Making Collective Progress Visible: The Design and Application of Idea Thread Mapper (ITM) for Sustained Knowledge Building

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Focus and Purpose

Essential to the productivity of knowledge-creating communities is a self-sustained, progressive trajectory of inquiry by which ideas are continually generated, refined, and further built upon by peers to formulate more advanced ideas and problems, expanding the community's collective knowledge that continually informs further initiatives (Bereiter, 2002; Dunbar, 1997; Engeström, 2008; Sawyer, 2007). However, existing inquiry learning programs mostly focus on relatively short inquiry activities (a few hours or days) carried out by small groups. Online tools developed to trace and represent idea development also focus on short-term, small-group discussions (Hewitt & Woodruff, 2010; Suthers et al., 2008).

The work discussed in this session contributes to expanding the vision of inquiry-based pedagogy to support a long-term, collective, sustained trajectory of inquiry for community-wide collaboration and knowledge building (Zhang, 2012). To represent and visualize community-wide, collective progress in extended online discourse, we recently created a software tool, Idea Threads Mapper (ITM), which interoperates with Knowledge Forum. With active student engagement, ITM helps make the collective trajectory of inquiry visible for ongoing reflection and advancement. It does so by capturing important themes emerging from interactive discourse and constructing theme-based idea threads, each of which is composed of a series of conceptually related discourse entries that address a shared principal problem over an extended period of time (Zhang et al., 2007). As a timeline-based collective knowledge-mapping tool, ITM helps students to monitor idea progress over time and create higher levels of knowledge representations (e.g. threads and journeys of thinking) for the whole classroom, which make idea progress further sharable across classrooms.

The purpose of this interactive session is to present the design and development of ITM, demonstrate its use, and analyze a set of pilot studies conducted in three elementary classrooms, with the audience engaged to collaborative envision how ITM may be used

and improved to support sustained knowledge building across classrooms.

Organization of This Session

This interactive session will be collaborative delivered by a team of presenters consisting of learning scientists, computer scientists, and classroom teachers. It will include four interactive presentations and conversations structured in a way that will engage participatory dialogues among the participants.

1. Making Collective Progress Visible in Online Discourse Through Idea Thread Mapping

Jianwei Zhang, Mei-Hwa Chen

This presentation will discuss the conceptual rationale of idea thread mapping for capturing collective progress in extended knowledge-building discourse, which is viewed as a multi-level, emergent system. Working as a knowledge-building community, members need to monitor how their diverse individual idea input relates, responds and builds on to one another to form into unfolding conceptual streams; how the different streams of inquiry evolve and relate to one another advancing their collective knowledge, so they can position their individual and collaborative efforts accordingly for collective knowledge advancement. Such ongoing co-monitoring of ideas across the micro (individuals, small groups focusing on specific topics) and macro levels (the community working as a whole unit) will further inform opportunities for continual build-on and advancement of ideas across timescales. Students connect what they are inquiring now to what they have done and known in the past as a community; and continually identify gaps, challenges, and opportunities emerging from their current work to inform directions of future inquiry. Such a self-sustained, long-term trajectory of collective inquiry is critical to the productivity of knowledge building. Therefore, computerized tools to represent and assess collective knowledge progress in collaborative learning environments need to go beyond a narrow focus on small group (e.g. 4 to 6 members) interactions over a short time period (a few hours or days) to capture social and cognitive interactions at the higher levels (whole community and across classrooms) and over longer terms (multiple months or years).

Idea thread mapping is an analysis method developed to trace idea improvement in extended discourse focusing on examining emergent advances of community knowledge (Zhang, 2004; Zhang et al., 2007). An idea thread represents a line of inquiry composed of a series of conceptually related discourse entries that address a shared principal problem, extending from the first to the last discourse entry. The design of the ITM software to represent and trace collective knowledge progress integrates three levels (or units) of ideas: an idea contributed in a Knowledge Forum note or build-on (response), an idea thread consisting of multiple notes, and a map/network of idea threads for a whole inquiry project. Constructing idea threads based on ideas contributed, synthesizing journeys of thinking in the idea threads, and mapping out a network of idea threads for

whole-class reflection help students to see the larger picture of their collective knowledge space and, more importantly, to rise above their individual idea contributions to build higher levels of conceptualizations that may crosscut different lines of work. Displaying idea threads on a timeline with options to zoom in/out helps students to see idea connections and build-on over time, which may last for multiple months or years. Our pilot studies provide preliminary evidence for such potential benefits. Our future upgrading of ITM will further expand its visualization and analysis functions focusing on conceptual, social, and temporal dynamics of knowledge building, which will provide rich data and feedback to students, teachers, and researchers.

