Using Epistemic Network Analysis to Explore Ways of Contributing to Knowledge Building Discourse

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Abstract: This study explores Epistemic Network Analysis (ENA) to assess Knowledge Building discourse. Knowledge Forum notes were coded using a "ways of contributing" framework, and students were grouped based on their use of Knowledge Forum scaffolds. Findings indicate that the epistemic networks for theory, question, and source groups were significantly different from one another, yet complementary. The potential for ENA to model contribution dynamics during cycles of knowledge advancement is discussed.

Introduction

Epistemic Network Analysis (ENA; Shaffer, 2017) is a method used for modeling the underlying structure of connections in discursive data. ENA produces weighted network visualizations by quantifying the co-occurrence of codes within discussions for each unit of analysis (e.g., individual speakers or sub-groups of speakers). These networks can then be simultaneously compared visually and statistically to further explore the similarities and differences between various speakers in a discussion. For example, when a group of students are engaged in Knowledge Building discourse to advance collective understanding (Scardamalia & Bereiter, 2017), they contribute important codes to the discussion, such as theorizing, questioning, providing evidence, and so on. Past work using statistical analyses to explore the relations between different ways of contributing to Knowledge Building discourse have revealed positive correlations between formulating questions and proposing explanations, as well as improving theories and providing evidence (Chuy, Resendes, & Scardamalia, 2010). The purpose of this study is to extend this work using ENA as a technique for modeling relationships between ways of contributing networks to better understand productive discourse moves during Knowledge Building.

Methods and analysis

In this study, we applied Epistemic Network Analysis to Knowledge Forum data (Scardamalia, 2017) using the ENA Web Tool (Marquart et al., 2018). Based on approximately 100 notes, we created units of analysis by grouping students based on their use of Knowledge Forum scaffolds. Although the class had 21 students, the theory group had 13 students, the question group had 18 students, and the source group had 7 students. The three networks were aggregated using a binary summation to reflect the presence or absence of the co-occurrence of each pair of codes within a 4-line stanza window. More specifically, our ENA model included the following codes from the "ways of contributing" framework (Chuy, Resendes, & Scardamalia, 2010): questioning, theorizing, obtaining evidence, working with evidence, creating syntheses/analogies, and supporting discussion. The ENA model normalized the networks for all units of analysis before they were subjected to a dimensional reduction, which accounts for the fact that different units of analysis may have different amounts of coded lines in the data. For the dimensional reduction, we used a singular value decomposition, which produces orthogonal dimensions that maximize the variance explained by each dimension. Figure 1 shows the network centroids for the three groups of students along a two-dimensional space, with the x-axis accounting for 32.1% of variation and the y-axis accounting for 25.3% of variation. It can be seen that each group has a relatively unique profile, with the theory group ("My theory is") occupying the top-left quadrant, the question group ("I need to understand/INTU") occupying the top-right quadrant, and the source group ("New information") occupying the bottom-left quadrant.

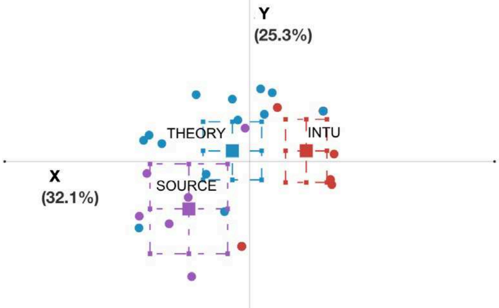

Figure 1. Network centroids for theory group (blue), question group (red), and source group (purple).

Mann-Whitney tests at the alpha=0.05 level showed that the theory group was statistically significantly different from the question group (U=205.50, p=0.00, r=-0.76) along the x-axis, and the theory group was statistically significantly different from the source group (U=29.50, p=0.05, r=0.53) along the y-axis.

Findings and future directions

The epistemic networks of the three groups were visualized using network graphs where nodes correspond to the codes, and edges reflect the relative frequency of co-occurrence, or connection, between two codes. The positions of the network graph nodes are fixed, and those positions are determined by an optimization routine that minimizes the difference between the plotted points and their corresponding network centroids. Our model had co-registration correlations of 0.95 (Pearson) and 0.96 (Spearman) for the first dimension and co-registration correlations of 0.80 (Pearson) and 0.82 (Spearman) for the second dimension, suggesting a good fit among the variables of interest.

a) b) c)

Figure 2. Mean networks for a) theory group, b) question group, and c) source group.

Figure 2a) shows the mean network for the theory group, where the strongest connection is between the theorizing and questioning codes, and the weakest connection is between the questioning and supporting discussion codes. Figure 2b) shows the mean network for the question group, where the strongest connection is between the theorizing and questioning codes, and the weakest connection is between the theorizing and obtaining evidence codes. In this network, there is no connection between the obtaining evidence and supporting discussion codes. Figure 2c) shows the mean network for the source group, where the strongest connection is between the theorizing and obtaining evidence codes, and the weakest connection is between the theorizing and questioning codes. In this network, there is no connection between the questioning and supporting discussion codes. It is interesting to note that the three networks complement one another based on their strongest and weakest connections, with the theory group producing the only network that holds all the codes together (e.g., questioning, theorizing, obtaining evidence, supporting discussion).

Our preliminary findings reinforce the centrality of theorizing and explaining in Knowledge Building discourse to engage students in working toward creating coherence among multiple sources of information, and in this case, multiple forms of contributions. As Chuy and colleagues (2010, p. 7) noted, “Different ways of contributing do not represent independent entities, but function as an inter-related system”. Based on this perspective, we anticipate that as students continue engaging in Knowledge Building discourse, the two codes – working with evidence and creating syntheses/analogies – will emerge, possibly in the empty quadrant on the bottom-right. Over time, we expect to see students designing new Knowledge Forum scaffolds to shape their discourse and epistemic networks as means to drive new cycles of knowledge advancement. Our study offers ENA as a promising approach to assess Knowledge Building discourse. Additional analyses are underway to compare changes in group and individual networks using network difference graphs and to understanding differences between various educational models. For example, inquiry learning is question-driven. Future studies will use ENA to analyze discourse moves associated with evolution of thought in different discourse communities.

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