

The Idea Manager: A tool to scaffold students in documenting, sorting, and distinguishing ideas during science inquiry

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Abstract: The Idea Manager is a tool integrated into the Web-based Inquiry Science Environment to help students collect and organize their ideas before writing explanations. Findings from its implementation in high school science classrooms show how the Idea Manager supported students in articulating and documenting their developing ideas, and helped identify impacts of curriculum materials on students' learning. We describe our design rationale and our planned refinements to the tool, and discuss areas for further research.

The Challenge of Supporting and Assessing Learning

Students have difficulty writing evidence-based scientific explanations and arguments (e.g., Sandoval & Millwood, 2005). Whereas existing scaffolds typically provide templates of standard argument structure that students must complete (e.g., Quintana & Zhang, 2004), the amount of potentially relevant information students encounter, both in school and from their personal experiences, can be overwhelming. As a result, students are likely to retain their initial, often conflicting ideas about science and to require help distinguishing and integrating these into a coherent explanation. By the Knowledge Integration (KI) perspective, when students are first prompted to articulate their prior understanding, they may more thoughtfully evaluate their own ideas against scientifically normative ones (Linn & Eylon, 20011), and ultimately make better predictions and more reasoned arguments (Gunstone & Champagne, 1990). Curriculum units designed in the Web-based Inquiry Science Environment (WISE) and guided by the KI framework have shown promise for helping students develop integrated understandings of science (Linn, Lee, Tinker, Husic, & Chiu, 2006). However, as with other design-based research, it can be challenging to determine how specific features of instructional materials impact learning outcomes, and thus, to identify areas for improvement.

The Design of the Idea Manager

To address these issues, we designed the Idea Manager, a tool integrated in the WISE interface to scaffold and assess knowledge integration. This tool is comprised of two dynamically linked components: the *Idea Basket* and the *Explanation Builder* (McElhaney, et al., 2012). The Idea Basket is a repository of students' existing and newly encountered ideas. By clicking an icon in the toolbar of the WISE interface, students may type or edit short descriptions of their ideas in the pop-up window that appears. To encourage students to be deliberative in categorizing and refining their ideas, text fields and menu options allow them to specify the source of each entry, to create ad hoc tags, and to flag entries for later consideration. Over the course of the unit, idea entries accumulate into a sortable list, which students may revisit at any time to make additions, deletions, or revisions. Associated with the Idea Basket is the Explanation Builder, an activity type placed at fixed points throughout a unit. Within the Explanation Builder interface, students can drag and drop ideas from their Idea Baskets onto a sorting space. Curriculum authors can customize this space with text and images according to how they wish to guide students' organization of ideas relative to the unit's driving question (e.g., containers labeled For/Against, or Helpful/Not Helpful/Not Sure). A text field within this same interface prompts students to construct verbal

explanations based on the spatial organization of their ideas. Because students' interactions with the Idea Manager are continuously logged, data show not only what ideas students' add, but also the time and point during a unit at which each idea was submitted, revised, and/or deleted, as well as when and where each idea was positioned within the Explanation Builder spaces. In this manner, the Idea Manager complements typical assessments that measure students' progress based on fixed points before and after an intervention. In addition to being a scaffold of the KI process, it also functions as a continuous record of students' changing repertoire of ideas. Below, we describe how we have used the Idea Manager to research how students integrate their diverse ideas into coherent understanding.

Classroom Implementation

We incorporated the Idea Manager into 3 different WISE units, each 4-10 hours long, and implemented these in several high school classrooms in the western United States. The units guided pairs of students through inquiry into topics in chemical bonding and planetary motion. As students made predictions, explored dynamic models, and created and interpreted multiple representations, they encountered embedded prompts. These prompts encouraged them to use their Idea Baskets to document ideas, and to distinguish these ideas from one another during pivotal Explanation Builder activities before writing explanations.

Analyses of the Idea Manager data revealed a number of insights. For instance, explicit prompts to update their Baskets appeared to encourage students to better attend to the information they encountered. Meanwhile, different activity formats varied in how successfully they elicited students' ideas, and in how likely students were to then articulate them in their explanations. However, the content rather than the number of idea entries predicted the quality of those explanations. By tracking the trajectories of students' ideas, we were able to identify particular concepts that were difficult for students to understand. This allowed us to identify where in integrating their ideas students might have benefited from more scaffolding, as well as how to refine the units accordingly (McElhaney, et al., 2012).

Informed by these and other findings, we plan to explore the advantages of allowing students to share, critique, and build upon their peers' Idea Baskets and Explanation Builder responses. We will also continue to investigate how various visual organizations of the Explanation Builder space might scaffold students in distinguishing their many ideas, and ultimately, in constructing better reasoned arguments and explanations.

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