

# The Current State of Knowledge-Building Analytics and Possible Future Directions

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**ABSTRACT:** Knowledge-building is the most prominent theory in the metaphor of learning as knowledge-creation, and its pedagogical approach facilitates the development of CSCL systems such as Knowledge Forum and activates many design-based studies in the world. In knowledge-building, learners engage in improving their ideas by utilizing conceptual artifacts through collaborative discourse. Although qualitative analysis provides fine-grained pictures of knowledge building practices, the quantitative approach needs to be developed for handling extensive data and conducting more powerful analyses in the mixed-methods. In this study, we discuss the current state of the quantitative analysis of kb discourse from the socio-semantic network analysis and possible future directions with the development of algorithms and technologies.

**Keywords:** Knowledge-building analytics, socio-semantic network analysis, the mixed-methods approach.

## 1 THEORETICAL BACKGROUND

In knowledge-building, knowledge is considered as an object to improve continuously (Scardamalia & Bereiter, 2014). It is assumed that the knowledge is collective, and the community of people shares and discusses their ideas through discourse then improves knowledge used in their ideas. Every learner has the collective cognitive responsibility to engage in the knowledge-building discourse. Through knowledge-building discourse, learners engage in improving their ideas comprised of their knowledge by using available conceptual artifacts. In the case that educational researchers use statistics to test their hypotheses, the hypotheses themselves are ideas to improve. The statistics they use for examining their hypotheses is a conceptual artifact. Thus, we need to consider analytics to capture what ideas learners improve (content-oriented) and how they improve their ideas by using their available conceptual artifacts (epistemic practice-oriented) to evaluate knowledge-building discourse.

## 2 THE CURRENT STATE OF KNOWLEDGE-BUILDING ANALYTICS

In the knowledge-building research community, several researchers have used a socio-semantic network analysis such as Knowledge Building Discourse Explorer (KBDeX). In the socio-semantic network analysis, they attempt to figure out how students engage in their collective knowledge advancement (e.g., Oshima et al., 2012), rotate their leaderships for improving their ideas (Ma et al.,

2016), and exert their shared epistemic agency through collaborative discourse (Oshima et al., 2018). Moreover, some research groups have developed new tools to evaluate idea promisingness (Chen et al., 2015) based on written discourse in notes on Knowledge Forum (Lee & Tan, 2017), and to provide learners with formative feedback for them to consider how they can extend their ideas (Feng et al., 2019).

While the socio-semantic network analysis of vocabulary has provided researchers with new insights on knowledge-building discourse, researchers have not fully discussed the epistemic practices in the knowledge-building discourse, i.e., how learners improve their ideas through their collaborative discourse. For examining the epistemic practice, Shaffer et al. (2017) proposed Epistemic Network Analysis (ENA). Their approach was also based on the connection between elements in the discourse, but more practice-oriented, i.e., codes representing cultural practices. ENA relies on the epistemic frame theory.

In their epistemic frame theory, Shaffer and colleagues (Rohde and Shaffer 2004) presumed that we use unique grammar in an established community of practice. First, we as humans have our epistemic frames formed as a collection of skills, knowledge, identity, value, and epistemology in the cultural grammar. Second, we gradually internalize the epistemic frames through participation in community practices. Third, we use the epistemic frame of a community when the specific perspective of a community determines how we act.

For conducting ENA, researchers have to identify what components could be detected to represent the epistemic frame. The components are Codes of the cultural practice in a community. They code the presence of cultural codes in each discourse analysis unit, then create network structures of the Codes by ENA based on the adjacency matrix of the co-occurrence of the Codes (Shaffer, 2017). Codes are plotted on a two-dimensional space created through a multivariate statistical procedure similar to factor analysis with varimax rotation (Shaffer, Collier, & Ruis, 2016). The statistically meaningful space for Codes makes it possible for researchers to directly compare the epistemic frames between different groups (e.g., high and low learning-outcome groups). The authors examined the shared epistemic agency by high-school students in their small group works by using ENA. They defined seven epistemic actions identified by Damşa et al. (2010) as Codes for identifying differences in their epistemic frames between high and low learning-outcome groups as well as another analysis of idea improvement process by using KBDeX. The double-layered analysis of discourse by ENA and KBDeX provided researchers with a more accurate understanding of differences in knowledge-building discourses between successful and unsuccessful groups. It was found that successful students controlled their epistemic actions to produce more ideas in their early stages of learning compared with unsuccessful ones.

### 3 FUTURE DIRECTIONS OF KNOWLEDGE-BUILDING ANALYTICS

In the presentation at this workshop, the authors summarize the current state of knowledge-building analytics and propose some future directions considering key concepts behind the socio-semantic network analysis such as KBDeX and ENA. First, we like to discuss the unit of analysis in more detail. Researchers rely on the co-occurrence of elements for creating a network graph. The co-occurrence is dependent on what unit of analysis we are going to define. In the analysis of discourse, dialogue is a key concept. What is the smallest unit of the dialogue? We will discuss it in

the session. Second, the current state of knowledge-building analytics relies on discourse data. However, nonverbal acts may influence group dynamics. A new direction of knowledge-building analytics would be directed at the multimodality of datasets. What kinds of action logs may be needed for further analysis? We also will discuss it in the session.

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