DESIGN FOR SUPPORTING DIALECTICAL CONSTRUCTIVIST LEARNING ACTIVITIES

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Abstract

Dialectical constructivism considers that the source of knowledge comes from constant and complex interactions between the evolving individual and the developing environment (Moshman, 1982). Dialectical constructivism informs dialectical learning pedagogy, where students constantly interact with each other in developing and refining arguments over an issue from multiple perspectives. With the advancement of the Internet, it is possible to design dialectical learning activities with technologies that can be seamlessly integrated into curriculum and facilitate learning. In this paper, we designed a prototype of a dialectical learning system, CriticalThinker, that engages students with dialectical constructivist activities, with technology affordances such as anchoring the group discussion on top of screen to serve as a reference for following discussions, displaying multiple arguments in one screen, and visualizing relationships among the arguments as a structured way for students to argue with each other. We also presented the application scenarios of the system in order to concretize the features and the affordances of CriticalThinker.

Keywords: dialectical learning, design-based research, scenario-based design

1 BACKGROUND

Dialectical learning has existed for thousands of years, in which the development of dialectic is considered as the source of knowledge (. Historically, dialectics were used among a group of people holding different perspectives over an issue to reach consensus and to develop the truth of matter (Plato, 1987). Modern educational researchers and practitioners also consider the development of dialectics among students to be an effective way of engaging students to learn with and from their peers (O'Donnell, 2012).

Modern dialectical learning pedagogy is derived from dialectical constructivism, which is a thread of constructivists' worldview of how knowledge is acquired (Moshman, 1982). Dialectical constructivists believe that only by constant interacting with the environment/context of where learning happens can one obtain knowledge (Moshman, 1982). This perspective informs the following principles for organizing dialectical learning activities: 1) knowledge is actively constructed by learners themselves, rather than passed along by instructors; 2) the active interactions among students are important; 3) learning requires a suitable context and environment (Fosnot 1996; Harris & Graham, 1994).

To illustrate this, consider a fictional example of dialectical learning of a debate over the issues brought by "Big Data" – does big data bring good or evil? One group of students could enumerate the benefits that come long with big data, such as how big data can facilitate understanding users' needs precisely in order for service providers to be able to offer users what they want exactly, and how big data can help intelligent agency to detect potential terrorist attach. Another student group could then respond with counter arguments accordingly, such as how big data also produces privacy concerns, in which users do not know who might be surveilling their private activities in online space. Other such pro and con points could be expressed and discussed among peer students. In this way, students could develop their own understanding over an issue and be exposed to multiple perspectives, which enriches their understanding of the context and enhances their ability to consider an issue from varying aspects.

Educational technologies have been investigated in a plethora of contexts and reported to be effective in various ways in helping learning. Oliver and Omari (1999) found that applying online technologies for problem-based learning facilitates students' engagement in learning and provides positive learning outcomes. Du and colleagues (2009, 2012) designed and investigated backchannel in classroom settings and found that the technology influences the feeling of sociality within the classroom. Some researchers have explored possible technologies to support a learning pedagogy that is similar to

dialectical learning (Graesser et al., 2005). However, such studies did not emphasize the interaction or collaborations among students for knowledge construction. To our knowledge, the technologies that support dialectical constructivist learning and their effectiveness have rarely been addressed by previous work.

Learning is an extremely complicated process. Researches that isolate variables and are carried out in lab experiment is detached from the real context that learning happens, which are likely to lead to an incomplete understanding how learning really happens (Brown, 1992). Learning scientists are becoming more engaged in developing contexts, frameworks, tools, and pedagogies in naturalistic settings in order to develop theories or discover ontological innovation of learning (diSessa and Cobb, 2004). In such contexts, researchers not only observe how learning is taking place, but also are actively involved in engineering the context systematically in a way that allows us to improve and generate evidence-based claims about learning (Barab and Squire, 2004). Such kind of research methodologies is recognized as design-based research (Brown, 1992; Collins, 1992; Collins et al., 2004).

