Common Knowledge: Supporting the Orchestration of Multi-Modal Note-Sharing in a Heterogeneous Classroom Ecology

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Abstract: We will present Common Knowledge (CK) – a pedagogical and technological innovation that supports teacher orchestration of inquiry discourse occurring in the digital and classroom environments. We designed CK to support a "knowledge community" pedagogy where students add their own ideas, build on peers' contributions, and structure their inquiry. Using tablets, students contributed to a knowledge base that was publicly displayed on an interactive whiteboard (IWB). The IWB visualized the community's idea flow, enabling learners to sort their ideas along socially-negotiated categories, and allowing teachers to track student progress to guide whole-class discussions. We present the final design, analyzed according to a Technology-Discourse-Activity system. We observed that teachers used "3R" orchestration cycle of Reflect-Refocus-Release, and offer guidelines about linking pedagogy to technology design.

Keywords: orchestration, discourse, inquiry, collaboration, technology, knowledge building

Introduction and Objectives

In learning environments that aim to engage students as a knowledge community in collaborative knowledge building (Group Scribbles - Roschelle et al., 2007; ConcertChat - Stahl, 2006), there is typically a heavy reliance on teacher-guided oral community discourse (Slotta & Najafi, 2010). However, this places a serious burden on teachers to orchestrate inquiry in heterogeneous classroom ecologies (i.e. F2F classrooms incorporating computer-mediated activities), as they must continuously traverse between online and F2F environments to guide discourse towards productive paths of inquiry. *Our main goal was to design a technology environment to support such traversing, and investigate how two elementary teachers used this in their orchestration of productive inquiry activity within their heterogeneous classroom ecologies.* A necessary secondary goal toward investigating the primary one, was to *develop an analysis framework that would capture how technology, teacher-guided discourse, and inquiry activity function as a coherent whole*. While our primary goal aligns with the "Linking pedagogy and heterogeneous technological resource ecologies" workshop track, and our secondary goal aligns with the "Methods and techniques to research heterogeneous ecologies" workshop track; we see this work as making a greater contribution to the pedagogy track than to the methods track.

We draw from the theoretical perspective of activity systems (Engeström, 1987), and Activity-Oriented Design Method (AODM - Mwanza, 2002), in which tools and materials are mediators of goal-directed human activity which are themselves transformed in the mediation process. The CK environment can be interpreted as a mediating tool for inquiry activity, with community discourse as a necessary mediator. Together, these elements can be viewed as forming a Technology-Discourse-Activity system, which informs our understanding of how any two dimensions can influence the third. This perspective also informs our design of successive iterations of CK, including specific technologies, activity sequences, and targeted patterns of discourse.

CK has been designed as a content-agnostic note-sharing application for collaborative inquiry. Using tablets, students contribute to a community knowledge base that is publicly visible on the classroom IWB. This interactive display visualizes the community's idea flow and enables learners to sort their ideas by topic. Now in its third iteration, CK has been designed to embody an inquiry script: scaffolding the community through three phases of science inquiry: Brainstorm, Propose, and Investigate. Students begin by *brainstorming* questions and theories to share with their community as "brainstorm notes", eventually tagging these notes with socially-negotiated themes emerging from the community knowledge base. Then, they collectively draw on brainstorm notes to *propose* research trajectories, which they share as "proposal notes". They then choose a fluid (i.e. changeable) special interest group, supported by a dedicated shared interactive display; carrying out *investigations* as defined in proposal notes, and sharing findings via "report notes".

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Theoretical Perspective

Our research is grounded in the theoretical tradition of classrooms as Knowledge Communities, where community members value a diversity of expertise, metacognitive awareness, a common goal of advancing the collective knowledge, and a means by which to share learning (Bielaczyc & Collins, 1999). The Knowledge Community and Inquiry (KCI - Slotta & Najafi, 2010) approach scaffolds students to work as a knowledge community in building a collective knowledge base, which becomes a resource for subsequent scaffolded inquiry activities, targeting specific learning goals (Slotta & Najafi, 2010).

Language has been shown to be a central mediator of thinking and learning within a knowledge community (Wertsch & Smolka, 1994). O'Connor and Michaels' (1996) analysis of "revoicing" – the oral or written re-phrasing of a student's contribution by another participant – describes how teachers orchestrate group lessons through language socialization into intellectual practices, offers a means for teachers to foster idea growth, reinforcing collective epistemology and guiding inquiry progression.

The enactment of any pedagogical designs, whether facilitated by technology or not, requires thoughtful management of students, activity, resources, technology, and time. Dillenbourg refers to this process as "orchestration" - "how a teacher manages, in real time, multi-layered activities in a multi-constraints context" (Dillenbourg et al. 2012; p.1). As an "orchestration tool" (Dillenbourg et al., 2012), the inquiry and collaborative scripts at the heart of CK offer a technology structure to manage the knowledge community's inquiry process.

