Reflective Assessment for Idea Improvement Through Collective Concept Mapping

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Abstract: The current research investigated Grade 5 students' reflective discourse during their co-design of an ecological concept map as a way to assess collaborative knowledge building. The result showed that students sustainably built on each other's ideas and inquiries about various ecological concepts to advance their scientific knowledge as a community. They also incorporated more academic and ecological terms as they participated in the co-designing activity. This study illustrated the potential use of the collective concept mapping to collaboratively advance knowledge in science disciplines as the student-driven reflective assessment.

Introduction

The 21st-century education needs to facilitate students' high-level agency to direct their learning and inquiry. Research on knowledge building communities (Chen, Scardamalia, & Bereiter, 2015; Zhang, Scardamalia, Reeve, & Messina, 2009) offers a model of education that engages student-directed collaborative efforts for sustained inquiry and idea improvement (Chen & Hong, 2016; Scardamalia & Bereiter, 2006; Scardamalia & Bereiter, 2010). A critical challenge is to design new classroom assessments in alignment with student-directed collaborative knowledge building. Such assessments need to engage student-directed, ongoing efforts to reflect on their collaborative knowledge progress and make informed decisions to refine their inquiry (van Aalst & Chan, 2007).

The current research explores using a co-designed concept map to support students' reflective assessments of knowledge building. In the related literature, concept maps have been used to track students' scientific knowledge (Novak & Musonda, 1991) and facilitate students' meaningful learning. In particular, concept mapping enhances students' creative thinking by presenting focal questions about key concepts, clarifying the concepts, exploring cross-links between the different concepts (Novak & Cañas, 2008). In this study, students worked collaboratively to create the concept map to co-organize their collective knowledge, reflect on idea progress and connection, and facilitate further collaboration. We investigated students' online and face-to-face discourse that occurred during the concept mapping activity. The research questions included: a) How did the students collectively design a concept map to assess their community's shared understandings, through what types of reflective conversation?; and b) How did the knowledge building discourse change from before to after the reflective assessment through collaborative concept mapping?

Data collection and analysis

The present study investigated 21 Grade 5 students' discourse during their co-design of a concept map in the ecology unit. The data sources were students' discourse in an online discussion forum called Knowledge Forum (KF) and videotaped face-to-face metacognitive meeting (MM). The ecology unit was covered twice a week for 14 weeks. Students discussed food chain, bees, animal behavior, underground, and plants by theorizing, building on ideas and raising inquiries. In the 8th week, students brought picture cards of concepts (creatures) that they researched and put them on a big paper. While building on ideas, they drew arrows between the creators to indicate the energy flows. They updated the concept map throughout five MMs until the end of the ecology unit. A teacher facilitated students' knowledge building by encouraging them to build on each other's ideas.

Discourse in students' notes on KF was analyzed by using text analysis tools called *AntConc* (Anthony, 2018) and *Vocabprofile* (Cobb, 2018) to classify words into academic words (Coxhead, 1998; Coxhead, 2000) and off-list words (special words beyond general and academic words). Words indexed in the life science section of Next Generation Science Standards (NSSS) were extracted (Marzano, Rogers, & Simms, 2010). The categorized words were compared between the two time spans (before and after the initial co-design of the concept map). Students' focal topic change was traced during the discussion in MM using *AntConc* (Anthony, 2018) and on KF through *KBDeX* (Oshima, Oshima, & Matsuzawa, 2012) to figure out the concepts with high betweenness centrality (how a certain word is mentioned with other words as it plays a central concept in the discourse network), respectively. In order for more in-depth analysis of students' idea improvement, Content

Analysis was conducted in terms of questioning, theorizing/explaining, collecting evidence, referencing sources, connecting and integrating (Tao & Zhang, 2018).

Findings

How did the students co-design a concept map to assess their community's shared understandings?

The teacher started the initial concept mapping by stating the purpose of the activity. She emphasized that students had discussed many different ecological concepts and needed to make connections between the concepts. She also pointed out making the connection between various concepts would provide students with driving ideas for further research. Students continued the collective concept mapping through four more consecutive MMs.

As students proceeded with the co-design of the concept map, they found the energy flows between the creatures and connected the creatures with arrows (see Figure 1), continuing research on the concepts on KF (see Figure 2). For instance, the left illustration in Figure 2 shows a segment of students' discourse with a stream of discussing 12 concepts over time. In this illustration, each vertical line demonstrates the moment when each focal concept was mentioned. Students started the discussion about *energy* and mentioned it intermittently throughout the discussion. S4 asked peers about where to put the *sun* on the concept map. Then, he constructed his theory, *"I think it starts from everything, so I think it should be connected to everything,"* and put the *sun* at the top of the concept map. As the MM progressed, S8 mentioned that *"Every different ecosystems have different food chains*." After then, students expanded the focal topic to various habitats where different species of creatures live (e.g., *desert*, *ocean*, *pine bush*, *woodland*, *forest*). Around the point when students had this conversation, students' discourse on KF contained a dramatic increase in the betweenness centrality of the focal concepts that students discussed during the concept mapping (see Figure 2).

Figure 1. The concept map that students co-designed.