Design-based research is considered as a series of approaches, with the purposes of development learning theories, artifacts, and practices that influence the naturalistic learning environment (Barab and Squire, 2004). The design of artifact is part of the research process. Also, the intervention natural of design-based research suggests that this kind of research is suitable for design of tools. For instances, Carroll et al. (1990) apply the minimalist principle to envision and design a software tool – View Matcher – to help programmers learn Smalltalk programming languages. Also, Carroll and colleagues (2012) illustrated a prototype of a learning technology, ClassConversations, and discussed how its technology affordances support learning activities and influence learning outcomes. Such designs can serve as the intervention for following studies, which align with design-based research.

In this paper, we will discuss the dialectical learning pedagogy and provide a design of software tool as a learning environment that supports the on-going conversation among students as the initial step of design-based research. Specifically, we will address the features and the affordances of the system that support the pedagogy. It serves as a starting point for our inquiry into developing practical pedagogy of dialectical learning and software tool that supports such learning activities.

2 THE DIALECTICAL LEARNING PEDAGOGY

The dialectical constructivist theory believes that teaching should offer learners conductive and specific practices so that they can structure their own questions, and build their own models and problem-solving strategies (Harris and Graham, 1994). The classroom should be organized as a societal microcosm promoting learners to be collaboratively involved in classroom activities, topic disquisitions, and learning reflections. Insomuch as every learner constructs knowledge differently, instructors should recognize that students might view curricula, course materials, and pedagogic props differently than themselves. Likewise, teachers should not intend to make knowledge transmission directly (Glasersfeld, 1995), but pay attention to how individual learners recognize the process of learning and how they justify their perspectives (McLeod, 2003).

Richardson (2003) suggests that teachers can afford rich opportunities for group dialogue heading for establishing shared understanding of the theme under study and fostering an environment that encourages learners to assess, modify, and even challenge their existing understandings and beliefs via stimulating instructional tasks, loosely structured instructions with the use of technological tools such as web sites. Fosnot (1996) also suggests "… *dialogue within a community engenders further thinking. The classroom should be a community of discourse engaged in activity, reflection, and conversation. Learners (rather than teachers) are responsible for defending, proving, justifying, and communicating their ideas to the classroom community*" (p.29), which illustrates the importance of the conversation among students for knowledge building.

Dialectical constructivist learning theory informs us that the pedagogy of dialectical learning should include the constant interaction between students and the environment, which consists of the course materials, peer students, and the instructor. Although, debate and critical thinking are employed in many classroom pedagogies, rarely are they considered as an end-to-end, integrative pedagogy. Taking dialectic more seriously can help to expose new pedagogical possibilities as well as clarifying requirements and possibilities for learning technology that promotes and supports dialectical constructivist approaches.

The above review entails that dialectical learning pedagogy requires students' active engagement and constant interaction with others. We consider that the collaborative analysis and construction of critical arguments, and a structured discussion and debate among student body will facilitate dialectical learning, which will be the major purpose of our design in the following sections.

3 DESIGN OF CRITICALTHINKER

No prior work has been found in designing and implementing a generic system to support dialectical learning activities. We intend to enable the on-going debate over an issue among students from multiple perspectives. We want students to construct arguments by themselves (constructivism), and constantly interact with other peers (dialectical constructivism). The CriticalThinker presented in this section is our design of the software tool that supports dialectical learning activities.

CriticalThinker is targeted at undergraduate level or graduate level course, where the educational goal is to facilitate dialectical reasoning skills, which is the ability of exploration of competing logics or points of view (Parker et al., 1989; Saye & Brush, 2002). The contents of the course should be structured as a series of issues and topic that can be addressed through discussion among students body. The learning outcome of the course should not be fixed technical skills, such as solving math equations and programming, but rather the ability to come up with generic opinion over an issue, and be able to defend it with reasons. In this section, we are going to describe the interfaces and technology affordances of CriticalThinker, and illustrate how it supports dialectical learning activities, specifically, the pro and con debate, and the synthesis process.

