

The Power of a Network Analysis Tool for Collaborative Learning

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Abstract: Net.Create is an open source network analysis software tool that affords simultaneous data-entry and network analysis to help students collaboratively co-construct knowledge about a large corpus of data. In this interactive demo, we demonstrate how the tool uniquely supports collaboration at both the small and large group level in a big lecture format to facilitate discovery, discussion, and reading comprehension in an interactive and engaging way.

Introduction

The Net.Create tool aims to bring the power of network analysis into university humanities classrooms to support student engagement and collaborative learning. Network analysis is increasingly seen as a powerful computational tool for making sense of big data sets that seek to describe the large network of interdependencies created by the overlap of many localized small networks. Net.Create is an open-source network-analysis software tool that affords simultaneous data-entry, network visualization and analysis to help students collaboratively co-construct knowledge about the text they are representing as a network. Though Net.Create was originally developed specifically for use in history instruction, it can be useful in any context where simultaneous or team-based network data entry is needed. The tool supports students as they enter information about actors (e.g., people and institutions) and the relationships among them. Unlike traditional network visualization tools that are intended for experts to individually enter data and engage in visualization, the Net.Create tool immediately displays the results of the whole network, including students' classmates' work, in a sociography, allowing them to continuously build off of each other's work and ideas. This immediacy and collaborative effort facilitate discovery, discussion, and reading comprehension.

For example, in a history class, Net.Create affords simultaneous data-entry and network analysis to help students collaboratively create the framework for a historical event and fill in its details (see Figure 1). During a Net.Create activity, students collaboratively do network-data entry in small groups who are each assigned a subsection of the larger historical text. As they do this, students can connect to and see the data that their peers are also entering. By dividing up a large, unfamiliar text into smaller pieces and assigning those to small collaborating groups whose work fed back into a whole-class network, the tool leverages the large collaborating group to support students in interpreting an entirely new text. This combination emphasizes both the localized details that make interactions manifest as well as the larger network that makes historical context visible and supports historical argumentation. In this interactive demo, we will demonstrate several student-created networks produced in Net.Create pilot studies and showcase how the specific features of Net.Create can offer a promising collaboration platform to encourage co-construction of knowledge in both the small and large group level. We'll introduce attendees to one of the sources our students have used, provide a short activity that lets attendees try their hands at one of the student activities based on that source, and then do a short debrief that affords time for discussion after the interactive portion of the demo concludes. The Net.Create team is finalizing a version of the software tool and a scaffolded activity that can be downloaded from www.netcreate.org for computers running MacOS 10.12 or greater.



Figure 1. Students' constructed network of Alexander the Great in Net.Create.

Using Net.Create to support argumentation and collaborative learning

The vast majority of humanities instructional strategies depends on consuming lengthy texts, both written texts and images as a form of text (Theibault, 2013). Novice students run into a number of common challenges as they read and discuss these texts. For example, novice history learners struggle to consume volume of historical texts because they may not understand the language used in the past, or the context in which events occurred (Craig, 2017). It is particularly difficult for them to grasp the connections between the many participants and events in the text, and these connections may not be explicitly spelled out for students (Wineburg, 1991). Network analysis can support students as they reflect on and explicitly represent the connections within the texts by reducing information in a network to single nodes (an item in the network) and edges (the connections between nodes) then using aggregate information from each node-and edge pairing to interpret the whole network (Carrington, Scott & Wasserman, 2005).

Next, integrating newly acquired network-visualization literacy into the arsenal of tools to present arguments can support students learning as they appropriate disciplinary norms. The gap between novice historians' assumptions about history as a "settled" straightforward linear narrative and expert practice in history as an argumentative discipline is an important consideration in leveraging the notion of *capta* "taken not given, constructed as an interpretation of the phenomenal world" in a history classroom (Drucker, 2014, p. 128). Student assumptions about history as a discipline with established facts are underscored by the lecture environment that is common to many undergraduate history surveys, and it only serves to exacerbate this gap between novice historians' view of history as settled and expert views of history as negotiated. When history is seen *not* as list of facts to memorize but as an interpretive account that collectively holds the cause and meaning of historical interactions supported by evidence, these novice students might more easily understand and remember the historical content (Theibault, 2013). Because of the broad scope contained in many historical texts, collaboration in creating these argumentation-evidence cycles should be encouraged for students, so that they can simultaneously examine the underlying factors that shape their interpretive history accounts and negotiate argument using the resources they have access. Therefore, it is important to foster multiple skills, such as corroboration, sourcing and perspective taking in order to transform the text into contextualized data (Simon, Erduran, & Osborne, 2002).

