An Online Inquiry Tool to Support the Exploration of Controversial Issues on the Internet

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Abstract

This paper describes a theoretically informed Online Inquiry Tool designed to support the exploration of controversial issues on the Internet. The tool's design is grounded in principles associated with theories of online research and comprehension, argumentation for learning, representational guidance, and cognitive load. The purpose of the tool is to help students organize, monitor, and regulate several complex cognitive activities likely to present challenges during online inquiry. Supports are embedded into the digital tool to help students plan their information search around a controversial issue, identify supporting arguments and counterarguments related to this issue, critically evaluate and synthesize information from multiple sources, and use a filled in representation of what they learned to organize and compose a cohesive essay.

Keywords: online inquiry, Internet, argumentation, representational guidance

Introduction

In contemporary society, learning from Web-based resources is a common classroom practice. Research suggests learning from online information requires students to locate, evaluate, compare, contrast, and integrate ideas from multiple sources (Leu, Kinzer, Coiro, Castek, & Henry, 2013; Rouet, 2006). When asked to explore online information involving complicated issues in society, mature learners also consider ideas from multiple perspectives and identify how different viewpoints are supported and opposed (Barzilai & Zohar, 2012). Unfortunately, many adolescents engage with online sources in a superficial and uncritical manner (Walraven, Brand-Gruwell, & Boshuizen, 2008) and they are unable to understand how to take full advantage of different points of view in order to learn and think more deeply about issues (Kirschner & van Merriënboer, 2013).

To prepare students for learning with information they encounter in complex online spaces, it is essential that we begin to design both digital and instructional supports. To date, there have been very few efforts in this area. Some researchers have created digital supports to scaffold students' ability to plan, regulate, and reflect as part of online inquiry (e.g., Stadtler & Bromme, 2008; Zhang & Quintana, 2012). Further, researchers in the field of argumentation have developed and tested representational tools to support students' collaborative argumentation skills (Marttunen & Laurinen, 2007; Munneke, van Amelsvoort, & Andriessen, 2003; Suthers, Weiner, Connelly & Paolucci, 1995). However, to our knowledge, no online digital scaffolds explicitly take into account the combined demands of exploring arguments while reading to learn in open Internet spaces. In this article, we introduce a newly developed Online Inquiry Tool and describe features explicitly designed to help students navigate the challenges of reading, thinking

deeply about, and synthesizing arguments across multiple and disparate sources while exploring controversial issues on the Internet.

Theoretical Underpinnings

The design of the Online Inquiry Tool is based on four theoretical underpinnings. First, we drew from a new literacies perspective of online research and comprehension (Leu, Kinzer, Coiro, & Cammack, 2004; Leu et al., 2013). This perspective frames online reading as a problem-based inquiry process that involves at least five complex practices: generating important questions, locating information, evaluating information critically, synthesizing information, and reading and writing to communicate learned information. Accordingly, these practices require new literacy skills and strategies over and above those required when reading and learning from printed books (Coiro, 2011). Elements in the Online Inquiry Tool are designed to guide students as they engage with these challenging online research and comprehension practices.

A second theoretical framing of our work assumes the critical role that argumentation plays in students' deep-level understanding of content and learning (Nussbaum, 2008). Argumentation refers to transactive reasoning aimed at investigating and evaluating evidence and alternative arguments (Kruger, 1993). Transactive reasoning involves the questioning, clarification, explanation, justification, and elaboration of ideas (Kruger, 1993; Munneke et al., 2003). Argumentation is particularly important when students explore open-ended questions with many alternative solutions and views of different stakeholders (Marttunen & Laurinen, 2006).

Because the Internet contains vast amounts of information with varying quality and purposes, the need for strong argumentation skills when reading online is even more pronounced. When using the Internet to explore a controversial issue (i.e., an issue about which there is more

than one set of beliefs), students need to carefully consider different perspectives, identify arguments, and critically evaluate the quality of writers' argumentation. Further, learners need to consider not only supporting arguments and counterarguments but also how to integrate them into an overall final position (Nussbaum, 2007). Consequently, a theoretical lens of argumentation for learning was used to frame elements within the representational tool, including prompts to guide students as they explore issues from multiple perspectives, search for relevant supporting arguments and counterarguments, and integrate these supporting and competing views to present their own informed opinion.

A third theoretical underpinning is Suthers' (2003) theory of representational guidance. Elements of a representational tool, or representational notations as described by Suthers, demonstrate a particular guidance toward practices considered beneficial for learning. Representational tools may provide elements that help learners construct, examine, and manipulate external representations of knowledge. Graphical representational tools may also help learners frame their conception of the task, make more explicit their relations between arguments (Suthers, 2001), and monitor their progress in the task (Veerman, Andriessen, & Kanselaar, 2002). Moreover, representational tools can mediate collaborative interaction by providing opportunities for learners to represent their emerging joint knowledge.

