Reading and connecting: using social annotation in online classes

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Abstract

Purpose – The COVID-19 pandemic has forced many instructors to rapidly shift to online/distance teaching. With a narrow preparation window, many instructors are at a loss of strategies that are both effective in responding to the crisis and compatible with their professional practices. One urgent need in classrooms at all levels is to support social reading of course materials. To fulfill this need, this paper aims to present a systematic literature review on using Web annotation in K-12 and higher education to provide practical and evidence-based recommendations for educators to incorporate social annotation in online teaching.

Design/methodology/approach – This paper presents a systematic literature review of the use of Web annotation in formal education. The authors reviewed 39 articles that met the inclusion criteria and extracted the following information from each article: level of education, subject area, learning theory, learning activity design, Web annotation technology, research methods and learning outcomes. Studies were further analyzed and synthesized by the genre of learning activity design.

Findings – The authors identified five types of social annotation activity design: processing domain-specific knowledge, supporting argumentation and inquiry, improving literacy skills, supporting instructor and peer assessment and connecting online learning spaces. In addition, the authors developed practical recommendations on setting pedagogical goals, selecting annotation tools, deciding instructor involvement and developing evaluation strategies.

Originality/value – This study provides a timely response to online/distance teaching under the COVID-19 pandemic. It is a hope that these identified application areas, in combination with four practical recommendations, would provide pragmatic and evidence-based support for educators to engage learners in reading, learning and connecting.

Keywords Collaborative learning, Online learning, Collaborative reading, Social annotation, Social reading, Web annotation

Paper type Research paper

Introduction

COVID-19 has forced schools and universities to pivot to online/distance learning. For many educators, this transition is an abrupt response to a crisis. While online instruction does allow many learning activities to continue, any attempt to fully replicate face-to-face (F2F)

instruction is misguided, and is destined to miscarry. Instructors, especially those who have not taught online, are at a loss of online teaching strategies that reflect their professional practices and identities.

Among various instructional needs, one learning activity that is popular in classrooms is the social reading of course materials. No matter whether the learning objective is to grasp scientific concepts or to critique literary texts, it is a common classroom practice to engage students in reading and discussing a shared document. This practice is supported by social constructivist views of learning that recognize critical roles played by language and social interaction (Vygotsky, 1962). In a F2F classroom, the teacher can rely on a range of verbal and non-verbal cues to facilitate this activity, diagnosing student understanding, encouraging turn-taking and orchestrating knowledge construction (Chi and Menekse, 2015; Michaels *et al.*, 2008). Moving online, teachers face a lingering question: *What online teaching strategies are available to support social reading and group discussion of course materials in the classroom?*

To answer this question, we present a systematic literature review of the use of Web annotation in K-12 and higher education. *Web annotation* is a genre of information technology that allows a user to annotate information in a Web document and anchor a discussion in the annotated information. As a matter of fact, annotation – paper-based or online – is an important part of human cognition; it serves a multitude of functions including procedural signals, placemarks, and visible traces of a reader's attention (Marshall, 1997; O'Hara and Sellen, 1997). Since the pioneering *Annotea* project, digital tools have been created to support Web annotation (Haslhofer *et al.*, 2012). In comparison with paper-based annotation, Web annotation harnesses simultaneous access to a shared document and creates a layer of interactivity on any Web document (W3C Web Annotation Working Group, 2016). In education, Web annotation is broadly used to support social reading, group sensemaking, knowledge construction and community building (Chen, 2019; Kalir *et al.*, 2020; Marshall, 1997; Plevinski *et al.*, 2017). In the following sections, we first describe methods and key findings. We then offer practical and cautionary recommendations that are applicable to the COVID-19 crisis and beyond.

Methods
Literature search strategy
In April 2020, we conducted a comprehensive literature search using Scopus. To capture educational literature on social annotation, we limited the search to Social Sciences and used an advanced combination of search terms including Web/online annotation, social reading/annotation, collaborative reading/annotation and anchored discussion. Only referred journal articles were included. This initial search yielded 249 results.

Inclusion criteria
We screened these studies based on the following inclusion criteria: being about social annotation in Web-based settings, including empirical research of learning (i.e. not solely about technology), being accessible online, being written in English and not being a literature review; 39 studies met the criteria and were included for analysis.