However, it is challenging to frame history as an interpretive account through collaborative effort in undergraduate history classrooms in part because of the large lecture format that is common to many undergraduate history survey classes and the single-authored nature of the historical document. Moreover, collaborative inquiry activity for novice students is not easy. The students are often asked to simultaneously regulate inquiry processes and activities, negotiate challenges, monitor progress, and articulate their argument as a group (Quintana et al., 2002). Establishing and sustaining mutual understanding via effective communication is a consistent challenge in collaboration. To support these challenges, Dillenbourg, Järvelä, & Fischer (2009) suggested that technology-rich environments should provide groups with a learning environment where they can set shared goals through the repeated negotiation over the course of collaboration and ensure the division of work. It is critical to use the group members as a source for clarifications and to ask relevant questions through productive interaction. Net.Create was designed specifically to support this kind of collaborative co-construction of knowledge.

Activity theory: Design framework of Net.Create

Our design of tool Net.Create is grounded in activity theory (Engeström, 1987). A core assumption in activity theory is that cognition and learning are socially mediated, or transformed by the multiple mediators of the activity, thus, it focuses on how individuals learn within rich activity contexts (Danish, 2014). The activity triangle (see Figure 2) is a representation of the key mediators of activity in the Net.Create context and their relationships with each other, and is intended to help visualize how they are all interconnected (Engeström, 1987). In this design, we positioned Net.Create as a mediating tool to scaffold student collaborative argumentation process across two different levels of learning to develop the necessary skills surrounding historical thinking.

Students within the proposed Net.Create activities are presumed to come to our classroom with some basic knowledge about social networking tools, and with a wide range of ideas about history (the *subject*). Their *object* (or shared motive) will be to make sense of a historical text. To help them accomplish this, we will present them with Net.Create (a new *tool*). Net.Create will fundamentally change how they engage with their motive and with the text (also a *tool*) by providing new ways of looking at the text, and new ways of looking at the information that the students glean from within the text (in the form of network visualizations). We believe that the students are more likely to engage with these tools in productive ways if they work collaboratively. Therefore, we will arrange them in small groups where they will be assumed to support each other by noticing, suggesting, and critiquing alternative elements within the text and resulting visualization (the *division of labor*). Finally, they will be expected to justify their answers within the tool providing significance and using citations (a *rule*) and to share

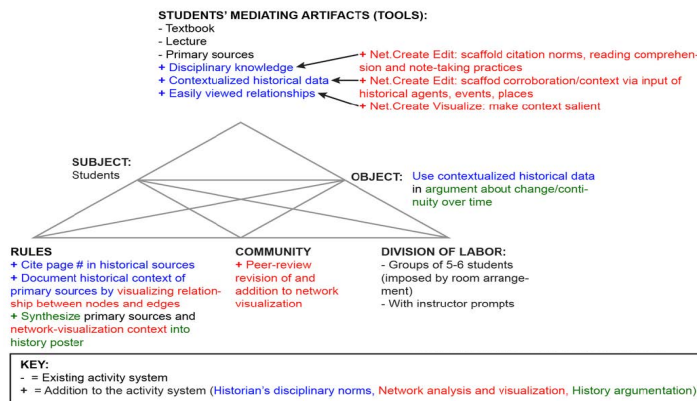


Figure 2. Activity triangle to integrate proposed Net.Create features into a classroom.

their aspects of the network with the entire class, who will also provide feedback. Thus, the community includes the other students in the entire class as well as the instructor who will be present for these discussions. Our assumption is that as students see new aspects of the historical phenomena, they will come to appreciate the value of using a network tool, while also learning how to use such a tool through practice. This appreciation is what we think will drive their appropriation in that they will know both how and why such a tool might be useful, and will be motivated to use one anew in the future.