3.1 The Interfaces and Technology Affordances

The classic dialectic dialogue includes a process of thesis-antithesis and synthesis. The major part of CriticalThinker contains Pro and Con debate phase, and a Synthesis phase, which mimic the thesis-antithesis and synthesis structure (Figure 1, 3). In Pro and Con phase, students enumerate the pro side of an issue, and respond with counter arguments (con side). The Synthesis phase was the process to reconcile the conflicts that generate from the thesis-antithesis debate with new thesis (Fox, 2005). In CriticalThinker, the Pro and Con view is designed to engage students' debate and conversation with each other, and the Synthesis view is to help them summarize what they have learned from the discussion and understand the issue better.

Figures 1,2,3 are the design of CriticalThinker. Figure 1 and 3 show the main interface of the system. The column on the left lists the topics of the course. Each topic includes a separated dialectical discussion space on the right. The discussion space contains four parts, which are Pro, Con (Figure 1), Synthesis (Figure 3), and Instructor's Comments (Figure 1 & 3). The group Pro and Group Con are anchored on top of the discussion space, which serves as the basis for dialectical discussion. If a pair of a Pro and Con are related to each other, for example, the Con is the response to the Pro, there will be a visible double-headed arrow links them together (Figure 1). The right arrow on the right in Figure 1 and the left arrow on the left in Figure 3 are used to switch between Pros & Cons view, and Synthesis view. In Synthesis view (Figure 2), system will automatically generate the synopses of all pros and cons on top of the page of the topic, and present the synthesis box below. The Instructor's Comments box in both Figure 1 and Figure 3 are for instructors to add comments and further perspectives in order to provide guidance and suggestions for the debate to move on.

Naturally, each Pro and Con box only displays the central claim of the argument, hiding all backing statements. The "+Backing" button at the bottom of each box is designed to show the details of each argument. The design of displaying the details for each Pro and Con box are presented in Figure 2. After clicking the "+Backing" button, the box will be expanded to present all the backing arguments that support the central claim. The "+Backing" button will then turn into "–" button, clicking which will collapse the expanded view. Also, after clicking "+Backing", one can submit new backing arguments to the proposition by adding text in the box at the bottom and click "Submit".

