Orchestrating Visualization Tools for Supporting Collaborative Problem Solving in the Classroom: A Case Study

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Abstract: This paper presents the preliminary instruction design and enactment of a collaborative concept-mapping project on Food and Nutrition in the Web-based Inquiry Science Environment (WISE) platform with grade 7 students (n=25) in an urban high school in Canada. In this study, we present the design of the collaborative inquiry curriculum and examine student performance and perception on tasks. It informs us some information of how to orchestrate visualization tools for supporting deep learning from instructional design and supporting structuring learning process perspective.

Keywords: collaborative concept mapping, visualization tool, science education, case study

Introduction
Many research-based pedagogical and technological scaffold often bear little resemblance to authentic inquiry practice; on the other side, most science teachers do not have adequate classroom time or resources to involve their students into collaborative inquiry activities (Dillenbourg, 2013). Therefore, the CSCL field requires further study of how to orchestrate appropriate interventions to scaffold collaborative inquiry in the classroom.

Considering visual tool have the advantages of making thinking visible, providing resources for conversation and functioning as a “convergence artifact” that expresses the group’s emerging consensus (Suthers, et al., 2007); it may sever as a pedagogical scaffolding for teacher to structure learning activities across different levels, while act as technological scaffolding for student to conduct dynamic collaboration and knowledge building. Thus, this preliminary study intends to investigate how to integrate appropriate visual tools in the classroom for both design and enactment the collaborative inquiry project.

Instructional design
According to Ontario curriculum expectation on Food and Nutrition, we designed a learning project addressing an open-end problem: “How to make a healthy food plan?” using WISE platform (Slotta & Linn, 2009). Consider that learners lack the knowledge experts for inquiry activities, and ideal inquiry involves adding new ideas and helping students distinguish among ideas in their repertoire, we design first three knowledge-orientation learning activities which are respectively supported in WISE by two built-in visual tools, namely Drawing and Explain builder and one embedded collaborative mapping tool, namely Mural.ly, and one inquiry-orientation learning activity supported by Mural.ly.

![Figure 1](image)

Figure 1. Chose “framework” and sorted foods in Drawing (a); Explain builder page of Nutrition category (b); and Mural.ly starter page: Carbohydrate group (c)

Specifically, in the first activity of understanding food groups, after sorting the 20 foods preloaded in Drawing tool into similar groups and writing a WISE reflection note to describe grouping rationales, students in pairs chose one of five pre-designed classification “frameworks” and sort the 20 foods again by “stamp” tool in Drawing tool (see Figure 1a). In the second activity of knowing six kinds of nutrition by exploring the Nutrition Fact Table (NFT), the NFT introductory page is designed and then a video of how to interpret the NFT is offered, which is followed by two small exercises to test pair students’ NFT understanding. Finally, an Explanation Builder page is visualized for students to add and organize group ideas of six nutritional categories.
on the radial framework (see Figure 1b). In the third activity of understand each nutrition’s function, 6 groups are assigned and each group is responsible for one of the nutritional categories. Based on readings of relevant learning material, each member in a group can log in Mural.ly to edit the same concept map simultaneously, seeing another’s edits, and communicating through a chat window. In order to scaffold students focusing on the salient aspects of their food category, we designed a “starter map” that included some of the basic nutritional elements, and some starter links, such as “role within the body” (see Figure 1c). The goal of the fourth activity is to make a healthy food plan for a fictional student named Jennifer, who had been introduced earlier during the first three activities. In this activity, new Mural.ly groups are created with 6 students, one from each of the six nutritional category groups based on the idea of the jigsaw. Once again, a “starter map” is created, this time in the form of a timeline, from 6 AM until midnight, with a clear prompt in the area above the time line, “Foods we think Jennifer should eat” and below “our ideas about nutrition and energy”. Students are asked to draw as many lines of connection between different foods, and ideas, as possible.

Methods
This study involved 7th grade 25 female students in an urban high school in Canada. The science teacher administered a 30-minute pre-and post-test, as well as the entire curriculum design over four 70-minute class periods. Data collected in this round of trials include: students’ pre-test and post-test performance on an assessment of conceptual understanding; students’ perception of the main technologies and their Mural.ly maps.

Results
Findings revealed that: (1) students’ learning gains around the targeted learning topic are improved (t=7.97, P<0.000<0.05), while they did not completely understand the relationships between food categories (t=-1.49, P=0.150>0.05) by a paired-sample t-test of the students’ pre-test and post-test scores. (2) Students show high positive acceptances of the technologies used in this study, see Figure 2. (3) By analyzing map-data from Mura.ly, student not only can collaboratively add picture, text and arrows in Mural.ly map to represent group’s understanding of learning topic, but also can group well to make some change to alter and extend group artifact.

![Figure 2](image)

Figure 2. Students’ perception of WISE (a) and of Mural.ly (b).

This study is the first design sequence to investigate how to orchestrate collaborative concept mapping in the classroom context of a meaningful inquiry activity. In this study, WISE was successful in orchestrating different visualization tools in different sub-activities. From the macro-perspective, WISE worked quite well to structure the overall inquiry activity. From a micro-perspective, the various visualization tools can practically served their purpose well in the classroom. However, we do not research the relationship between the orchestration design and the learning effect in the classroom. Therefore, for the future, the second-round study will emphasize more in the role of collaborative concept maps in supporting knowledge development.

References