Method

The design of a scaffolding technology environment like CK requires an understanding of how teachers orchestrate inquiry using discourse that engages students in reflection about their idea progress. Hence the need for research of discourse and activity sequences in technology-mediated inquiry environments. We analyze such sequences in the context of an overarching Technology-Discourse-Activity system to understand how CK technology, teacher-guided discourse patterns, and the inquiry activity script inter-relate. Because the technology and activity script were designed to be enacted in the classroom context, the discourse is one variable left open to the teacher to serve as a means of achieving those specified designs. In this way, CK research is deeply connected to classroom practice (Design-Based Research Collective, 2003).

A grounded approach to video coding was used to determine teachers' orchestrational and discursive scaffolds. Participants were two veteran grade 5/6 teachers, 'Brad' and 'Jen', in a private elementary inquiry-oriented school located in a large Canadian city, with 23 students each (approximately equal numbers of grade 5 and 6 students). By our third iteration of Common Knowledge (CK3), Brad had been teaching for 8 years, and Jen for 5 years.

CK3 is a content-agnostic technology environment, designed in close coupling with a KCI-inspired inquiry script. Consistent with the KCI approach, students are scaffolded to work as a knowledge community through several distinct phases of inquiry, contributing to a shared knowledge base in each phase. Since the knowledge base is indexed to socially-negotiated themes, teachers are tasked with orchestrating the community's inquiry towards themes that address their pre-determined specific learning/curricular goals. CK3 also aims to capitalize on the physical classroom layout as an additional dimension of collaboration scripting and collective knowledge mapping. This was a 9-week grade 5/6 Astronomy inquiry progression supported by CK3, and was enacted in the spring of 2013.

To investigate *teachers' orchestration of classroom activity*, we measured the classroom time teachers allocated to teacher-guided and student-driven inquiry activity involving CK3 over the 9-week enactments. A grounded approach to video coding was used, with coarse-grain coding focused on teachers' activity orchestration. Video data of three 90-minute CK3 classroom periods from each teacher were chosen for finer grain coding, based on the richness of CK-driven classroom discourse and opportunities for CK note contributions during the same session. Finer grain coding focused on teachers' discourse patterns during CDEs, to *discover possible discourse patterns*.

Findings and Discussion

Qualitative video analyses was conducted on teacher-guided community discourse episodes ("CDE") and student-driven activities that involved Common Knowledge ("SD-CK"). Figure 1 provides details of Brad's orchestration during the three classroom sessions selected for further analysis. The top panel (i.e., "# of Notes") presents students' note contribution activity. The number of notes shown begins with a non-zero value, as some notes had been contributed in class sessions preceding those that were coded.

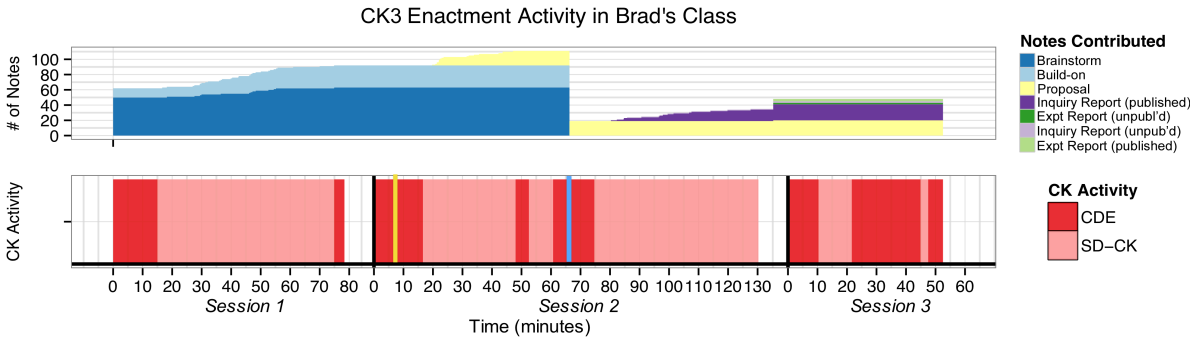

Figure 1. Enactment timeline for Brad's orchestration during three selected CK3 sessions. The bottom (red/pink) level shows the orchestration sequencing of CK3 activity. The top level shows students' contributions of different types of CK3 notes. The black vertical lines delineate each session. The yellow vertical line marks initiation of the *Propose* phase of inquiry. The blue vertical line marks initiation of the *Investigate* phase.

Teachers used students' CK notes to launch and guide F2F community discussion during the *reflect* (CDE/red) phase of their orchestration, culminating in teachers' instructions that *refocus* the community's subsequent inquiry activity, providing direction to students about strategies to address issues that emerged from that discussion. Students were then *released* (pink/SD-CK) to pursue their inquiry trajectories – resulting in further note contributions to the community knowledge base (see "# of Notes" graphs in Figure 1). This 3R cycle (Reflect-Refocus-Release) figured prominently in teachers' orchestration, and was pivotal in helping students develop awareness of their community's state of knowledge, achieve knowledge convergence, and receive teacher guidance towards productive inquiry.

