assume that situative theories of learning (i.e., Brown et al., 1989) call for "real world" (i.e., professionally authentic) experiences (e.g., Herrington, 2014) and because of Engle's problematic contrast with "bounded" framing.

Our presentation will first summarize the theory and practice of expansively framed, personally authentic social annotations. This will include using *socio-political uncertainties* (Agarwal & Sengupta-Irving, 2019; Hickey & Quick, 2020) that invite minoritized learners to position themselves as having unique expertise. The presentation will then summarize supporting evidence from discourse analysis in case studies of three fully online courses. These include secondary computing, undergraduate learning theories, and graduate learning & cognition.

Identifying linguistic, cognitive, and social indicators of undergraduate students' social annotation
Remi Kalir, Justin Hodgson and Chris Andrews

The use of social annotation as a learning activity in undergraduate education can productively support students' textual analysis, collaboration, and knowledge production (Kalir et al., 2020; Morales et al., 2020). In the context of composition and literature courses, social annotation can aid students' reading strategies and writing skills as "readerly additions" (Davis & Mueller, 2020) augment mentor texts and enhance peer discourse (Hodgson, Kalir, & Andrews, 2023). This paper reports initial findings from a broader, large-scale study of undergraduate students' reading and writing practices to identify the prevalence of linguistic, cognitive, and social qualities in student writing as evidenced by social annotation.

Through a research-practice partnership, the English Department at a large public research university in the Midwest implemented social annotation activities in all standard sections of a required composition course for first-year students. During the spring 2021, fall 2021, and spring 2022 semesters, over 50 course sections each term–enrolling on average over 1,000 students–used the social annotation tool Hypothesis to read and discuss texts. We examined student social annotation of three texts selected because each appeared in the most sections across the three semesters (S21, F21, S22): A chapter of Gloria Anzaldúa's *Borderlands/La Frontera* was annotated in 40 sections by 772 students; a selection from Jeffrey Jerome Cohen's *Monster Theory: Reading Culture* was annotated in 37 sections by 695 students; and a chapter of John Berger's *Ways of Seeing* was

annotated in 33 sections by 633 students. Following data collection, we used Linguistic Inquiry Word Count (LIWC; Pennebaker et al., 2015), a validated text analysis tool, to calculate the frequency of linguistic features found in 3,868 student annotations of Anzaldúa's text, 3,425 annotations of Cohen, and 3,029 annotations of Berger. Table 1 reports the average frequency of key linguistic, cognitive, and social language indicators as demonstrated in undergraduate students' social annotation.

Table 1
Average Linguistic Frequencies of Students' Social Annotation (S21, F21, S22)

Text	Analytic	Clout	Authenticity	Tone	Cognition	Social Processes
Anzaldúa	47.72	53.91	35.55	32.61	17.08	17.38
Cohen	55.68	51.64	45.73	26.60	17.85	11.96
Berger	55.03	62.84	42.70	33.26	16.67	15.44

Across three texts and three semesters, our results indicate that undergraduate students' social annotation demonstrated a mix of analytical thinking and conversational discourse, expressive confidence in line with other studies of online learning (e.g., Moore et al., 2021), and moderate levels of emotional authenticity and tone. When responding to varied texts and peers, cognitive features of student writing were evident in approximately 17% of all annotation text, a frequency higher than similar analyses of students' online discussion (e.g., Zhu et al., 2019). This analysis of first-year students' writing is an exploratory account of how regularly linguistic, cognitive, and social attributes appear in over 10,000 instances of social annotation. As data were collected prior to the widespread use of generative artificial intelligence writing tools, our results also provide descriptive insight about students' authentic online language use and sense-making when jointly interacting with texts and peers.

Supporting actionable social annotation through learning analytics

Yeonji Jung and Alyssa Wise

Effective social annotation relies on students actively engaging with shared materials and co-developing ideas with peers. However, challenges such as inconsistent engagement, low-quality annotations, and hesitation in tool use hinder its potential (Novak et al., 2012). These issues manifest in students' tendencies to focus on irrelevant details, produce repetitive annotations, and accept information uncritically, stemming from difficulties in interacting with related information and identifying the parts needed for attention (Ghadirian et al., 2018; Novak et al., 2012).

To address the challenges, this study uses a learning analytics approach to promote effective learning through social annotation (Zhu et al., 2020). Through extensive human-centered design activities with students and instructors, the student-facing analytic tool was developed with the primary objective of meeting the need for timely guidance in identifying areas for meaningful contributions to the social annotation activities. The tool provided individualized analytic-driven suggestions about where they could contribute to their social annotation tasks (e.g., "Buzz! Check out this active conversation", "Connect with someone new"), featuring three tool characteristics: integration into existing learning tools, direct paths to action, and alignment of analytics with learning activity timing. This tool was implemented in a fully asynchronous course to 91 students twice a week for five weeks. Students received different versions of the analytics depending on their participation status (whether they had started participating in the learning task or not) and the time of the week (early or late).

