International Society of the Learning Sciences

Advancing Technology Environments for Learning Communities

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Abstract: This symposium will examine and envision new possibilities to design next generation technology environments for advancing the study of classroom learning communities as a pedagogical approach. Of the many different kinds of technology environments used in educational research, technology designed for learning communities represents a unique genre in which the environments must support particular epistemic values, modes of learning, and discourse. The talks in this session represent five distinct projects, each focusing on the features of a technological environment and how they support learning communities (e.g., making learners' ideas salient; representing community knowledge; enabling idea interaction across boundaries; fostering a sense of progress). Across the papers, we identify cross-cutting research priorities and common technological elements that characterize this pivotal research area, with implications for future research and the development of community-supporting technology.

Introduction

Within the learning sciences, the 1990s gave rise to a *sociocultural revolution* that produced conceptual shifts whereby learning was conceptualized as inherently social and cultural activities and tools are emphasized (Hod, Bielaczyc, & Ben-Zvi, 2018). A good example of this shift is the so-called "learning community approach" (Bielaczyc & Collins, 1999, 2006) in which students are engaged in a collective effort toward understanding and advancing their community knowledge. In recent decades, a small community of researchers has been actively exploring topics such as collective epistemology (Acosta et al, 2018), knowledge building discourse (Chen & Hong, 2016), collective inquiry designs (Slotta, Quintana & Moher, 2018), microblogging (short and real-time digital posts) combined with 'talk rules' (Rasmussen et al., 2019), and cross-community collaboration (Zhang et al., 2018). Within this research, a new generation of methods and technologies have emerged, including support for automated discourse analysis and learning analytics for live student feedback (Stahl, 2015). These technologies scaffold student interactions, support community knowledge construction, and foster a sense of collective progress and idea improvement (Cress, Stahl, Ludvigsen, & Law, 2015) – all with the ultimate aim of transforming classrooms into learning communities.

Against this background, our field still confronts a significant challenge in designing such *technology environments for learning communities*, as well as supporting their uptakes in classrooms. Our world is facing the serious consequences of an ongoing pandemic, climate change, political polarization, and misinformation. These challenges cannot be fully explained by individual cognition but are deeply embedded in social and cultural norms and practices, which are segregated by attention-grabbing social media platforms. Recently, the co-editors-in-chief of ijCSCL have advocated for the CSCL community to help illuminate how to design technological settings for group collaboration and how people live and learn as we collectively explore what post-COVID education will become (Järvelä & Rosé, 2020). More than ever, researchers face core conceptual and design challenges in motivating and sustaining collaborative inquiry and knowledge-building dialogues, informing students' dynamic and creative interactions with ideas, and supporting knowledge building across social levels (individual, small groups, community, and open networks) and over sustained durations of time.

This symposium brings together five different research groups, each investigating its own particular questions relating to learning communities. Together we offer a suite of technologies for learning communities grounded in core design principles and classroom research: (1) Talkwall is a socially oriented technology for increasing and shaping class participation, (2) Idea Thread Mapper expands student collaborative discourse across

multiple classrooms with continual idea build-on across school years, (3) CROWDLAAERS is a dashboard of social analytics for annotations of the web to visualize, make sense of and (re)mediate knowledge construction, (4) IdeaMagnets brings student discourse beyond the classroom by combining in-class knowledge building with public discourse on the web, (5) SCORE is a curriculum authoring, orchestration, and student learning environment for hybrid learning designs. Each tool has been designed based on the distinct theoretical and methodological perspectives of its authors (e.g., knowledge building, social networks, scripting, learning analytics). Yet the environments share commonalities (e.g., student discourse and inquiry) and offer complementarities as well as cross-cutting insights. This session will advance our exploration of these possibilities, including scaffolded discourse, social annotations, social learning analytics, orchestration of complex learning activities and interactions, and visualization of community knowledge.

This session will include two parts. First, totaling 60 minutes, each presenter will introduce their theoretical perspective and the corresponding technology environment within the context of a current research study, with time for questions after each presentation. Second, totaling 30 minutes, our discussant (Yotam Hod, from the University of Haifa, Israel) will facilitate a panel discussion with the presenters to engage in conversations across the different technologies and perspectives, and engage audience members in questions and answers. Together with the audience, we will identify opportunities for connecting these next-generation technologies to advance our field's investigation and support of learning communities.