Features to scaffold students in Net.Create for network entry and analysis

To use network analysis and visualization as supporting tools for collaborative argumentation, we need to scaffold student encounters with these tools. Most undergraduates do not have high proficiency for understanding, interpreting, and creating data visualizations, particularly network visualizations that are likely unfamiliar to students and have complex visual elements. Fortunately, prior work has shown that even users who are new to network visualizations intuitively understand how the elements of a network visualization represent the actual elements of the network: lines are representative of connections between nodes in the network, and connection distances represent the relative similarity or difference of those nodes within their shared category (Nickerson, Tversky, Corter, Yu, & Mason, 2010). This suggests that Net.Create is still accessible to students with limited data-visualization skills, particularly considering prior successes in two short pilots. However, our pilot also suggests that engaging with network analysis is still challenging, so our aim is to scaffold the necessary skills surrounding network analysis in a number of ways.

First, the history students in small groups can collaboratively enter information from historical texts through a simple data entry form (Figure 3) and see the visualized connection live in a network. The students need

Figure 3. Nodes and edges entry form.

to first review and interpret the text and negotiate the options for recording a historical data point. As they negotiate, the node entry form guides students to consider historical categories for nodes that include person, group, event, or place. Second, students need to determine if the node can be associated with any other nodes. The edge form prompts students to look at the relationship between nodes by asking them to select from a pre-populated dropdown menu (e.g., "has martial or adversarial interaction with", "has peaceful, familial or conversational interaction with", "is a group member of", "makes visit to [a place]", "participates in [an event]"). These options invite students to clearly identify the type of relationships between nodes within the text. They are also encouraged to make their work verifiable by two other features in the edge entry form: a citation field and a significance field. The former means their source material will be readily available to other students engaged in the collaborative process; the latter asks them to be explicit about why they chose to record details and features of a specific edge. The process emphasizes disciplinary norms of citation and historical argumentation and encourages students to interpret and reflect on the historical significance for each detail while reading the text and collaboratively co-construct the historical connections among many possible entries.

Secondly, the tool provides live network visualizations with based on the most recent student input. As students engage in data entry, the tool will calculate the number of times two nodes appear in an edge relationship in order to visualize a “weight” through thickness that tells how strong the edge between two nodes should be (see Figure 1). As students input a new node or edge, instructor tools allow deletion, merging and editing of accidental duplicate entry and the network visualization will adjust to provide students with a clear view of the live network. The immediate effect in the tool can support students to understand the network as a whole rather than looking at the local network built by small groups. For instance, few historical agents in a historical context have no connections. Therefore, as students add new nodes, we can prompt students to draw on elements of the network visualization provided by other students as they determine whether they need to also add more historical context for that node based on the whole network. The network can serve as a reference point for the whole class discussion, leveraging the work of small collaboration groups to support connections only visible in the aggregate. Finally, the tool generates nodes and edges tables (see Figure 4) so that students can seek specific information while reading the text that wasn’t assigned previously and investigate multiple nodes, edges, significance, or citations in one place. In this unique way, the large lecture format that typically limits collaboration options can become a positive feature of the activity by leveraging the large collaborating group to support students in making sense of an entirely new text in a limited time with the small collaborating groups whose work fed back into a whole-class network.

Source	Target	Citation	Significance
Aesacus	Neoptolemus	2.1	Aesacus, son of Zeus, is Neoptolemus' great-something grandfather
Neoptolemus	Alexander	2.1	N is Alexander's great-something grandfather and purported to be the son of Achilles
Olympias	Philip	2.10	Assassinated Philip
Olympias	Philip	2.10	Blamed for Philip's death
Alexander	Syrmus	2.10	Defeated Syrmus in a great battle
Demetrius	Alexander	2.10	Called Alexander a boy
Alexander	Diogenes of Sinope	2.14	Cynic Philosopher
Alexander	Isthmus	2.14	
Philip	Alexander	2.3	Philip is Alexander's father
Olympias	Philip	2.3	Philip and Olympias are married

Figure 4. Edges table.

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Acknowledgements

The authors thank Colin Elliott, Assistant Professor of History at Indiana University for supporting the project and *Inquirium* for designing and developing the tool. This study was made possible by the National Science Foundation, award #1848655.