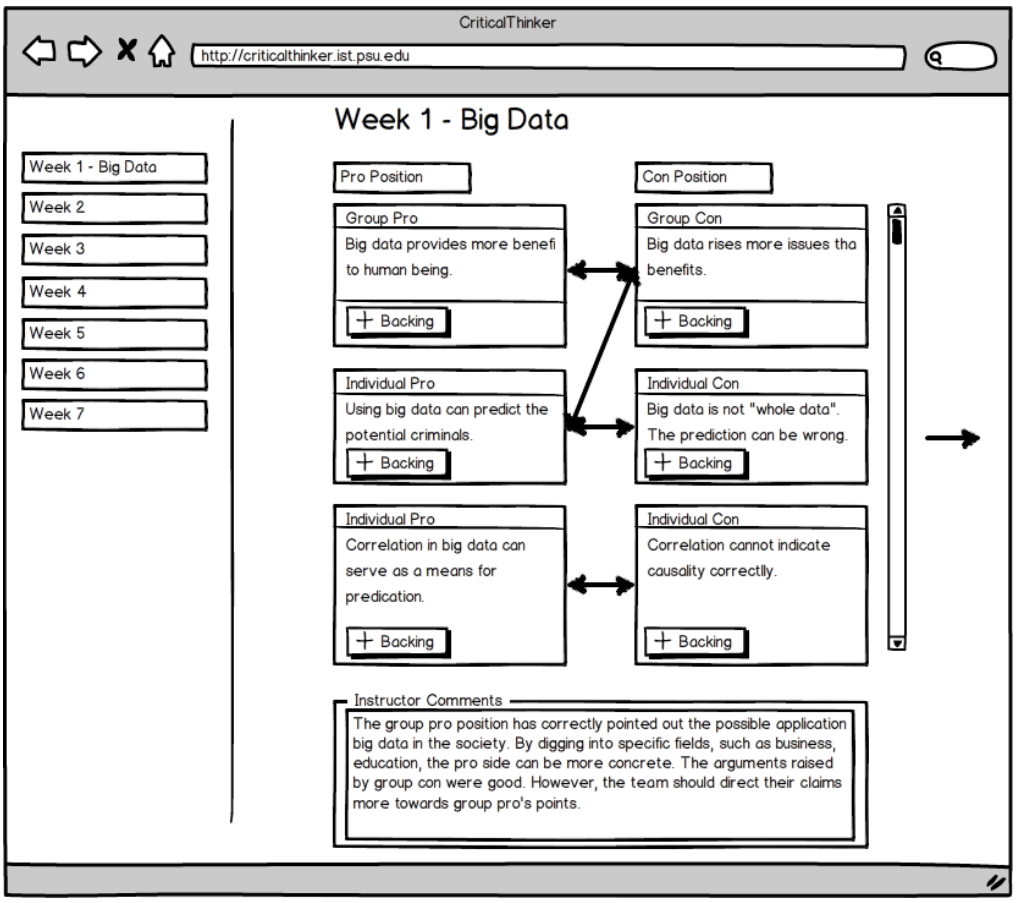

Figure 1: Pro and Con View

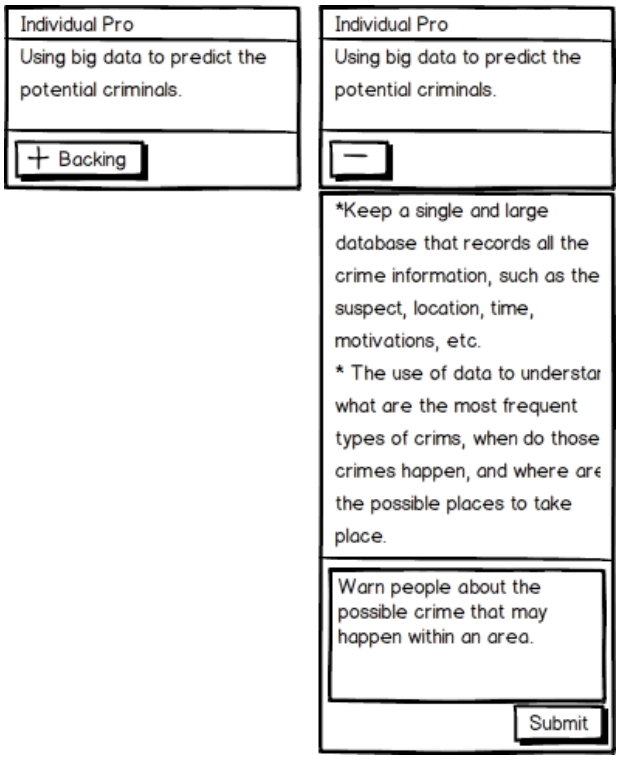

Figure 2: Backing arguments

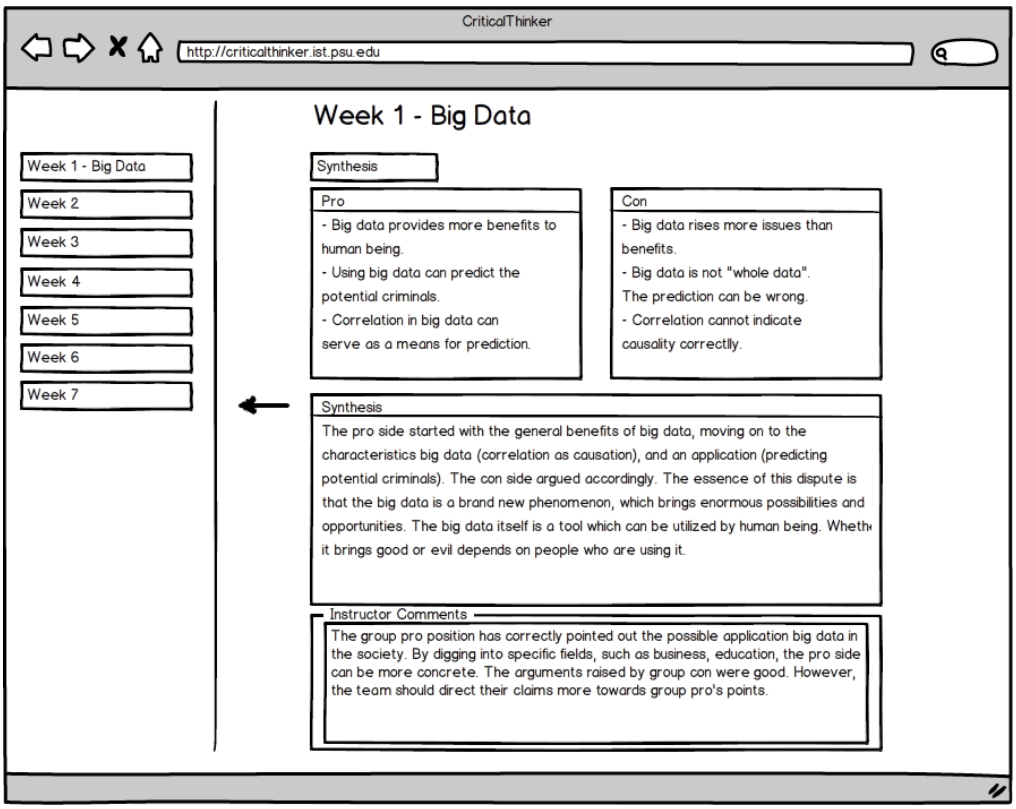

Figure 3: Synthesis View

3.2 Rationale for the design of Pro and Con debate

One of the essential ideas of our dialectical pedagogy is to facilitate the debate and discussion among students over an issue from multiple perspectives. Specifically, we structured the discussion into Pro and Con debate, allowing students to argue for the pro side of the issue and present counter arguments, which is the the con side of the issue. Figure 1 and Figure 2 show how pro and con arguments are structured and displayed in CriticalThinker. Specifically, there is a pair of group Pro and Con anchored on top of the screen (Figure 1). The group Pro and Con in CriticalThinker serves the following purposes:

1) It is a collaborative construction of arguments from student teams. As noted by Richardson (2003), the group dialogue facilitates the establishing of shared understanding, and fosters an environment that encourages learners to reflect on their stance, and challenge their own beliefs. The group Pro and Con are constructed by two groups of students, with their collective efforts on analysis, critique, and synthesis of information, which encourages the interactions among learners.

2) It serves as a starting point for discussion. The discussion and debate over an issue needs to start from somewhere, and the collective effort on the group Pro and Con creates opportunities for students to build shared understanding over the issue initially, which allows individual students responses and further arguments.

3) It can be used as a reference for the following discussion. When students compose individual Pro and Con, they can refer back to the group Pro and Con instantly because the group Pro and Con pair is anchored on top.