Talkwall - Microblogging for students' reasoning through sharing ideas

Anja Amundrud and Ole Smørdal

Since 2008, we have explored socially oriented technologies to improve the quality of talk and increase the level of participation in classrooms, using various off-the-shelf platforms such as wikis, chats, and microblogging tools. How students and teachers talk together is often implicit and based on historical precedent, such as teachers asking questions or students should wait for their turn to talk. We have worked with teachers to grow a dialogic classroom culture through the introduction and maintenance of explicit 'talk rules' (Rasmussen et al., 2019), aiming to potentially transform pedagogical practices fostering the 'complex competencies' today's students need (for instance, by critically thinking about one's own ideas and how they relate to ideas of others through elaboration and reasoning). Recently, we have developed Talkwall (see figure 1), a microblogging tool aiming to better support same-time, same-place interactions, in line with the specific research-based understandings of dialogic teaching in the Thinking Together approach (Mercer et al., 1999). Here, we present our design, situated within a case where students (aged 11-12) use Talkwall to separate facts from opinions. The findings show that microblogging can provide new possibilities for peer interactions by systematically enabling students to access more of their peers' opinions, produce and discuss collective ideas and contribute and participate in productive talk. In particular, the creative use of a concept tagging activity proved to be a well suited resource for the facilitation of peer interactions where students practice their reasoning together. Microblogging can increase participation, allow for new perspectives to enter dialogues, and support teachers and students in conveying ideas from small group to whole-class interactions.

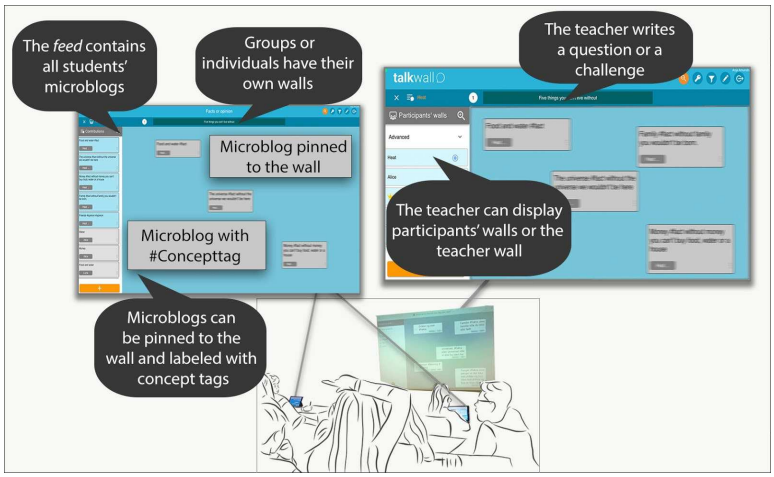

Figure 1. Talkwall being used in a classroom

In order to analyse how ideas travel between group interactions and whole-class conversations, a research tool called "swimlanes" was developed based on digital trace data from Talkwall interactions (such as

'create', 'edit', 'pin' and 'move'). The 'swimlane' visualisation shows groups along an x-axis and their interactions over time along a y-axis, and may show how ideas appear that in one group are taken up and improved in another, or used in a spatial arrangement of ideas by a third group. Such visualisations can provide a powerful complement when combined with verbal transcripts of video recordings, allowing a multi-level coding of the dialogic character of the lesson.

Finally, the consequences of the current pandemic are now bringing education into unfamiliar territory, with hybrid and often incongruent oral and digital practices, we argue that joint negotiation of 'talk rules' may help students and teachers to connect diverse discourses (Staarman et al., 2003) across home, school, and diverse technologies.

Idea thread mapper: Expand and sustain collaborative knowledge building across communities