Coding and synthesis
After the screening, we reviewed each article and extracted the following information: level of education, subject area, learning theory, learning activity design, annotation technology, research methods and learning outcomes. After coding, studies were further synthesized by the genre of learning activity design.

Using Web annotation in classrooms

The synthesis resulted in five categories: *processing domain-specific knowledge*; *supporting argumentation and inquiry*; *improving literacy skills*; *supporting instructor and peer assessment*; and *connecting online learning spaces*. Table 1 presents a summary of all studies. Before presenting the categories, we stress that both successes and challenges were reported across studies and any attempts to incorporate social annotation need to consider the context (Kalir *et al.*, 2020). In this section, we spotlight learning activity designs to illuminate possibilities of social annotation in education.

Processing domain-specific knowledge

Web annotation is used to support learner sensemaking of domain-specific knowledge in both K-12 (Jan *et al.*, 2016) and higher education (Chan and Pow, 2020). With Web annotation tools, learners annotate online texts, discuss with each other, and connect the texts with prior knowledge for deeper understanding. For instance, Mohd Nor *et al.* (2013) designed an online reading system to facilitate reading processes for ESL (English as a Second Language) learners in an undergraduate class in Malaysia. To facilitate domain understanding, the instructors provided guiding questions and prompts for students' group annotation activities. Survey responses from 81 students indicated 95% of them used the tool for highlighting important points and perplexing areas. Analysis showed students also used annotations to ask questions, express opinions, make inferences and create summaries.

In a study involving medical pathology junior and senior college students, individual and collaborative annotation activities were designed to help students differentiate the images of normal and abnormal human tissues (Sahota *et al.*, 2016). Relying on an image annotation tool called *Slice*, students annotated digitized microscopic slides, followed by quizzes, questionnaires and instructor feedback. For senior students, research showed a significant improvement in their quiz scores following the collaborative annotation activity. However, this study did not find such positive effect of collaborative annotations among junior students, who had less prior knowledge and collaboration experiences.

One challenge facing the use of social annotation is the occurrence of "low-quality" student annotations. In an undergraduate physics class, a "seeded annotation" intervention was designed by embedding high-quality annotations made by former student cohorts in the materials (Miller *et al.*, 2016). Findings revealed positive effects on both the quality and quantity of student annotations, as well as more prompt participation by students. In another study involving high school students in Taiwan, special features were built in an annotation tool to filter "poor quality" annotations, leading to stronger reading performance and reduced cognitive load (Jan *et al.*, 2016). Overall, these studies showed social annotation could facilitate students' domain understanding so long as challenges are sufficiently dealt with.

Supporting argumentation, inquiry, and knowledge construction

While domain understanding can be facilitated through annotating materials, in some cases the generated annotations are gathered to further facilitate argumentation, inquiry and multiple perspectives. In a study by Lu and Deng (2013), *Diigo*, a social bookmarking and annotation tool, was incorporated to help 10th graders critically read materials, evaluate multiple viewpoints, and build arguments about "whether Hong Kong should construct a high-speed rail system." Students first annotated key concepts (in green), supporting views (red), and opposing views (blue) in articles selected by the instructor. The annotations were extracted from Diigo for groups to discuss and construct well-reasoned arguments. Research findings showed that when the instructor provided sufficient scaffolding for evidentiary

