
Critical Thinking in Collaboration: Talk Less, Perceive More

Na Sun

Pennsylvania State University
nzs162@psu.edu

Chien Wen (Tina) Yuan

Pennsylvania State University
tuy11@psu.edu

Mary Beth Rosson

Pennsylvania State University
mrosson@psu.edu

Wu Yu

Pennsylvania State University
yuw132@psu.edu

John M. Carroll

Pennsylvania State University
jmcarroll@psu.edu

Abstract

Collaborative learning technology has been used across disciplines in support of argument development. These technologies allow multiple users to concurrently analyze and edit documents in the same online virtual space, and can offer richer cues for collaboration awareness. However, little is known about how such synchronization mechanisms work together to support small group collaborative argumentation. This exploratory study reports the experiences and reactions of 14 dyads that worked together using Critical Thinker, a web application that allows learners to collaboratively develop structured arguments in a synchronous workspace with collaboration affordances. Our qualitative data shows how the structural juxtaposition provided by the tool can scaffold dialectical construction of arguments, while the synchronization mechanisms can facilitate collaborative learning tasks. We use these findings to inform ongoing design efforts to deploy Critical Thinker as classroom technology. This paper reports how synchronization mechanisms can work together in Critical Thinker, a web application that allows learners to develop structured arguments collaboratively in a synchronous workspace with awareness support.

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H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

Introduction

Learning to argue is critical in constructing and acquiring knowledge [1]. Although argumentation is a foundation skill for a variety of learning activities (e.g., concept understanding, intelligent reasoning, decision-making), it is often overlooked and even considered counter-productive in science education. For educational purposes, argumentation involves collaborating, resolving conflict, and making compromises instead of debating a point to “win”. Educators describe the construction of argument propositions as a dialectical process [4,6]: collaborative argumentation leads to more complex and critical thinking by evoking a social mode of thought [2, 3]. This implies a need to support knowledge co-construction processes while also attending to the social expectations, reactions and even potential tensions among the learners.

It is rare for educational technology designs to address awareness cues in a shared workspace. One approach to synchronization is to use a deadlock mechanism, but this may lead to one partner dominating the discourse [5]. Similarly, use of time-lagged editing access (e.g., the one minute interval in Belvedere [5]) or requiring an extra action (like a “submit” button) may lead to interruption in production flow and missing data [3]. Nevertheless, shared workspaces and instant

communication are not mutually exclusive, but in fact can be positively related and complementary [2]. For example, our Critical Thinker tool supports synchronous collaborative awareness using multiple synching mechanisms, with the goal of minimizing wasted or duplicated effort, and thus encouraging a free-flowing dialectical process.

To support collaborative argumentation with Critical Thinker we investigate simple structuring support for dialectical thinking in combination with several synching mechanisms. We expect that a simple dialectical structure will direct attention to alternative perspectives and argument logistics in a correspondent fashion, and thus promote an argument that is coherent and well founded. Multiple synching mechanisms support a more transparent collaborative environment for negotiating and coordinating argumentation among a team. In this late breaking work paper we report a preliminary investigation of how these features are perceived and used for argument development.

Method

The study evaluated the Critical Thinker tool that was designed to support dialectical constructivist learning. Participants engaged in a simulated learning activity using Critical Thinker, after which they completed a post-study feedback survey. The following sections describe our participants, data collection, study procedure, the software support, and other factors of interest.

Participants

28 undergraduate students (all above 18 years old) from a variety of disciplines, including computer science, engineering, and social science, were recruited

at a university located in the northeastern U.S. The participants received course extra credit as compensation. Their mean age was 19.36 ($SD=3.234$); 24 were males. Participants joined an online session without prior knowledge of their dyad partner.

Tasks and Procedure

As illustrated in Figure 1, we emailed to students to pair and schedule them into dyads for a distributed synchronous session. Instructions about technical requirements (use of the Chrome browser with Google Hangout capability) and a general description of what the session would entail were included in the email. Replies to the emails indicated their confirmation of the arrangement. Participants did not know the details of the task until they began the session.

Each online session consisted of three tasks. First, the researcher (who was also online in the Google Hangout) directed the dyad to spend 15 minutes reading three short articles that covered a controversial issue (the right to be forgotten online). This issue was selected because it is a good example of a possible learning topic within the students' department (an information school). The general goal was to encourage discussion of human rights in the virtual world in contrast to existing policies and IT industry practices. The readings introduced background on the discussion topic and presented multiple perspectives related to it.

After finishing these readings, participants accessed the web-based Critical Thinker to collaboratively develop arguments relating to the proposition that humans have the right to be forgotten online. The dyad partners were randomly assigned to either the pro or con side. Each session lasted for 25 minutes. Unbeknownst to

them, each partner was presented with pre-constructed "confederate" positions; these were presented as if they had been constructed by another dyad who took the opposing side. The dyads were told to create five points with backing evidence (that is, the pro partner responded to confederate con positions and vice versa). The confederate arguments were carefully drafted to be isomorphic in content, provocativeness, and soundness of reasoning so that the participants would experience equivalent levels of challenge in formulating their own arguments.