For the most part, representational tools used in previous research (e.g. Cho & Jonassen, 2002; Salminen, Marttunen, & Laurinen, 2010; Scheuer, Loll, Pinkwart, & McLaren, 2010; Scheuer, McLaren, Weinberger, & Niebuhr, 2014) are not specifically designed to support reading, analysis, and synthesis of argumentative online sources. In addition, they lack scaffolds to help learners critically evaluate the reliability of online sources or monitor their use of online sources needed to complete complex inquiry tasks (Leu et al., 2013). With this in mind, the

current tool was designed to support these central practices as students engage in online inquiry around controversial issues.

The fourth theory informing the design of the tool is cognitive load theory. Because all learners have a limit to their cognitive capacity, instructional design should optimize the load that directly contributes to learning (i.e., germane load), and minimize the load that is not necessary for learning (i.e., extraneous load) (Kester, Paas, & van Merriënboer, 2010). Online inquiry in argumentative contexts already imposes a heavy cognitive load on learners as they are expected to negotiate and organize multiple complex cognitive processes (Brand-Gruwel, Wopereis, & Vermetten, 2005; Coiro & Dobler, 2007). As a result, the tool's interface has been kept as simple as possible in order to minimize any extraneous cognitive load. The inquiry tool is specifically designed to optimize germane load, or the effort associated with processing new schema to construct a cohesive synthesis (Chipperfield, 2006). In essence, the Online Inquiry Tool provides learners with a carefully sequenced but flexible set of opportunities to monitor and control their cognitive steps toward deeper knowledge construction. This knowledge construction could be prompted by a number of different reading and thinking tasks. Here, we focus on how features in the tool could be combined with the exploration of controversial issues to support challenging elements of online inquiry and argumentation.

Previous Research on Online Inquiry and Argumentation Skills

Previous research has shown that students at a range of grade levels have difficulty with several aspects of online inquiry. On the Internet, students often quickly flutter from one piece of information to another without a proper plan (Kirschner & van Merriënboer, 2013). Some students struggle with locating relevant information online because they lack skills for using proper search terms (Guinee, Eagleton & Hall, 2003) or for how to revise their search strategies

when they encounter a problem (Kiili, Laurinen, & Marttunen, 2009). Students also struggle with critically evaluating the quality of information in online sources (Coiro, Coscarelli, Maykel, & Forzani, 2015; Kiili, Laurinen, & Marttunen, 2008; Walraven et al., 2008). However, Britt & Anglinskas (2002) report some evidence that even minor supports may improve students' critical evaluation skills. Others have found that students may possess the skills to evaluate information but they do not necessarily apply these skills without prompting (Walraven, Brand-Gruwel, & Boshuizen, 2009). In addition, it appears that integrating ideas from multiple web sources during online inquiry is difficult for readers (Goldman, Braasch, Wiley, Graesser, & Bridowinska, 2012).

Furthermore, both secondary school students and university students struggle with different aspects of argumentation. Many have difficulties identifying arguments and analyzing even single argumentative texts (Larson, Britt, & Larson, 2004) or critically evaluating arguments (Brem, Russell, & Weems, 2001; Larson, Britt, & Kurby, 2009). One of the major weaknesses in both oral and written argumentation is the lack of counter-argumentation (Knudson, 1992; Koschman, 2003; Leitão, 2003). There is a tendency to support one's own position with little consideration of opposing points of view (Nussbaum, Kardash, & Graham, 2005). Scaffolding systems embedded into instruction and digital tools have been found to help students develop a more balanced argumentation discourse that considers both supporting arguments and counterarguments (Newell, Beach, Smith, & VanDerHeide, 2011; Nussbaum et al., 2005).

Online Inquiry Tool

The representational tool, called the Online Inquiry Tool, is presented in Figure 1. Next, we describe how the tool is designed to support at least nine complex cognitive online reading

processes (see also Table 1) as students explore controversial issues on the Internet. For our purposes, a controversial issue is one about which "there is more than one set of firmly held beliefs" (CDIP Project, n.d., p. 2). Notably, in the context of an increasingly diverse student body and disparate collections of online texts, almost any issue has the possibility of being controversial. An example of a controversial issue for older adolescents might revolve around whether the use of social media increases or decreases one's quality of life while for younger middle school students, the issue might examine whether or not energy drinks should be sold in the school cafeteria. Specific prompts and visual spaces within the digital tool interface are designed to encourage learners to grapple with new ideas, understand opposing views, and articulate their own beliefs as part of their online inquiry.