2. The Design and Development of Idea Thread Mapper (ITM)

Huixian Li, Yuheng Zhao, Jingping Chen, Baibhav Lal Rajbhandari, Mei-Hwa Chen Jianwei Zhang

ITM was designed using a multi-tiered web architecture and implemented in JSP/Java programming language and MySQL database management system. The current version of the ITM tool is hosted on http://tccl.rit.albany.edu:8080/ITM/index.jsp. Users including students, teachers, and researchers can visit ITM by clicking the ITM icon embedded in Knowledge Forum; or they can directly log onto the tool via the ITM login page. The function of ITM is to foster students' metacognitive efforts to review their collaborative discourse in Knowledge Forum (and possibly other online learning environments), so they can develop a clear sense of the important themes (i.e., problems of understanding) that have emerged from their discourse, monitor collective progress made across the themes, and identify deeper issues and efforts to further their inquiry. On the basis of data retrieved from Knowledge Forum, ITM supports user actions to generate a map of idea threads for each inquiry-based learning project. Specifically, ITM provides three primary features for creating, viewing, and editing projects, idea threads, and idea thread maps, as described below:

1. Project: A project is an inquiry initiative carried out by students to address a curriculum topic over an extended period of time, such as multiple months.

1.1 Creating a project for idea thread mapping: The users can create a new project by entering the topic of study (project name), grade, teacher's name, school's name, school year, and the Knowledge Forum user group(s) involved.

1.2 Opening and viewing an existing project. The users can view and edit an existing project by clicking the project's name shown on a dropdown list. The project's page displays project information including project name, teacher name, and the number of idea threads created in the project.

2. Thread: An idea thread consists of a series of discourse entries (notes) that address a shared, thematic problem, displayed on a chronological scale. Each idea thread is augmented with a journey of thinking created by students to summarize what they have learned and what they need to further understand.

2.1 Creating a new idea thread: The user first enters the name (focus) of the thread, then searches notes for the thread from the current project's Knowledge Forum views based on key words used in title or note content and time period when the notes were created. Once notes are found and selected for the thread, a graphical chart is displayed rendering the distribution of the notes on a timeline from the first to the last note created. The user can choose to show/hide titles, authors, build-on links, and content of notes in the thread chart and zoom into a specific time period (by day, by week, by month) to review the notes and build-on links (see Figure 1).