Jianwei Zhang and Mei-Hwa Chen

To prepare students for a new "white water" world featuring extraordinary challenges and rapid changes, research on learning communities needs to embrace more dynamic and transformative forms of collaboration through which students work creatively and continually on emergent challenges and move beyond pre-set frames and boundaries. Aligned with this need, researchers call for pedagogical and technological innovations to extend and expand collaborative learning over longer timescales and across multiple social levels (Stahl, 2013; Wise & Schwarz, 2017; Zhang, Yuan, & Bogouslavsky, 2020). The Idea Thread Mapper (ITM) project (see http://idea-thread.net) aims to address this need by creating technology support that serves to make collective progress in online discourse visible for student reflection and further accessible for cross-community sharing. With such support, students can better monitor emergent advances and directions in their own classroom's discourse and further build idea connections between different classrooms that investigate related challenges. The design of ITM is guided by a dynamic system view of cross-community knowledge building featuring emergent, multi-level interaction and boundary crossing (Yuan & Zhang, 2019; Zhang et al., 2020). Accordingly, ITM uses a multi-layer framework to organize the collaborative spaces, which include the local discourse space of each classroom where students conduct collaborative discourse to advance their understandings of various problems and a cross-classroom meta-space where students can access and interact with the ideas from the "buddy classrooms" (Figure 2). Valuable ideas and problems developed in each community can be further shared in the cross-community space for higher-level discourse. At the same time, insights developed in the cross-community space are brought back to each community to develop further inquiry and integrated understandings. Learning analytics and visualizations are embedded in the local and the cross-community space to support students' reflective monitoring of emerging inquiry directions, progress, and idea connections. These include theme- and timeline-based visualization of students' online discourse as idea threads, reflective supports for co-authoring "super note" (Journey of Thinking) reflection to deliberate idea progress and problems in each thread of inquiry, a cross-classroom meta-space for sharing inquiry area maps and super notes (Journey of Thinking syntheses), and cross-classroom Super Talk to address emergent challenging issues of common interests.

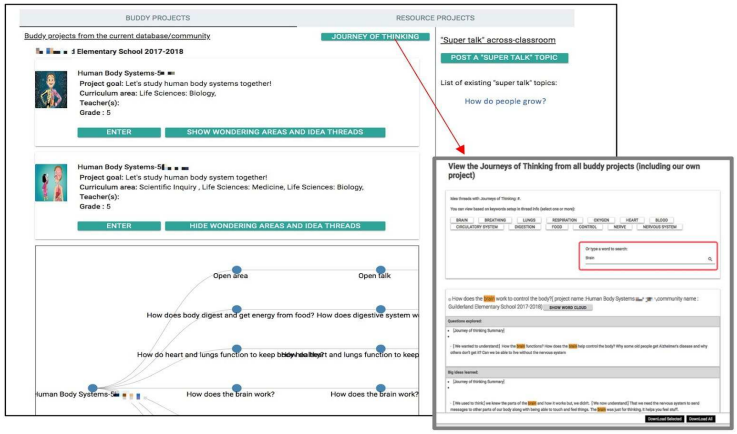

Figure 2. ITM's meta-space for cross-classroom interaction

We conducted a design-based research on cross-community knowledge building in a network of Grades 5 classrooms over three school years. While members of each classroom worked together to investigate various

problems and deepen their understandings in their own discourse space, they composed super notes to synthesize each productive line of inquiry, posted in a meta-space accessible to the partner classrooms. Some of the challenging problems emerging from the cross-classroom sharing resonated with the interests of different classrooms and became the focus of Super Talk across classrooms. Social network analysis revealed intensive connections formed among the students within each classroom, between different classrooms and student cohorts across school years. Mixed methods analyses of the multi-level discourse suggest that dialoguing with the ideas of different communities helped students to enrich and broaden their knowledge, engage in deeper reflection and inquiry, and further rise above distributed expertise to investigate complex issues (Yuan & Zhang, 2019; Zhang, et al., 2020; Yuan et al., 2021).

Co-designing a social learning Aanalytics dashboard to support community collaboration via social annotation

Jeremiah (Remi) Kalir

This study examines dialogic collaboration and knowledge building as jointly mediated by group use of social annotation (SA) and a social learning analytics dashboard. SA is a genre of learning technology that enables the annotation of digital resources for information sharing, social interaction, and knowledge construction (Kalir, 2020; Novak et al., 2012; Zhu et al., 2020). Research suggests SA enables interaction with texts as discursive contexts whereby "anchored discourse" (Gao, 2013) encourages "group-level" (Stahl, 2017) knowledge construction and meaning-making (e.g., Chan & Pow, 2020; Kalir & Garcia, 2019; Plevinski et al., 2017). To augment annotation-enabled discourse, a social learning analytics dashboard has been iteratively developed to help visualize group-level "activity traces" (Shum & Ferguson, 2012) and reveal to a given group their SA discourses, content, and activity contexts (Kalir, in press). Extending methods of participatory design research in the learning sciences (Bang & Vossoughi, 2016; Svihla & Reeve, 2016), this study asks: *How can group-level "meaningful participation" (Espinoza et al., 2020) in joint SA and social learning analytics activity foster collaborative learning?*