Noted that we deliberately hide the detailed arguments for each claim. Although helping students to be able to develop high quality and well-structured arguments is part of the goal of CriticalThinker, the main reason of CriticalThinker is to facilitate the intellectual conversation among students, where they build ideas upon each other. By displaying only the central claims while hiding the detailed arguments, the students will have a better sense of how the ideas flow from one to another, and can focus on construct their own claims in order to respond to others. In this way, the detailed arguments of each

claim become redundant information for students to generate and compare ideas. In this sense, hiding detailed arguments for each claim also reduces extraneous cognitive load (Sweller, 1994) in engaging students with the conversation of ideas. If students want to know about how a claim is supported or add banking arguments, they can simply click "+Backing" button, which expands the hidden arguments.

Also, CriticalThinker provides visual connection between Pro and Con pairs. As shown in Figure 1, Pro and Con pairs are linked by double-headed arrows. Group Pro and Con is naturally connected. When students post an individual Pro or Con claim, they can choose whether it is a standalone claim or it is a response to another claim. Therefore, on either Pro or Con side of Figure 1, CriticalThinker allows claims that are not connected to others, because when some claims are initially posted, they are the starting point of the following debate. Also, claims are allowed to connect with more than one counter part. For example, in Figure 1, the group Con is connected with both the group Pro and an individual Pro. After group Con responded to the group Pro, someone responded the group Con as a counter argument. And then another student responded to the individual Pro using an individual Con. In this way, the debate can be kept ongoing among students, and the structure of the debate is made clear by the visualization of the links using double-headed arrows.