Figure 1: Screenshot of Online Inquiry Tool with embedded supports

Note. *Numbers 1-9 correspond to the nine embedded supports outlined in Table 1*

Supports for Planning Information Search

As students begin their web-based exploration of a controversial issue, they are offered a "Palette of Perspectives" to help them initially ponder the kinds of perspectives from which they could approach the issue at hand. When the link is selected (see the upper left corner of Figure 1), the pop-up palette (see Figure 2) highlights possible points of view to guide students' thinking toward suitable perspectives for their topic. This additional support was added to the tool when we noticed it was difficult for adolescents to think of possible perspectives around an issue without any help (Coiro, Kiili, Hämäläinen, Cedillo, Naylor, O'Connell, & Quinn, 2014). Once students choose a perspective to start with, they type it into the perspective box and formulate questions that help concretely connect that perspective to the issue at hand. Learners can then use these questions to guide choices of proper terms for their search queries. As they progress in their inquiry, students can click the green "add perspective" bar to add new perspective rows into their graph to represent their deepening understanding of the issue. However, the tool is designed to help students concentrate on one perspective at a time and thus, provide a proper structure within which to deepen their understanding.

Palette of Perspectives

educational
political
judicial
ideological
cultural
global
social   ethical
environmental
multicultural
psychological
financial   medical
professional
historical   religious
equality   artistic
international   individual
educational policy

Figure 2: Supports to help students identify perspectives suitable for considering the topic at hand

Supports for Analysing Argumentation of Online Texts

Students' construction of the argument graph within the Online Inquiry Tool interface begins by writing an overall claim for inquiry against which they then reflect on related arguments found online. It is important that the claim is clear and unambiguous. Then, the tool encourages students to search for, identify, and organize reasons in support of the claim and reasons against the claim. This frame also helps students visually monitor and determine whether or not their argumentation is balanced (i.e., whether it includes both reasons for and against the claim within each perspective).

Supports for Critically Evaluating Online Information

The tool prompts readers to evaluate online information by asking them to judge the trustworthiness of their sources. First, they select the most fitting traffic light -- green indicates the source appears to be reliable, yellow warrants some degree of caution, and red suggests the information/source may not be reliable. Students justify their evaluations in a pop up box that appears after choosing the appropriate traffic light. Once the justification box is closed, the traffic light remains lit up as a quick visual reminder of their previous credibility evaluations. These quality indicators may, in turn, inform their selection of arguments to include in their final synthesis of each perspective. Students can also copy the URL-address into the box beneath each reason so they can easily return to the online sources they found earlier. Thus, the tool helps students record, organize, and revisit online information sources they found most useful.

Supports for Synthesizing Information

The URL-addresses students insert below each reason also help them monitor their use of online sources and whether they are relying on a single source or multiple sources in their argumentation. When students use the tool, synthesis processing is sequenced so that students can concentrate on creating their synthesis of one perspective using one limited set of source documents at a time. The tool's design visually prompts students to look across both sets of reasons concerning a certain perspective as they compose each segment of their synthesis, rather than asking students to list reasons in the sequence in which they were found. Concentrating on one perspective and on a limited amount of ideas may help students integrate supporting and competing reasons into a more coherent whole.

When students compose their final concluding synthesis (e.g. an essay) across multiple perspectives, the tool enables them to take advantage of efforts to synthesize previous information on a smaller scale without having to hold in memory the set of documents they

encountered at each different point in their search. Finally, students can print a report of their work and use it to help them develop a logical structure for their essay by following the sequence of perspectives and related insights they collected in their inquiry. Thus, the synthesis boxes serve as representational scaffolds to guide students' reasoning of supporting and competing views around a controversial issue from multiple perspectives.

Concluding Remarks

Online inquiry is a multifaceted practice that requires learners to organize, monitor, and regulate complex cognitive activities (Quintana, Zhang, & Krajcik, 2005). The Online Inquiry Tool is designed to support learners to handle these complexities when they are reading across multiple online sources. Table 1 summarizes the supports that are embedded into the digital tool.