Activity design	Subject area	Course level	Study – technology used
Processing Domain-specific Knowledge	Chemistry	Secondary	Jan et al. (2016) – WCRAS – TQAFM
	Statistics	Undergraduate	Alrushiedat and Olfman (2014) – AAOD
	Education	Undergraduate	Chan and Pow (2020) – WASP; Gao (2013) – Diggo; Sun and Gao (2017) – Diigo; van der Pol et al. (2006) – self developed
	Health Education	Undergraduate	Eryilmaz et al. (2013) – Annotation Tool
	Second Language Learning	Undergraduate	Mohd Nor et al. (2013) – The Annotation Tool
	Physics	Undergraduate	Miller et al. (2016) – NB Annotation System
	Event Management	Undergraduate	Olson and Brown (2018) – Nota bene
	Computer Science	Undergraduate	Su et al. (2010) – PAMS 2.0; Zarzour and Sellami (2017) – L2OD; Zarzour and Sellami (2018) – CAALDT;
	Pathology	Undergraduate	Sahota et al. (2016) – self developed
	Literature and Reading	Undergraduate	Thoms and Poole (2017) – Hylighter
	Not Defined	Undergraduate	Yang et al. (2011) – PAMS 2.0
	Education	Graduate	Eryilmaz et al. (2014) – self-developed
Supporting Argumentation, Inquiry, and Knowledge Integration	Liberal Study	Secondary	Lu and Deng (2013) – Diigo
	Education	University level	Li et al. (2015) – Diigo
	Communication	Undergraduate	Passig and Maidel-Kravetsky (2016) – Self developed
	Sport Psychology	Undergraduate	Samuel et al. (2011) – HyLighter
	Education	Professional Learning	Kalir (2020) – Hypothes.is
Practicing Literacy Skills	Literature and Reading	Elementary	Chen et al. (2020) – WCRAS; Chen et al. (2019) – CRAS-FAFM; Yang et al. (2013) – SURF; Chen and Chen (2014) – CRAS-RAIDS
	Literature and Reading	Elementary	Lin et al. (2014) – Group Scribbles
	Second Language Learning	Secondary	Chen et al. (2016) – CDRAS
	Second Language Learning	Secondary	Hwang et al. (2011) – VPen
	Second Language Learning	Undergraduate	Thoms et al. (2017) – eComma; Lo et al. (2013) – Paragraph Annotator; Tseng and Yeh (2018) – Google Doc; Yeh et al. (2017) – Google Doc
Supporting Instructor or Peer Assessment	Second Language Learning	Secondary	Chen et al. (2010) – TACO
	International Business	Undergraduate	Lin and Lai (2013) – CAFAS
	Second Language Learning	Undergraduate	Yeh and Lo (2009) – Online Annotator for EFL Writing; Zhao et al. (2018) – Zoho Docs
Connect Online Learning Spaces	Education	Graduate	Chen (2019) – Hypothes.is; Hollett and Kalir (2017) – Hypothes.is

Table 1.
Reviewed studies organized by learning activity design

reasoning, social annotation supported students to become more attentive, critical and reflective when developing claims.

In another study, Li *et al.* (2015) incorporated Diigo in a university-level course to engage 24 students in collaborative inquiry into authentic, ill-structured social issues (e.g. "Should the right to public knowledge override the right to privacy?"). Group members foraged and bookmarked Web pages to build a Diigo database around their select social issue. Diigo annotations, comprising text highlights, annotations and replies, were fed into a group deliberation to co-create mind maps about the social issue. Results showed a positive linkage between social annotation and collaborative inquiry, but groups varied in their engagement level and quality of their mind maps. The authors suggested instructor facilitation was critical for achieving the desired outcome. Together with other studies (Passig and Maidel-Kravetsky, 2016), the literature shows social annotation could help students organize information and ideas for argumentation, collaborative inquiry and knowledge construction.

Improving literacy skills
Social annotation can also promote reading comprehension and language capabilities. This is especially useful in first and second language learning classrooms where reading is a means to achieve language learning objectives (Hwang *et al.*, 2011; Lin *et al.*, 2014). In this case, the content becomes less important than the language skills that are transferable across subject domains.

In an undergraduate English reading class, 22 low-achieving EFL (English as a Foreign Language) learners participated in an annotation and discussion activity in groups of 3–4 using the commenting feature in *Google Docs* (Tseng and Yeh, 2018). Following the Reciprocal Teaching approach (Palinscar and Brown, 1984), students applied four group discussion strategies in the activity: predicting, questioning, clarifying and summarizing. Results showed significant improvement in reading comprehension skills among students. Among the four strategies, students found summarizing and clarifying less useful due to their limited language proficiency. Questioning and predicting were found most useful as they led to a transformation from passive reading to a deeper level of comprehension.

Along with other studies (Chen and Chen, 2014; Lo *et al.*, 2013; Thoms *et al.*, 2017; Yang *et al.*, 2013), social annotation has shown efficacy in promoting literacy skills. By annotating socially, students revisited ideas in the reading, engaged in peer interaction and developed higher-order competencies.