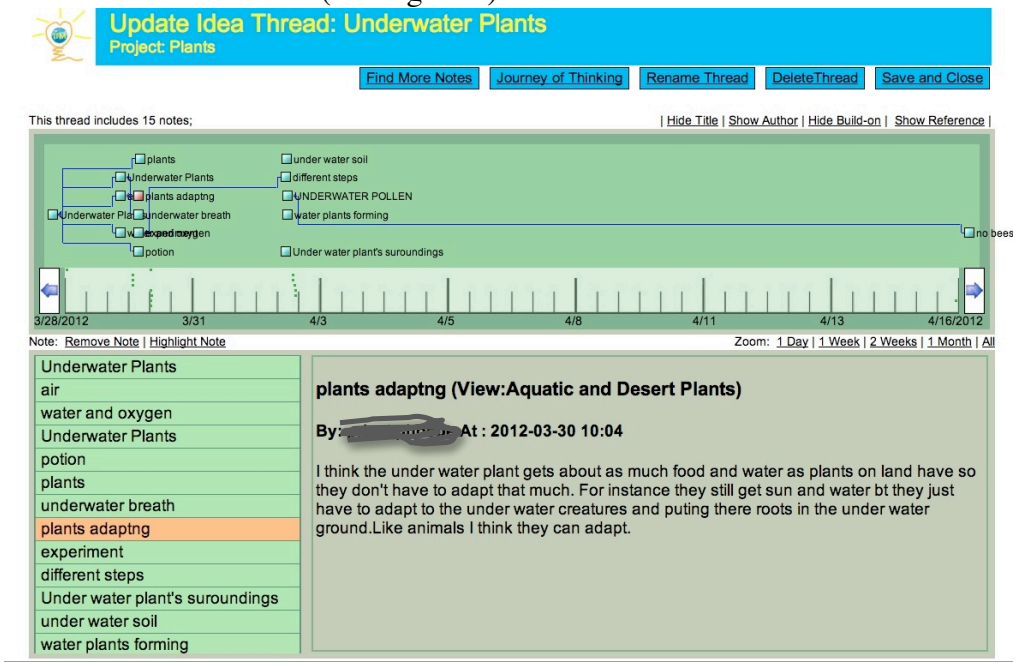

Figure 1. An idea thread created by a Grade 3 classroom studying plants. The focus of the thread was on how underwater plants grow, with 15 Knowledge Forum notes addressing this problem from March 28 to April 16. Each square in the thread represents a note, and a line between two notes represents a build-on link. The lower part of this screen shows the full list of note titles and the content of a selected note, entitled with "plants adapting."

2.2 Viewing and editing an idea thread: Students can view existing threads and edit a chosen thread by adding more notes, removing some of the notes, highlighting important notes, renaming the thread, or deleting the thread.

2.3 Journey of thinking: After reviewing the notes in a thread, students can summarize their journey of thinking in this line of inquiry aided by a set of scaffold supports (e.g., our problem, we used to think, we now understand, we need to do more. Such journeys of thinking summarized for different threads are co-editable by all members of the classroom community, with all versions of the summaries recorded for later browsing and analysis.

3. Map of Idea Threads: A map of idea threads displays all (or selected) idea threads in an inquiry-based learning project. The user can select some or all of the idea threads and show them based on the same timeline (see Figure 2 attached); show/hide titles, authors, build-on links of notes in all the threads; and zoom into a specific time period to review the notes and build-ons. Links embedded in the map allow users to open an idea thread to view its details and make updates, and to open the journey of thinking of any thread for reviewing and co-editing.

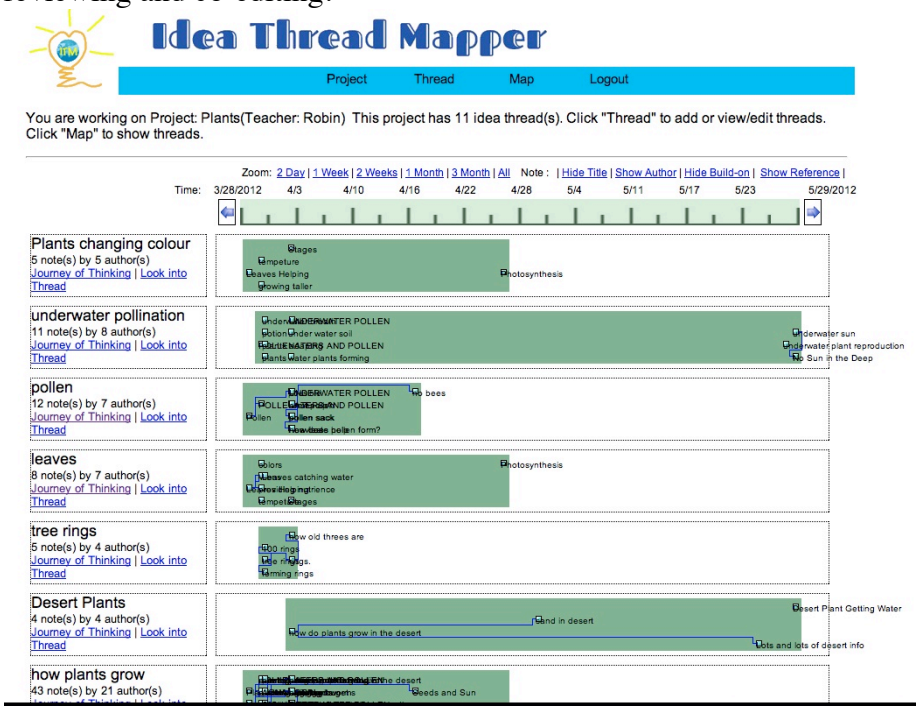

Figure 2. A map of idea threads created by a Grade 3 classroom studying plants.