Component of online inquiry	Embedded supports
Planning	1. Prompt readers to start the task by pondering perspectives from which to approach the issue at hand
	2. Offer readers a Palette of Perspectives to help identify perspectives suitable for the topic at hand
	3. Ask readers to formulate guiding questions that may help them recognize effective search terms

Locating information	4. Help readers structure their information search by concentrating on one perspective at the time
Evaluating sources	5. Prompt readers to rate the trustworthiness of each source with the traffic lights and use a pop-up box to justify their evaluations
Identifying arguments	6. Help readers focus on identifying arguments in source texts while encouraging them to search for both supportive arguments and counterarguments
Synthesizing information	7. Help readers record URL-address to monitor their use of online sources and easily revisit for details
	8. Allow readers to build a synthesis one perspective at the time and helps include arguments both for and against the issue with each perspective
Composing an argumentative text	9. Help readers develop the structure for their essay and move beyond their own perspective in their writing

Table 1: Supports embedded into the Online Inquiry Tool to scaffold a student's use of several complex cognitive processes during online reading and writing from sources

Given the range of other digital tools designed to support argumentation, several features highlight how this particular online inquiry tool is different. Probably the most unique feature is that the Online Inquiry Tool is designed specifically to scaffold learners both sequentially and visually through a series of overlapping online inquiry processes that research has suggested are quite challenging. By visually mapping cognitive prompts (e.g., a pop-up palette of perspectives, visual traffic lights, explicit questioning techniques) to particular boxes in the interface, students can use the organizer to fill in the appropriate content and automatically see how it relates to other ideas they gathered. Empty boxes with labeled prompts remind learners of often overlooked inquiry processes caused by cognitive overload; this feature easily highlights what still needs to be completed or which areas of reasoning could be better fleshed out before forming a conclusion. For example, after using the perspective palette to prompt discussion that considers a variety of stakeholders, the blank perspective boxes are designed to scaffold thinking beyond idea collection to a more abstract level of thinking required to generate common perspectives around these collected ideas.

While many argumentation and/or concept mapping tools are designed to illuminate students' argumentative discussions (Scheuer, Loll, Pinkwart, & McLaren, 2010), they are not explicitly designed for analyzing and generating arguments across multiple online texts. In addition, many interfaces expect students to generate content as well as the connections between ideas while not losing sight of the need to consider multiple dimensions of an issue. The Online Inquiry Tool combines explicit supports and visual markers around these challenging issues. Over time, the aim is that these overlapping processes and balanced considerations will become an internalized part of reading and reasoning across multiple online sources.

Another unique feature that pilot work (Coiro et al., 2014) has shown students and teachers find especially useful is the inclusion of blank boxes that prompt students to synthesize across the pros and cons of an issue from one perspective before considering how these ideas interact with those of other perspectives. Not only do the synthesis boxes prompt and simplify reasoning across multiple perspectives during inquiry, placement of the boxes also allows students to more easily transition to extended writing about these ideas after inquiry. Learners can use the vertical sequence of synthesized ideas as an initial organizer for their essays, and then be encouraged to look across these integrated ideas to notice original patterns that can inform a well-reasoned conclusion across perspectives.

By design, the tool's framework is relatively open-ended so that it can be used in different disciplines, for multiple purposes, and for building either individual or collaborative understanding. In a pilot study of the Online Inquiry Tool (Coiro et al., 2014), teachers designed tasks that invited students to explore controversial issues related to disciplines including history, language arts, science, and sociology. Some ways to use the digital tool in any of these disciplines include engaging students with a careful argumentative analysis of a single text, an analysis of an issue from multiple perspectives, source-based writing, decision-making, and/or preparation for a discussion or debate. Results of this study also suggested that different tasks support students' use of the tool differently. This finding aligns with Säljö's (2016) notion that it's not the digital environment that supports students' meaning making per se, but rather how we design tasks that direct students' engagements with the tool.

In addition, the tool can be used either individually or collaboratively. So far, the tool embeds supports to enhance collaborative knowledge building in face-to-face situations, but plans are now being made to integrate additional features that enable synchronous collaboration

with partners in different locations. Digital recordings of these interactions can also be used to gather evidence of previously hidden complex inquiry processes that precede and support performance on the final task (e.g., information search, relevance judgments, note-taking, and credibility evaluation).

It should be noted that presently, the tool features are grounded primarily in theory and our review of previous research around elements of online inquiry and particularly challenging dimensions of these practices for younger and older students.

We are currently testing the efficacy of the Online Inquiry Tool in both individual and collaborative learning situations in high school and university settings (Coiro & Kiili, 2014-2016; Marttunen & Kiili, 2015-2016). In addition, it is important to explore how the tool mediates collaborative interaction as well as possible drawbacks of using such a tool. With the help of the Online Inquiry Tool, researchers can form a better understanding of the complexities of online inquiry and further refine the tool and instruction to support students' knowledge construction and the ability to reason about real world issues from multiple perspectives.

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