Supporting instructor and peer assessment
Web annotation can provide additional opportunities for assessment and feedback. In the simplest form, an instructor can provide feedback by leaving annotations in online documents submitted by EFL college students to help them correct writing errors (Yeh and Lo, 2009). In a more sophisticated technological setup, Chen *et al.* (2010) applied text mining algorithms to student annotations/tags to automatically score each student's progression on reading comprehension. This scoring mechanism allowed 56 EFL high school students to assess their tags, re-read the article when their tags received low scores, and discuss tags with their peers. While the assessment mechanism improved reading comprehension skills and was well received by students and instructors, the authors also attributed these improvements to rereading and discussion activities. In another undergraduate class, Lin and Lai (2013) introduced social annotation as a formative assessment and feedback mechanism for 164 students. The system developed in the study allowed students to receive feedback from both instructors and a database of peer-generated annotations. When reviewing an error, the student could use existing annotations to rectify misconceptions; in

case no meaningful annotations were provided, the student could seek additional sources to understand the error and share back to the database via annotations. Results showed the experimental group achieved higher scores on both the midterm and final, even though the effect was less substantial on the final. Students benefited from the system when they were willing to spend more time on review and collaborative annotation.

In summary, as a feedback mechanism social annotation may allow students to put more time into review, consult with peers or other resources and achieve better outcomes; but it is also necessary to recognize that feedback should be incorporated with other learning processes (e.g. rereading) to be effective.

Connecting online learning spaces

Web annotation can be used to help learners link learning spaces (e.g. formal and informal) to make learning experiences more integrated and personally meaningful. This use is especially relevant to adult learners and learning professionals who bring professional identities and social networks to a learning experience. For them, Web annotation, together with many tools, creates and sustains learners' connections with people, resources and ideas in the openly networked world.

Reflecting this use of Web annotation, Hollett and Kalir (2017) designed "playgrids" that integrate Web annotation and other social media tools for professional learning. Playgrids are defined "as the creative knitting together of social media tools to effectively participate across space, time, and scale" (Hollett and Kalir, 2017, p. 237). In one case of a Master's level course, 13 adult learners used *Hypothes.is* to support three types of playgrids: annotation across platforms, annotation as blog commentary and annotation flash mobs. In an annotation flash mob, learners used Hypothes.is to create self-organized and improvisational dialogues beyond the course requirements. Following a public invitation on Twitter and blogs, learners gathered at an online location at a particular time to annotate simultaneously. The synchronous annotation activities "spilled over" to other social media spaces like Twitter and reached learners' personal networks beyond the class.

In a case study by Chen (2019), the instructor intentionally decoupled learning from traditional learning management systems to facilitate networked conversations on the Web. In a graduate-level class, the instructor used Hypothes.is to engage students in annotating course readings on a weekly basis. The instructor intentionally orchestrated idea movements across discourse spaces. Hypothes.is annotations were synchronized in the class' group chat environment to allow learners to enter the discourse from multiple places. Findings indicated that students formed dense social ties on both Hypothes.is and found Hypothes.is useful for collaborative sensemaking of challenging readings and community building. However, they found the annotation tool less user-friendly than that group chat tool; some earlier-starter students communicated challenges with the timing of participation as they needed to check back multiple times to read their peers' contributions.

In summary, social annotation does not only provide opportunities to engage with Web materials or inquiry activities, it is also poised to serve as an infrastructure to connect online learning spaces.

Practical recommendations

In this review, we synthesized the research on social annotation in formal classrooms into five areas of application (Table 1). Below, we offer four practical recommendations that are grounded in the review and cut across these five areas.

Articulate pedagogical goals when incorporating social annotation
To begin with, annotation strategies should be designed with specific pedagogical intentions in mind. This review has demonstrated myriad ways to support online teaching and learning with social annotation. To generate desirable learning outcomes, it is important to clearly identify the pedagogical goals and align social annotation activities with these goals. For instance, in one study, social annotation is recommended over the threaded discussion forum as the pedagogical intention is to make "targeted critiques or self-reflections to specific sections of the material" (Sun and Gao, 2017, p. 77). In another study that aimed to promote student argumentation, social annotation was a means to support the process of building arguments from Web sources (Li *et al.*, 2015). Exploring the alignment between one's pedagogical goals with activity designs presented in the previous section would be a good starting point of adopting social annotation.