Using student access data and interview responses, this study examined how students engage in the learning tasks of social annotation throughout the week and whether and how their use of analytics might make a difference to their existing learning routines. Findings showed that while opening the analytics promptly, students used the analytics in different ways for social annotation, either backward or forward in their learning routines. In some cases, students did not initially use the analytics as a precursor to the annotation tasks. Instead, they later used them to review and stay connected with the completed tasks. However, lower open rates identified in backward use raise questions about connection between task completion and importance attributed to analytics. In other cases, students used the analytics as a proactive tool to prepare for upcoming annotation tasks, even including other course assignments, gaining a prospective idea of what would happen in the annotation tasks before starting them. Several students, who followed an all-at-once learning routine, tended to make comments based on the analytics while reading, particularly when the analytics suggested intriguing questions or relevant content. In a few cases, some students took a combined approach, using the analytics as an aid when encountering

difficulties in understanding readings and identifying relevant spots to contribute, which was identified as a critical need in the participatory design process. In this case, they focused on reading to extract the main ideas or clarify complex aspects, further helping them generate ideas and make comments on ongoing conversations. The variation in student use of analytics depending on their learning status indicates that aligning the delivery of analytics with students' existing routines may promote timely access, but it is not enough. This was coupled with students' reported challenges that while they opened their analytics right away, this was not the time when they normally did annotation tasks, so they did not use analytics directly. This highlights potential areas for future work, considering customizing the timing of analytics delivery to ensure that students receive timely and relevant feedback in their own timelines of engaging in social annotation tasks. This study suggests the potential of using analytics to foster social annotation learning for students to find particular areas for contribution and enhance engagement.

Supporting knowledge synthesis in social annotation activities

Xinran Zhu, Bodong Chen, Hong Shui and Pingting Chen

The knowledge-creation perspective grounded in CSCL literature (Paavola & Hakkarainen, 2014; Paavola & Hakkarainen, 2021) emphasizes the role that student-created artifacts play in mediating learning and collaboration. This viewpoint conceptualizes learning as the process of creating and progressively refining shared artifacts through interactions with peers. From this perspective, the design of social annotation activities should consider two key aspects: facilitating learning and collaboration by acknowledging annotations as valuable artifacts and nurturing the continuous development of students' ideas that emerge from engagements on social annotation platforms. In this presentation, we introduce a design research project, named Knowledge Synthesis, that aims to foster productive interaction and related knowledge practices in social annotation activities by recognizing these aspects, as part of a multi-year research-practice partnership.

The Knowledge Synthesis project tackles a key challenge in social annotation practices: the limited opportunities for successive idea refinement beyond the initial round of annotations. Typically, social annotation activities end once students have completed their annotations, neglecting the potential of these contributions to facilitate ongoing collaborative learning. Consequently, ideas generated from the annotations remain isolated from other learning activities, thereby restricting their further development and hindering their integration into broader knowledge practices. This project aims to address this challenge by proposing a *knowledge synthesis intervention*. Knowledge synthesis is an important form of human cognition that involves skillfully and strategically weaving together diverse strands of information to foster conceptual innovation, generate novel knowledge, and design creative solutions (Deschryver, 2014; Morabito & Chan, 2021; Scardamalia & Bereiter, 2014). This intervention recognizes students' annotations as objects open to continuous development, engaging students to connect, analyze, and expand upon their ideas through the synthesis processes. Meanwhile, the synthesis products can be integrated into other learning events, enriching the overall learning experiences. Concepts related to knowledge synthesis, such as "rise above" in Knowledge Building (Scardamalia & Bereiter, 2014), have been recognized across various fields for their role in fostering individual growth and collaboration. Despite its recognized importance, there is still a notable gap in understanding how knowledge synthesis operates within CSCL environments and how it can be explicitly supported to become a pivotal element in knowledge creation.