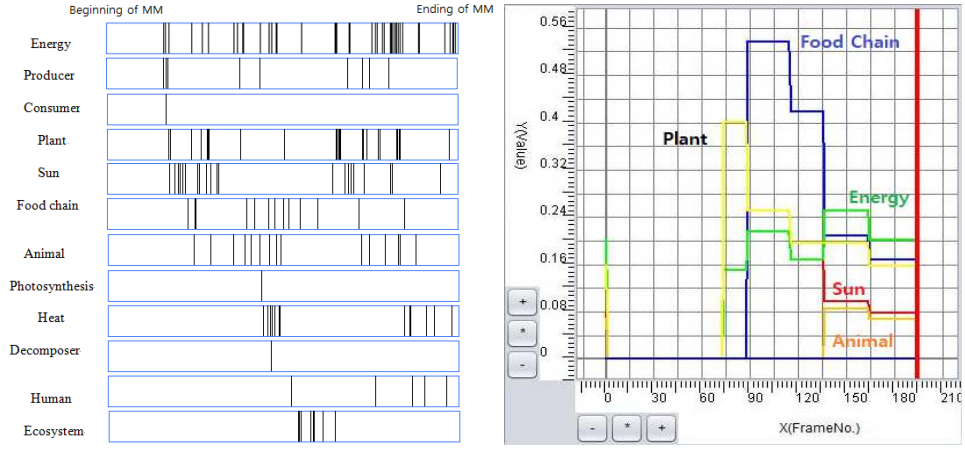

Figure 2. Timeline flow of focal concepts during collective concept mapping in MM (left) and dramatic increase in betweenness centrality of the focal concepts on KF (right).

How did the knowledge building discourse change?

Students used more diverse words on KF after the initial co-designing activity (see Figure 3). They used more off-list words and words indexed in life science of NGSS in the 2nd phase while using slightly fewer academic words. The higher mean of individual students' word use was also found in academic words and off-list words.

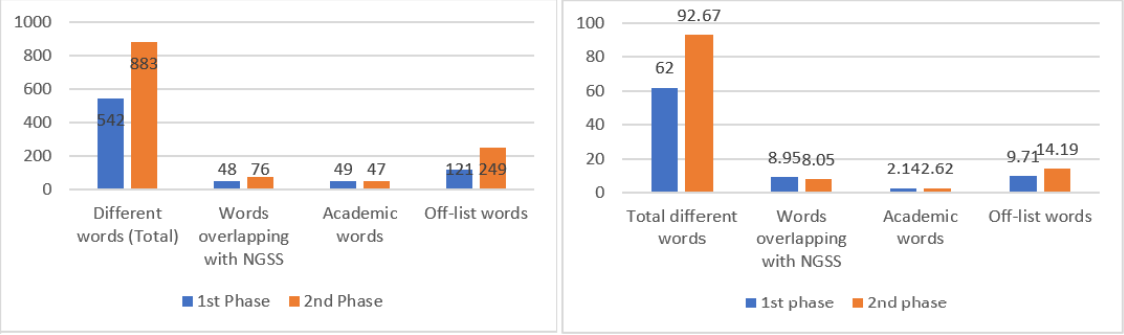

Figure 3. Sum of word types (left) and mean of individual students' word types (right) before and after initial concept mapping.

Students' discourse in their KF postings was coded based on knowledge contribution types (Tao & Zhang, 2018) (see Table 1). Students showed the advanced discourse moves after the initial activity of collaborative concept mapping. They elaborated more refined and sophisticated explanations by stating opposite opinions and describing complicated concepts. Moreover, they wrote higher-quality writings with personal stories of conducting scientific experiments, knowledge obtained from online and reading resources, and synthesis of diverse ideas. They asked questions to explore more in-depth inquiries and seek explanatory ideas in the 2nd phase.

Table 1: Knowledge building discourse on KF before and after initial concept mapping

	1st Phase	2nd Phase
Questioning	29	**32**
Factual question	**7**	5
Explanatory question	4	**6**
Idea-initiating wonderment	6	**7**
Idea deepening/elaborating question	12	**14**
Theorizing/Explaining	**36**	31
Intuitive explanation	**28**	14
Alternative explanation	4	**6**
Refined explanation	4	**11**
Referencing sources	28	**38**
Collecting evidence	0	**7**
Connecting and integrating	1	**7**
Total	94	**115**

Conclusion

The current research investigated Grade 5 students' reflective assessment of collective knowledge building by co-designing the concept map. The results showed that students cumulatively visualized the energy flows between ecological concepts through the on-going reflection of the community's idea improvement. They expanded the focal concepts, built and synthesized in-depth theories and inquiries, used reliable resources, produced more academic and scientific words, and continued to discuss the concepts in the online learning community.

The findings infer that students monitored their progressive idea improvement regarding the scientific concepts which they should pay attention to during and after the collaborative concept mapping. Students' collective designing of the concept map facilitated their conceptualization of the key ecological concepts and their understanding of the invisible mechanism behind how the creatures survive together in the ecosystem by

consuming other creatures (Novak & Cañas, 2008). What's more significant about this activity is that students were the core contributors to the reflective assessment and knowledge building in the community, while the teacher facilitated students' activity. The future research should assess students' on-going idea improvement more systematically through iterative and concurrent analytics of the learning data to deepen collective knowledge.

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