The continuous traversing between student-driven activities in the CK environment (Release) and F2F community discourse events (Reflect), each informing the other, was guided by teachers' Refocusing instructions. These instructions emerged naturally from student input during Reflection community discussions. A closer examination of teachers' discourse moves during these discussions was done to investigate how they facilitated the discussions towards productive trajectories and guided ensuing student-directed inquiry work for the subsequent Release phase of activity orchestration.

A grounded approach to video coding of teachers' discourse moves during their facilitation of community discourse events (i.e. Reflect phase of orchestration) in their 3 selected CK3 enactment sessions, revealed four orientations of teacher-initiated exchanges: (1) Teacher Reflection (TR), in which the teacher "revoices" or engages in a personal reflection about recent ideas or progress; (2) Individual Student Reflection (IR), in which individual students or groups were posed an inquiry question; (3) Whole Class Reflection (CR), in which the teacher poses a reflection question to the classroom as a whole; and (4) Class Instruction (CI), in which the teacher issued straightforward instructions to the class. Teachers used these orientations to guide community discourse, promote reflection on the community's collective knowledge base, and engage the community in discursive knowledge work.

Principles, Guidelines, and Conclusions

A pedagogical model such as KCI can inform the development of the inquiry script, as well as technological features of CK. We now offer some lessons learnt regarding the linking of KCI pedagogy to technology design, the analysis of such technology in a heterogeneous ecology, and the orchestration of a note-sharing technology that scaffolds inquiry in a blended classroom environment.

First, there are tensions between supporting autonomous student inquiry and scripting procedural inquiry elements into the technology design. Second, indexing of the shared community knowledge base should not be a final one-time occurrence, but rather, a more continuous process spanning the length of the inquiry term to support inquiry breadth over time. CK's design focused on scaffolding students' progression and this came with a trade-off in terms of the breadth of their investigations. This remains an unresolved challenge and it is important to keep this trade-off in mind in future design efforts.

Third, the Propose phase of CK3 slowed inquiry progress with the intention of productively constraining idea diversity (i.e. brainstorming) and engaging students in knowledge convergence as they created Proposals by synthesizing Brainstorm notes – thoughtfully considering their peers' multiple small ideas to form "big idea" Proposals. However, this proved to be cognitively too advanced for grade 5/6 students and dampened the communities' motivation. Hence, technology needs to provide further scaffolding to support students'

knowledge convergence processes. Fourth, CK3 also sought to productively constrain idea diversity by (1) allowing untagged Brainstorm notes to "disappear" during the Brainstorm phase, then by (2) having Brainstorm notes "disappear" with the launch of the Investigate phase. The goal of this was to focus the community's attention on ideas in the collective knowledge base that were relevant to the socially-negotiated topic categories of the knowledge base, and to ensure investigative progress. However, teachers reported that they would have liked to have had read-only access to Brainstorm notes during the final Investigate phase, to support student reflection on inquiry progress and to see if any early brainstorm ideas that had been ignored in Proposals could perhaps be connected to more advanced understandings in final Investigation Reports. All this begs the question of whether intended productive constraints such as the intentional periodical slowing of progress and the limiting of inquiry breadth, can actually be productive.

Fifth, the Technology-Discourse-Activity system provided a viable framework for analyzing how technology, teacher-guided discourse, and inquiry activity function as a coherent whole; yielding redesign goals for subsequent iterations of CK and uncovering a teacher orchestration pattern. Sixth, CK's content-agnosticity enabled knowledge communities to pursue topics based on their interest, and its scripting of inquiry processes reduced teachers' orchestration load. However, the teacher's orchestration of a community's knowledge flow was pivotal in ensuring progress towards productive inquiry trajectories. Seventh, teachers utilized a "3R" orchestration cycle of Reflect, Refocus, Release; to manage productive inquiry activity within their heterogeneous classroom ecologies. In particular, Refocus was crucial in connecting knowledge flow between online and F2F environments – providing guidance toward productive trajectories, based on student ideas that were shared as CK notes online and as discursive contributions to F2F classroom discussions.

By engaging students in reflective note-sharing as part of a scripted inquiry progression, we were able to investigate how CK could help students and teachers engage in a Knowledge Community and Inquiry (KCI) approach. By adding CK as an inquiry scaffold, we produced a blended form of learning environment, where individual students develop and share their inquiry work within a common digital repository, motivating teacher-guided discussions, which in turn motivate new, refocused inquiry using CK. The note-sharing system becomes a tool that mediates between the two learning environments: students' collective inquiry done in the digital note-sharing environment and community knowledge work done during teacher-guided classroom discussions. Successful mediation of this blended learning environment entails the agile orchestration of inquiry activity between the online and F2F environments, and strategic guidance of the community toward inquiry progression. Hence the note-sharing system serves a dual purpose: to mediate between inquiry learning environments, and to support teachers' orchestration of the learning progression.

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