3.3 Rationale for the design of Synthesis

After the structured inquiry over an issue with pros and cons, an integrating synthesis of the discussion will help students understand deeper of both Pro and Con position, and transcend the discussion into the next phase. In the Synthesis View, the central claims from both Pro and Con are automatically generated and listed in Pro and Con boxes. When students are composing synthesis, they are presented with all the central ideas and arguments of the issue with instructor's comments down below, which help understand the flow of the discussion and provide raw materials for synthesis.

When students are finished with the Pro and Con debate, and want to move on to the Synthesis phase, they can simply click the right arrow ("->", Figure 1) to open the Synthesis view (Figure 3). And the left arrow in Synthesis view (Figure 3) brings them back to the Pro and Con view.

4 APPLICATION SCENARIOS

In the previous section, we presented the detailed design of CriticalThinker. In order to demonstrate how the design supports dialectical learning activities, we adopt scenario-based design method to develop application scenarios. Scenario-based design (SBD) is a family of techniques in which the use of a future system is concretely described at an early point in the development process (Rosson and Carroll, 2009). As CriticalThinker is a prototype for a future system that supports dialectical learning pedagogy, SBD can be a powerful tool to understand its application scenarios.

Scenario-Based Design has two major advantages (Rosson and Carroll, 2009). First, the description of people using technology are essential in discussing and analyzing how the technology is (or could be) used to shape their activities. Second, scenario descriptions can be created before a system is built and its impact felt (Rosson and Carroll, 2002). SBD has three important features: concrete but rough, oriented to people and their needs, raising questions at many levels. A design produced by SBD is a user interaction scenario, which reconcile concreteness and flexibility. It usually specifies a possible design by indicating the tasks user may carry out, so that designer can evaluate and refine. But it is also rough that it can be easily altered and many details can be deferred (Rosson and Carroll, 2009). Scenarios describe systems in terms of the work that users will try to do when they use the systems, ensuring that design will remain focused on the needs and concerns of users (Rosson and Carroll, 2009). Also, scenarios of use are multifarious design objects: they can describe design at multiple levels of details and with respect to multiple perspectives. They can help designers reflect on several aspects of a problem situation simultaneously (Rosson and Carroll, 2009).

We are going to present three related application scenarios that happen in an undergraduate seminar course to concretize how the design of CriticalThinker affords the dialectical learning pedagogy.

4.1 Scenario 1: Group Pro

Ben is a freshman, who enrolled in an undergraduate seminar course that addresses the popular issues and topics that happen in the field of Information Sciences and Technology. The first week of the class discusses "Big Data", specifically, what big data brings to the society and how it may

changes people's life. Ben is assigned in a four-member team, who is responsible for creating one claim about the Pro side of Big Data before the classroom discussion. Ben and his teammates have never thought about the impact of big data on the society. So they agree to first find and read materials separately and meet before class to compose the claim and supporting arguments. Ben and teammates read the required course materials, and find many other news articles, research papers, and blog posts that discuss what big data is and how it is going to change everyday life. At the group meeting, after an intense discussion, Ben and his teammates agree that although big data can create problems, such as the violation of privacy of people's online behavior, it indeed has the potentials to bring more benefits to human beings, such as the precise understanding and prediction of human behavior, and variety of applications that derived from big data – big data analytics for example. After Ben's team reached an agreement, they post their central claim "Big Data provides more benefits to human being" with several supporting arguments in the group Pro box of CriticalThinker (Figure 1).