Since 2017, a team of researchers has developed a dashboard for Capturing and Reporting Open Web Data for Learning Analytics, Annotation, and Education Researchers (CROWDLAAERS; pronounced "crowd layers"). As a dashboard visualizing collaborative processes (e.g., Martinez-Maldonado et al., 2015), CROWDLAAERS displays social ("crowd") interaction and helps reveal how annotation ("layers") mediates collaboration. The dashboard reports social learning analytics associated with the open-source Hypothesis SA tool (Kalir, in press). We report on a study of the Right to Learn Undergraduate Research Collective (R2L), a university-based group studying case law to understand how concepts of dignity and equality are fundamental to the right of personhood. Working asynchronously and across continents, R2L has used Hypothesis SA and CROWDLAAERS to analyze a corpus of 52 legal documents (over 2,000 pages). As one participant noted, "Hypothesis was our tool of choice because of its capacity to function as a digital historian of our thinking." This study analyzes design artifacts, R2L's SA data, CROWDLAAERS activity traces, and audio recordings of group sessions. We document patterns of meaningful and multimodal group dialogue, conflict, and synthesis across social and technological contexts. Groups like R2L can leverage collaborative SA practices and open-access analytics resources like CROWDLAAERS to help visualize, make sense of, and (re)mediate knowledge construction. This case indicates promising approaches to the enactment of group-level constitutive acts and sociotechnical practices for meaningful participation in community learning.

Connect knowledge building and public discourse with the IdeaMagnets tool

Bodong Chen, Yu-Hui Chang, and David Groos

Our world is facing serious challenges such as an ongoing pandemic, climate change, political polarization, and misinformation. It will be "a great waste" for learners if school is largely disconnected from what is going on in the world. This study attempts to connect knowledge-building classrooms with public discourse by supporting the movement of knowledge artifacts across web spaces. This work builds on the Knowledge Building (KB) tradition that involves classes of students to work as knowledge communities to solve authentic problems through the continual improvement of their ideas (Chen & Hong, 2016; Scardamalia & Bereiter, 2014). To firmly connect the knowledge-building enterprises in schools and society, we posit that new technological infrastructures that embrace openness and bridge different web spaces are needed. To cohere learners' engagement in school and societal issues, we need to create entry points from the open web to sustained knowledge work, and vise versa.

Following the design-based research approach (Collins et al., 2004), we developed the IdeaMagnets tool based on an open-source web annotation technology named Hypothesis. The technological design of IdeaMagnets

included two key components: (a) a collaborative web annotation system based on Hypothesis for students to annotate web documents; and (b) a Knowledge Forum add-on that queries Hypothesis annotations and enables learners to import annotations into Knowledge Forum for further discussion. Essentially, IdeaMagnets opens a gate for information from the open web to seamlessly enter Knowledge Forum while also projecting a knowledge-building mindset to learners' engagement with web resources.

To pilot the IdeaMagnets tool, we worked with five science classes (n = 95) in an urban public school in the United States. During this pilot, students studied a science unit on energy in connection with the "Green New Deal" that was trending in the US public discourse. Multiple sources of data were collected including student interviews, researcher fieldnotes, video recordings of classroom activities, and students' online discussions. Results showed that students approached the "Green New Deal" from different disciplinary angles (e.g., energy, economics, population, public health) and incorporated annotated information from public discourse to advance their Knowledge Forum discussions. Figure 3 presents a discussion thread made of 16 notes contributed by seven students. While this thread was launched based on a news article about rare-earth mining, students enriched their work by incorporating ideas captured in other web sources; five students created six notes containing web annotations imported via IdeaMagnets. The discourse pattern illustrated by the example was reflected in all five classes, showing the promise of supporting students to connect in-class knowledge building with public discourse.

Based on the study, we discuss the following opportunities of designing future technology for learning communities: (a) interfacing a community's knowledge processes with the open world, (b) allowing CSCL technologies to converse with general-purpose open-source tools while focusing on epistemic scaffolding, and (c) exploring open data exchanges among learning systems to enrich learning experiences and learning analytics.