Select Web annotation tools that are appropriate for the context
Various Web annotation technologies are represented in this review. Some tools are custom-built, with sophisticated functionalities for unique purposes (Chen and Chen, 2014; Eryilmaz *et al.*, 2013). However, there are also studies that adopt tools that are readily available, such as Diigo, Hypothes.is, and even Google Docs. As shown in this review, common features of Web annotation tools include highlighting, tagging, color-coding and filtering. While these features are not available in all Web annotation tools, it is important to remember they are only useful when they serve pedagogical goals. When a custom feature that guides student attention by altering the font size (Eryilmaz *et al.*, 2013) is not available, the instructor could pre-annotate the reading to provide similar attention guidance. In comparison with custom-built Web annotation tools, general-purpose tools like Google Docs have advantages due to their low barriers to entry.

Decide the level of instructor involvement
When it comes to the instructor involvement, more is not always better. The decision should take into consideration the learners' characteristics and the nature of the learning objectives. In most studies, instructors provided tool tutorials to get students started. Other than that, several studies provided additional support only when technical issues or discussion challenges emerged (Chen and Chen, 2014; Chen *et al.*, 2019). When learners have adequate domain understanding and self-regulation skills, a lower level of instructor involvement may provide more flexibility to learners while also reducing the instructor's workload.

In other cases, learner engagement needs to be purposefully scaffolded by providing prompt questions, reading strategies, attention guidance and gamification techniques (Chan and Pow, 2020; Chen *et al.*, 2020; Eryilmaz *et al.*, 2014; Tseng and Yeh, 2018). Instructors can guide learners' attention to challenging concepts by altering the font size or embedding high quality annotations (Eryilmaz *et al.*, 2013; Miller *et al.*, 2016). Dividing the class into smaller groups can generate more unique ideas and efficient communication by avoiding annotation saturation; pairing low- and high-performing students can also enhance discussion quality and interaction (Chen *et al.*, 2019; Miller *et al.*, 2016; Thoms *et al.*, 2017). A deliberately designed involvement plan is important for mitigating challenges while avoiding unnecessary efforts for both the instructors and students.

Develop an evaluation strategy
As demonstrated in several studies, social annotation does not always work and there are emerging challenges. For instance, not all annotation tools were found intuitive to use, as found in a study involving graduate students (Chen, 2019). In another study, undergraduate students

reported difficulty in making distinct annotations, while some peer annotations might even impede their understanding (Thoms and Poole, 2017). Kalir *et al.* (2020) also revealed that undergraduate students perceived divergent social qualities and benefits of social annotation, for instance, some students perceived it as useful for peer interaction but less valuable for the creation of course community. In Chen *et al.* (2020), 5th graders felt being distracted by the competition mechanism in a gamified annotation activity given these challenges, it is important to create a feedback loop and a strategy to evaluate the use of social annotation in a particular context. Such an evaluation strategy could cover a range of areas including learning outcomes, technology usability, inclusivity, and socio-emotional factors.

As Web annotation activities generate digital trace data that provide indicators of learning, one approach worth considering is to derive learning analytics that extracts annotation data to be analyzed for evaluation purposes. For instance, the "Crowd Layers" is a dashboard tool that extracts data from Hypothes.is and reports learner engagement measures to learners and educators (Kalir, 2020). Chen *et al.* (2010) applied text mining algorithms to learner annotation data to assess domain understanding. Social network analysis of annotation data is used by Chen (2019) to examine peer interaction patterns. In some Web annotation tools, log data can be harnessed to evaluate the extent to which pedagogical goals are attained by social annotation.

Conclusions

In the COVID-19 pandemic, we need to forge and sustain connections more than ever. While video conferencing provides one way to connect learners from distance in a synchronous fashion, this review suggests unique affordances Web annotation technologies could provide for online learning to achieve various pedagogical goals. In particular, Web annotation can help processing domain-specific knowledge; supporting argumentation, inquiry and knowledge construction; improving literacy skills; supporting instructor and peer assessment; and connecting online learning spaces. It is our hope that these identified application areas, in combination with four practical recommendations, would provide pragmatic and evidence-based support for educators to engage learners in reading, learning, and connecting.

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271

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