3. Foster Sustained Knowledge Building through ITM-Aided Collaborative Reflection: Teacher Perspectives and Research Analysis

Robin Shaw, Benjamin Peebles, Julia Cain, Sarah Naqvi, Jingping Chen, Teresa Ferrer-Mico, Yanqing Sun, Jianwei Zhang

We conducted a set of pilot studies in a grade 3 and two grades 5/6 classrooms at the Dr. Jackman Institute of Child Study (J-ICS) in Toronto. Students in each classroom investigated a science topic—plants for grade 3 and the human body for grades 5/6—using Knowledge Forum over a two-month period. Around the middle of their inquiry unit, students engaged in a collaborative reflection session (2-3 lesson hours) supported by the ITM tool. They first identified "big ideas"—or "juicy topics"—that had emerged from their inquiry and discourse as represented in Knowledge Forum, with their teacher recording the themes on a board. Students then worked together in the ITM tool to identify important Knowledge Forum notes for each theme to construct idea threads (see Figure 2 for example). Small groups were then formed to write a summary (journey of

thinking) for each major idea thread to reflect on their problems, progress, and next steps. This collaborative reflection session was concluded with a whole class conversation in which students examined the map that displayed all the idea threads to identify areas with important advances as well as those that required substantial efforts. Focusing on the weak areas identified, students engaged in deeper inquiries in the following weeks. Another collaborative reflection session has been scheduled toward the end of their two-month inquiry to revisit the idea thread map and update the idea threads in reflection of new advances made.

Data were collected to test the usability of ITM and address three specific research questions: (a) How did these young students engage in collaborative reflection on their collective knowledge work with the support of ITM? (b) What roles did the teachers play to scaffold student reflection and metacognitive discourse? And (c) to what extent could such collaborative reflection aided by ITM foster student awareness of collective knowledge and collaborative efforts to advance it? To address the first two questions, we video-recorded the collaborative reflection sessions in the classrooms, with ITM automatically recording the idea thread maps and summaries created through the reflection sessions. To address the third question, we interviewed 5 to 6 students from each classroom before the ITM-aided reflection and 5 to 6 different students after the reflection session. The interview protocol focused on student awareness of the important themes that had been explored so far by their community, the advances and discoveries, as well as topics or problems that their class as a whole needed to better understand in the next few weeks. (This interview additionally included questions about students' experiences with ITM and suggestions for its improvement.) Complementing the interview data, we also collected copies of students' notes in their notebooks written before the ITM reflection to record their personal thoughts about the "big ideas" (juicy topics) emerged from their inquiry. Knowledge Forum recorded time-marked data about student online discourse, so we could analyze changes in discourse patterns enabled by ITM-aided collaborative reflection.

While comprehensive data analysis is still underway, our initial data analysis suggests the benefits of ITM-aided collaborative reflection, including:

(a) Expanding individual student awareness of their community's knowledge: Each student identified approximately 3 to 4 important themes of inquiry (e.g., brain, heart, in the unit of the human body) in the individual interviews and notebooks. Idea threads constructed by the whole community included 9 to 12 themes, bringing important focuses to the attention of all members. Reviewing notes in threads, summarizing journeys of thinking, and sharing/presenting their summaries in a whole community further helped the students to understand specific problems and knowledge advances in each theme. As a student said: "I really like this part of ITM (ITM Map). This is really helpful. I look at this a lot and it shows me…the big popular things and then I go read the notes and see what people say."

(b) Fostering idea connection, build-on, and improvement over time: Searching important

notes to construct theme-based idea threads helps students to realize how their ideas connect to existing contributions of their peers beyond those that they have explicitly referenced or responded to. Reviewing ideas in threads and summarizing journeys of thinking further helps them understand their progress and further challenges, informing future directions and actions. As the students commented, “I think so (it’s helpful) because you can see when the note was put in, so you can look at the earliest ones and look at the latest ones and then you can see how your ideas have developed.” When summarizing journeys of thinking in different idea threads, these young students could effectively identify problems of understanding as the focal goal of each thread, highlight conceptual change (e.g. [we used to think] petals only make flowers look good. [Now we know] they help attract pollinators.), and identify deeper questions for further inquiry. As a student commented, "I think that it can help you know what you should study more and look into more." The deeper questions and issues identified then became the focus of their subsequent inquiry and discourse in the following weeks.

4. ITM Use and Future Improvements: Open Conversation.
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We will give the participants the opportunity to try out this tool and then discuss how this tool may be used in different classroom contexts, what additional features are needed, and how the future upgrading of this tool may possibly integrate with various new development projects to support knowledge building practice and assessment in the Knowledge Forum community.

This interactive session will run for approximately 90 minutes.

Acknowledgements

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