4.2 Scenario 2: Con – Responding to a Pro/Adding backing

Amy is Ben's classmate of the same course. The weekly topic is about Big Data, and she is assigned as neither Pro position nor Con position this week. Class discussion will take place tomorrow. She has read several materials about this topic already and she wants to see what opinions her classmates hold on this issue. So she opens CrticalThinker, select "Week 1 – Big Data", and finds out that her peers have already posted the proup Pro and Con and an individual Pro, which is "Using big data can predict potential criminals" (Figure 1). Although Amy understand the power of big data, which can be applied in predicting many things, such as user's preferences over some commodities, the trending topics on a social networking site, etc., she does not feel comfortable that big data can be applied in predicting criminals. After mediating for a while, she comes up with the following argument: although big data is large, it is not comprehensive, and even with the most advanced algorithm, the prediction generated from big data can be wrong; and the false result can be devastating to people who are predicted as criminals. She then responds on CriticalThinker as an individual Con to the individual Pro, with her claim of "Big data is not whole data, and the prediction can be wrong" and the supporting arguments (Figure 1, 2). Also, she links her claim with the individual Pro with the double-headed arrow to make it clear of which statements she has responded to.

4.3 Scenario 3: Synthesis

John, a classmate of both Ben and Amy, is assigned in the team who is responsible for creating the synthesis for the discussion of Week 1 – big data. All the creating of group Pro and Con and individual Pro and Con are happened before classroom discussion, and because of this, the discussion in class is rich and passionate: everybody has their own opinions and is able to defend themselves, and meanwhile the class is exposed to a lot of ideas and arguments. John feels like that he has learned a lot from the discussion both on CriticalThinker and inside classroom. Now he is sitting together with his teammates to discuss how to synthesize the discussion into succinct argument, which summarizes the big data debate and moves the discussion forward. After clicking the "->" arrow in Pro and Con view, CriticalThinker opens the Synthesis View, which automatically generates the essential claims from both Pro and Con, with instructor's comments of the debate. John and his teammates find the synopsis of the pro and con debate very useful because they are currently very familiar with the arguments, and they just need those bulletin points of claims to remind them what the central tenet of the issue is. After a conversation among the team members, John and his teammates consider that the conflicts of the dispute over Big Data are because it is a new phenomenon, which has enormous potentials and possibilities. It can be used in either good way or evil way depending on who and how people use it. Therefore, John and his team post their synthesis of the discussion on CriticalThinker. The next day, when Amy is preparing the materials for Week 2, she sees the synthesis from John's team and agrees with them. She is then considering about what can we do to make people utilize the bright side and restrict the dark side of big data!

4.4 Discussion

In this section, we presented three related application scenarios of CriticalThinker in implementing the dialectical learning activities. The scenarios covered most of the features and technology affordances of CriticalThinker, which can serve as concrete example of the potential application of the tool in supporting dialectical learning activities. Also, the scenarios presented are rough enough that any designer who wants to implement the CriticalThinker in a practical environment can alter both the tool and the pedagogy to fit their needs. And all three scenarios are oriented in addressing the essential

needs, which is a technology tool that supports dialectical learning activities. The scenarios are focused in the alignment of both tool and the pedagogy, which take learners' learning activity as the central concern. Moreover, the design of CriticalThinker considers the perspectives of learners, instructional designer, lecturer, and system designer. The scenarios presented in this section provide a concrete context for designers to reflect on each stakeholder from a big picture.

5 CONCLUSION

Dialectical learning is a promising pedagogy that allows student to collaboratively analyze, criticize, and synthesize information from multiple perspectives. However, neither researchers nor practitioners have addressed the design and implementation of the tools that support such pedagogy. As design-based research is becoming a popular research methodology in the field of educational technologies (Anderson and Shattuck, 2012), we illustrated a design and provided rationale of a tool – CriticalThinker – that supports dialectical learning activities as the initial step of design-based research. We presented the prototype of CriticalThinker with its features and interfaces (Figure 1,2,3), and discussed its technology affordances. We also presented three application scenarios of CriticalThinker in order to concretize how the tool supports dialectical pedagogy and provide guideline for implementation of both the tool and dialectical learning activities.

For future research, we would like to implement the design of CriticalThinker and apply it in real educational environment, and then evaluate both the effectiveness of the tool and the learning outcome.

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