The knowledge synthesis intervention involves a web application developed by the research team, named the Synthesis Lab, which retrieves students' social annotation data and provides explicit scaffolds to guide students' synthesis making process. The workflow within the tool aims to achieve two primary goals: categorizing peers' ideas into Conceptual Building Blocks (Morabito & Chan, 2021), and developing a synthesis of the discourse. The application provides a structured workspace for students to decompose the complex synthesis task into smaller building blocks, such as distilling, connecting, analyzing, and rising above ideas generated from the annotations. To effectively incorporate this tool into classroom settings, pedagogical support informed by the CSCL literature has been designed. One such design involves collaborative scripts that scaffold student participation. This is achieved by assigning a pair of students each week as discourse facilitators. These facilitators were asked to promote deep thinking in annotations and foster engagement in peer responses. Additionally, they used the Synthesis Lab to connect and synthesize student ideas from the annotations before in-person class discussions, with particular focus on key themes, disagreement, and confusions. This synthesis was then used to mediate further in-person discussions or group projects, thereby enhancing the overall collaborative learning experience. Through empirical implementation of the design in a graduate classroom, we examine how students perceive knowledge synthesis as a part of their collaborative learning, how they synthesize the student-created artifacts, and how knowledge synthesis mediates ongoing interaction and knowledge creation throughout the learning experience.

In this project, CSCL theories were used to guide both technological and pedagogical designs, particularly in how it conceptualizes learning as the process of creating and developing shared artifacts. A key aspect of this alignment is the recognition of the mediational role played by student-created artifacts in their collaborations, such as their annotations and syntheses. This approach emphasizes the importance of digital artifacts not just as byproducts of learning activities but as living components in the ongoing collaborative discourse process, shaping further learning and application. Additionally, investigation of this intervention also demonstrates the potential to further expand theories of learning and CSCL designs.

Exploring instructor use of social annotation in undergraduate online courses

Rukmini Manasa Avadhanam

Research on social annotation in higher education online learning has increased exponentially in the past two decades (e.g., Novak et al., 2012; Zhu et al., 2020). However, this rich body of literature mainly studied the evaluation of social annotation tools and their effectiveness on student-related measures, and very few studies discuss instructors' perspectives and their use of social annotation. There needs to be more knowledge about the processes and challenges instructors face in using and implementing social annotation in undergraduate online courses. The lack of studies on instructor perspectives on social annotation makes it challenging to understand the teaching, assessment, and participation strategies that effectively achieve the course objectives, improve student learning outcomes, and engage students in learning. It is also important to understand instructors' design and pedagogical processes as they use social annotation tools to facilitate collaborative learning in online learning environments and their processes to facilitate learning through student annotations.

Through a rich, descriptive, in-depth qualitative case study, this study delved into instructors' processes behind the thoughtful and intentional design of social annotation activities that enhance CSCL in undergraduate students. This study aims to understand how and why instructors use social annotation to achieve their pedagogical goals, the processes behind the thoughtful and intentional design of social annotation activities for their online classes, and their perception of how it impacts student learning experiences. The findings of this study illustrate rich descriptions of instructor design and implementation processes of five instructors teaching online courses in two modalities, asynchronous and synchronous. The instructors were mainly from the schools of social sciences and humanities, whose teaching philosophies included social constructivism and active student dialogue and conversations to enhance learning. They learned about social annotation tools and tried the tools with zest as they identified that their course objectives aligned well with the use of social annotation. Instructors strongly voiced their dislike for threaded discussion boards and shared how they noticed visible student dialogue and critique as they used social annotation tools like Hypothesis. Thematic analysis of qualitative data sources also elaborates that instructors use social annotation tools to create an authentic, collaborative learning community for student discussion and to ensure student perspectives are more visible. Instructors' design and pedagogical processes, like providing guiding prompts, participation-based assessment strategies, and instructor participation to further student discussion, are also evident. They also indicated the differences in synchronous and asynchronous modalities of online courses, how they influence student participation in social annotation, and the added challenge of designing and facilitating the conversations. The study's implications indicate how there should be more focus on instructor use of learning technologies, support them institutionally with professional development, and communities of practice.

Significance of the symposium

In this symposium, we engage learning and CSCL researchers in conversations with designers and participants of social annotation activities to collaboratively explore the integration of social annotation as a complex practice in education. Studies presented at this symposium approach learning and CSCL theories from different angles, including examining students' reading strategies and writing skills demonstrated in social annotation through linguistic, cognitive, and social language indicators (Kalir et al.), exploring the role of personal authenticity in the framing of annotations from a socio-political lens (Hickey & Chartrand), applying learning analytics to enhance student engagement in social annotation (Jung & Wise), understanding the role of annotations as knowledge artifacts in mediating ongoing collaborative learning processes (Zhu et al.), and investigating instructors' perspectives in implementing social annotation in higher education classrooms (Avadhanam). Collectively, this symposium demonstrates meaningful application of theories, explicit consideration of learning constructs, support for instructor decision making, and careful design of technological and analytical support. This hybrid symposium will not only contribute to social annotation practice in the classroom but also help learning scientists and CSCL researchers in achieving broader impacts in the education system.

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