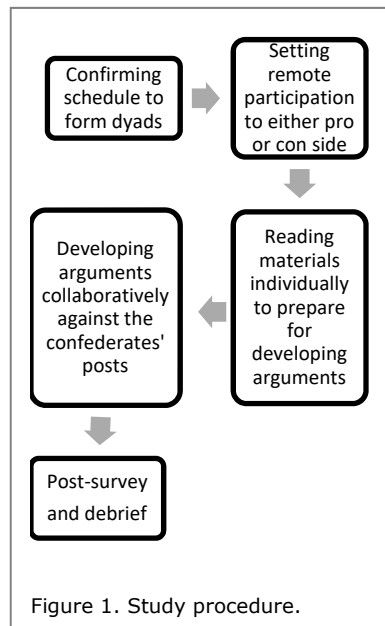
Upon finishing their tasks, participants completed an open-ended survey about their experiences using Critical Thinker. This survey probed users' feedback about task flow, specific features of Critical Thinker, and recommendations for improvement of the tool. Responses were solicited right after their use of the tool in order to minimize the recall bias.

After the session, our research team sent a debriefing email to reveal the fact that the set of arguments they read from the opposing side had been prepared by the research team in advance.

Throughout the user study, one of the researchers took the role of administrator to mediate the remote collaborative process on task clarification, technical assistance, and time management using system chat or Hangout messages.

The collaborative environment: Critical Thinker

A bottom-up approach, informed by earlier classroom experiences that used Piazza [10], was used to consider users' needs in argumentation activities. This resulted in the following design features: a clear user



interface layout that juxtaposes competing arguments, communication channels and awareness support for design features and their functions.

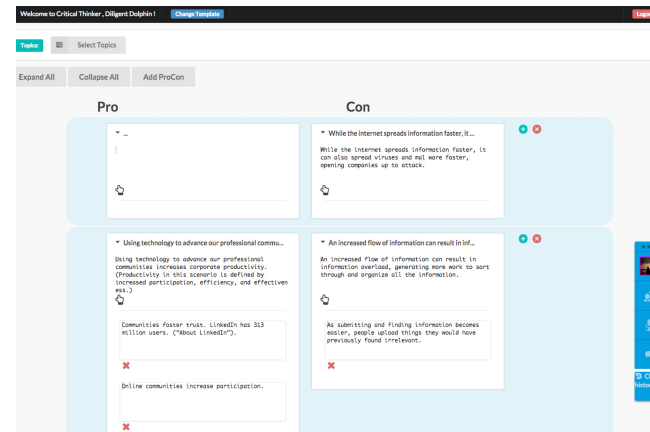
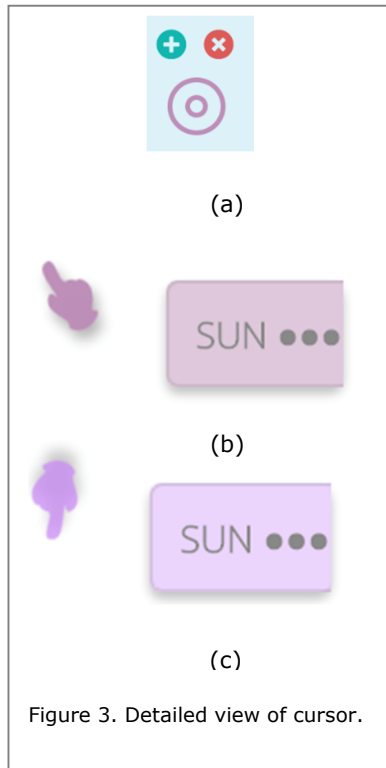


Figure 2. Juxtaposed Pro and Con argumentation structure.

1. Juxtaposed Argumentation Structure

In contrast to the sequential and vertical layout in most argumentation tools that support argument development for learning purposes (e.g. SAM, Piazza [3,7]), Critical Thinker juxtaposes the pro and con arguments in a horizontal layout (see Figure 2). Learners can thus easily see and consider opposing arguments while constructing their own.

2. Synchronous communication and awareness Dialog is supported semi-synchronously during the task via an instant message pop-up window. The resulting conversation is also archived for review during argument construction.

Participants were provided with several collaboration awareness prompts, including synchronized character-by-character text editing, location of the partner's latest cursor movement, and an activity indicator, (whether or not the remote partner is writing or idle) color-coded by person. The cursor feedback includes three cues used to convey the partner's interaction with the system: as shown in Figure 3, (a) two concentric circles on the most recently clicked location after one double click; (b) a hand icon that indicates the current cursor position while the user is typing, or (c) a pointing icon communicating a current cursor position that is below the current screen.

Survey Instrument

Our post-session survey probed reactions to Critical Thinker using open-ended questions from multiple angles, including the structure of argument input, reactions to several specific features (e.g. side chat and awareness support), general ease of learning, overall fit of the system to the activity, and suggestions for improvement. We adapted the instrument from prior research that was also studying dialectical thinking, to gauge design progress [3].

Results

In this preliminary report we focus on the qualitative feedback gathered in the post-task survey. We carried out a thematic analysis of these responses to examine reactions to the design features, particularly the argument structuring and synchronization mechanisms.