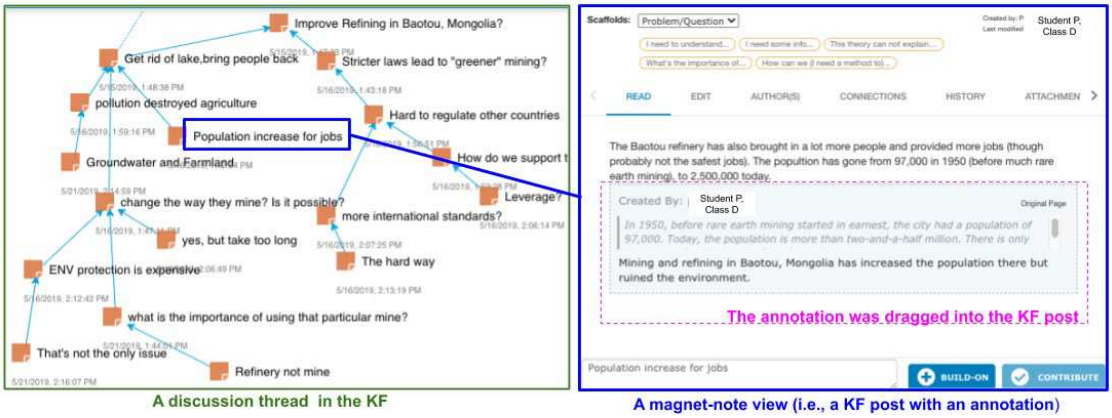

Figure 3. An example of using IdeaMagnets to connect public discourse with Knowledge Forum.

Scripting and orchestration of knowledge community and inquiry

Joel Wiebe and Jim Slotta

The pedagogical model called Knowledge Community and Inquiry (KCI) has been developed to guide our design of learning community curricula that engage students in collective forms of inquiry in which they, develop shared knowledge and practices while engaging in scripted inquiry activities (Slotta & Peters, 2008; Slotta, Quintana & Moher, 2018). KCI employs collaboration scripts (Kollar, Fischer & Hesse, 2006) to coordinate the orchestration of complex collaborative tasks, explicating roles, goals, groupings, sequences, and materials (Slotta, Tissenbaum & Lui, 2013). In KCI, students construct a collective knowledge base, indexed to a specified set of learning goals, that serves as a central resource for subsequent scripted inquiry activities (Slotta & Peters, 2010; Slotta & Najafi, 2013). Over the past decade, KCI has investigated forms of knowledge representation, classroom discourse, and inquiry designs (Moher et al., 2015; Fong & Slotta, 2018) often supported by bespoke technology environments, tailored for particular research contexts, including real-time analytics, intelligent agents, and student and group process modeling (Fong & Slotta, 2018; Slotta & Acosta, 2017).

We are currently developing a next-generation learning environment called SCORE (SCripting and ORchestration Environment) that adds a powerful layer for authoring and run-time orchestration capable of supporting a broad range of KCI inquiry scripts. The SCORE platform was launched in early 2020, coincident with the emergence of the COVID-19 pandemic. Our technology and pedagogy have positioned our research as a means to design for and promote peer-supported learning during these unique times of hybrid and online learning. This paper will begin with a summary of KCI and SCORE, followed by a review of early studies of undergraduate students in Wuhan, China and pre-services teachers in Munich, Germany. We then present a study

of intermediate statistics in a graduate program in Toronto, Canada in which we re-envisioned the notion of *flipped classrooms* (Bishop & Verleger, 2013), that included pre-recorded lectures at-home activities, by re-imagining *how* they can be delivered as digestible, interactive activities in the context of cooperative and collaborative scripts. These at-home activities were then developed and orchestrated within SCORE. We describe how our collaboration scripts served to coordinate individual, collaborative, and collective activities that aim to improve peer-support for learning. We present student outcomes in terms of epistemological beliefs about the value of their peers and learning community pedagogy. We close with a discussion of the opportunities for further research in scripting and orchestration that may be afforded by a flexible authoring environment like SCORE. At present, we are developing new features for SCORE, including improved learning analytics, orchestration controls for teachers to monitor and guide activities, components for helping small groups negotiate and socially annotate community knowledge, and intelligent agents to support effective student groupings, alerts, and activity transitions. We also discuss possible intersections with other tools and environments presented within this session.

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