Juxtaposed Structure of Argumentations

The juxtaposed structure of pros and cons seemed to help students compare and contrast arguments. Eleven users noted that exposure to the opposing arguments

was useful. “Visually dividing the pros and cons” in a horizontal manner was considered efficient, providing “an easy experience to formulate good ideas.” In addition, participants found that the display was beneficial in assessing the argument in terms of value and coherence, so that more balanced and well-rounded viewpoints could be developed. Meanwhile, the display was also reported to reduce the time spent on grasping the core of an issue and different aspects of it.

My first approach was to just use the information from the articles to form Pros. However, I read the existing Cons and tried to view them in a different perspective to form a Pro. (#17)

Distributed Collaboration through Online Chatting

Most users also commented that chatting helped them develop arguments, especially in terms of formulating and expanding ideas and asking questions. Five participants said that they negotiated with their partners to affirm the appropriate wording, the validity of arguments, or the content of the arguments.

I used the chat to clarify the wording that I had in my mind and asked for opinions to come out with the best claiming. It was a beneficial tool that helped collaborating easier with my team members. (#25, male, sophomore, undecided)

Informal scrutiny of chat messages revealed that most conversations reflected curiosity about a partner or attempts to build social relationships (e.g., jokes, self-disclosure, etc.). Rapport building seemed especially helpful in group cohesion if it happened at later task stages (e.g., synthesis). Off-topic messages early on

seemed to distract partners or make a partner seem less committed and were not appreciated by partners.

Synched Workspace with Awareness support

Critical Thinker allows users to revise each other’s work. Thirteen participants identified co-editing or revising as a salient feature for collaboration. Seven participants pointed out that they used it to convey disagreement in a less intrusive way that would have been experienced in the chat. The capability to revise each other’s text in a synchronous workspace complemented the chat in a way that minimizes possible conflict or tension between collaborators. It also can offer additional task-related information without needing explicit (dialog-based) coordination.

We both revised each other's input, but we did not converse very much via instant message. I feel like this is because we did not know each other, therefore we did not feel comfortable enough criticizing each other's ideas. (#15, female, freshman, undecided major)

The character-by-character synchronicity of text editing makes it possible to construct arguments together at a fine-grained level. However, it was rare for partners to edit the same input box at the same time.

The aforesaid phenomenon contradicted with our design intention in response to users’ frustration with losing their editing efforts due to the asynchronous collaborative argument editing of a previous study [3]. However, such confusion was enlightened as other design features were considered. As seven participants pointed out, additional contextual cues, such as cursor updates, enable each group member to be aware of their partner’s local context and activities. The

knowledge about what others are working with at the moment suggests what action was needed so that redundant work can be avoided. Knowing what has been done enables users to coordinate on resources and to fully take advantage of each other's intellectual efforts towards the shared objective of task completion.

I made use of my group member's cursor so I could see which topic he was working on and I could work on a different one. (#23)

Social presence is indicated through a color-coded dot (green is used to show being online and active) on the right pane of the screen, as well as keyboard input status showing when a partner is engaged in writing. Our participants said that these indicators reassured them about collaboration engagement.

Discussion

Our analysis of users' feedback reinforced the design rationale for Critical Thinker regarding its juxtaposed structure and a synchronized argumentation workspace. First, users' comments substantiated our design goal of promoting dialectical argumentative discourse via the horizontally aligned proposition structure. Our participants appreciated the structure because it facilitated their sensemaking process about the subject matter in a short time frame, and also helped their arguments to be more coherent and well-grounded with respect to the opposing views presented on the other side of the screen.

Second, our study demonstrated how a synchronized collaborative space could be supported through both chatting and awareness cues. Although synchronized text editing (in the same input field) was possible in

Critical Thinker, the participants did not use it much. Previous studies report that users experience frustration about lost content when two users are simultaneously editing the same text [3]. Although Critical Thinker supports synchronized editing, our participants may have deliberately avoided conflicts in simultaneous editing thanks to another feature: the transparency of the workspace. A user can infer what the partner is working on based on the awareness prompts; this seems to promote efficiency in collaborative tasks. In addition, the rich set of group awareness support, ranging from cursor updates, typing status, and users' online presence, fulfilled users' needs to streamline and stay informed regarding team and individual work processes.

Future work

In addition to examining our design rationale for Critical Thinker, the current user study revealed some interesting socio-technological phenomena. For instance, awareness features in a collaborative argumentation tool affect communication and coordination in the process of constructing arguments. The unobtrusive editing of others' work obviated direct negotiation and questioning, which might slow the development of social relationships or lower the argument quality. Therefore, future designs for collaborative learning might distinguish the editing efforts by individuals so that misunderstanding can be identified and disagreement can be resolved. Further, the synchronicity of the co-editing capacity seems to be moderated by the awareness support provided by Critical Thinker; this may lead to labor division in terms of strategy instead of lower-granularity collaboration. Therefore, future investigation is needed for understanding the ways in which synching mechanisms

interact, and their corresponding impacts on cognitive artifacts and social relationships.

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