Researching and Designing for the Orchestration of Learning in the CSCL Classroom

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Abstract: Designing tools for teachers to orchestrate computer supported collaborative learning activities in their classrooms requires that attention be paid to the range of roles and activities a teacher must take throughout the process. Drawing on the Implementing Collaborative Learning in the Classroom framework proposed by Kaendler, Wiedmann, Rummel and Spada (2014), the contributors to this symposium will speak to the way their designs address the various parts of this framework, allowing us to draw conclusions about what has been successful for different parts of this process, and identifying future directions for development and research.

Keywords: teachers, design issues, classroom technology, collaborative learning

Focus of the symposium

As the field of computer-supported collaborative learning embraces an ever-widening set of technologies, the opportunities to implement CSCL activities into classrooms increases, and the role of the teacher in orchestrating the learning experiences becomes a central concern. Moving away from standard personal computer and online activities, in favor of handheld devices, immersive simulations, large interactive surfaces, and device ecologies in classrooms allows for more face-to-face CSCL interactions in classrooms. These tools provide new opportunities to use the students' interactions with the technology to provide insight into the collaboration and learning processes, through the use of learning analytics. Thus, there is both the potential and the need to design tools for teachers to use when orchestrating CSCL activities in their classroom (Dillenbourg & Jermann, 2010).

The teacher's role in supporting collaborative learning has received limited attention in the research literature (Webb, 2009), however, in a recent paper, Kaendler, Wiedmann, Rummel and Spada, (2014) propose a framework for teacher competencies in the implementation of collaborative learning in classrooms. Building on the premise that effective collaborative learning is largely dependent on the quality of student interactions, the framework focuses on teachers' competencies in planning for, monitoring, supporting, consolidating and reflecting on these interactions. Three phases of activity are identified in the Implementing Collaborative Learning in the Classroom (ICLC) framework. In the first phase, the pre-active phase, the teacher is involved in planning the collaborative activity. In the second, the inter-active phase, the teacher focuses on monitoring, supporting and consolidating the collaboration, while students engage in collaborative, cognitive and meta-cognitive activities. During the final, post-active phase, teachers focus on reflecting on the activity and evaluating the student interactions in order to inform future activities. They propose that teachers draw on their professional knowledge and beliefs to develop these competencies. This framework provides a useful starting place for those involved in designing computer-supported collaborative learning activities for classrooms, as it highlights the ways in which the teacher participates in these activities. This allows researchers to consider the range of opportunities for teacher engagement with collaborative activities, and design tools that support teachers during the different stages or activities in this process.

The major issues addressed and contribution of each presentation

The goal of this symposium is to bring together researchers who focus on computer-supported collaborative learning in classrooms. Using their research and design work as it relates to the role of the teacher they will elaborate on the ICLC framework, identify areas for further development of the framework, and suggest how it can be used to guide the design of orchestration tools. Two of the contributions focus directly on the design of tools to support teacher engagement during the inter-active phase of CSCL activities, providing initial examples of the integration of technology into the orchestration process. Two focus on the actions of teachers during CSCL activities in classrooms, developing our understanding of when and how teachers intervene at the small group or whole class level, to inform future design decisions. The final three contributions focus on different aspects of what teachers need in order to engage in the CSCL process, providing different lenses through which to examine and extend the ICLC framework (fostering student interactions and teacher competencies with technology and collaborative learning pedagogy).

In the first contribution, Martinez-Maldonado draws on research from the University of Sydney that examines how visual indicators can be used to help inform teachers about how students are interacting during collaborative tasks on multi-touch tables during the interactive phase of the ICLC framework. In a similar vein, Mercier's contribution examines how providing teachers with updates about the content being created by group members can be used by teachers to identify which groups or students need their attention.

The contributions from both Fong and colleagues, and Joyce-Gibbons, pay attention to the way in which teachers orchestrate the whole-class interaction activities, during computer-supported collaborative learning tasks. From these we draw a deeper understanding of the inter-active phases of the framework, and in particular the informational needs of the teacher to help make decisions about when and how to intervene at the small group or whole class level.

The final three contributions ask what the teacher needs in order to 1) support the students' interaction behaviors, 2) use technology effectively and 3) use collaborative learning effectively. The contribution from Israel looks at two important aspects of supporting CSCL – the preparation of students to participate in collaboration, and on-going interactions of teachers to align students with the expected collaborative interaction behaviors. Using a framework to teach students about positive collaborative interactions developed by teachers in the research site, Israel reports on how it provides a basis for teachers to monitor and support students during collaborative processes. Forssell focuses on how to support teachers using technology – a key aspect of implementation. Drawing on survey data of practicing teachers, she identifies the prerequisite teacher beliefs and knowledge for adoption or adaptation of technology in the classroom. Finally, Shehab's contribution draws on survey data from teachers who actively use collaborative learning, focusing on the key issues that they identify, in an effort to further elaborate the design requirements for tools to support orchestration of CSCL.

Significance

This session will be organized as a structured poster session. Each contributor will take five minutes to describe their work at the beginning of the session. The rest of the time will be equally divided between audience engagement with the posters and an audience-wide discussion of future directions for this work. Rummel, an author of the ICLC framework, will provide commentary about the contributions and their relation to the framework at the beginning of the audience-wide discussion.

The significance of this symposium will be in drawing out the specific design issues related to the ICLC framework, informed by research that is actively addressing the role of teachers in CSCL classrooms. It will allow future development work to build on this framework, providing common terminology and a shared understanding of the issues to facilitate comparisons or joint development work.

Learning analytics and teachers' awareness in the CSCL classroom

Roberto Martinez-Maldonado

Parts of the model addressed: Inter-active phase (monitoring and supporting).

A particular recent strand of research carried out at The University of Sydney has focused on enhancing teacher's awareness in a multi-tabletop CSCL Classroom: the MTClassroom (Martinez-Maldonado, 2014), by developing and evaluating a series of awareness tools. By awareness tools we refer to those that provide a user (e.g. the instructor) with an enhanced level of awareness of what other actors (e.g. students) are doing in the learning space. This research has explored different ways to exploit student's data that can be pervasively captured through enriched multi-touch interactive tabletops to provide teachers with group indicators that cannot be easily evaluated by teachers in the limited classroom time. This provision of visual indicators is strongly linked to the field of *Learning Analytics* (LA) which has emerged in recent years as a multidisciplinary research area with the aim to improve the overall learning experience for instructors and students. This suggests the potential value of the overlap between CSCL and the LA fields to provide novel and practical support in the classroom.

Part of the research studies in this project has included the exploration of real-time visualizations and notifications that can suggest (or more directly alert) teachers about groups that may be facing problems (Martinez-Maldonado et al., 2014). Additionally, a number of data mining techniques has been applied to detect student's behaviours that may not be collaborative and to identify the frequent patterns that are mostly associated with high or low achieving groups (Martinez-Maldonado, 2014). However, the most significant contribution and recent contribution of the project is a proposed workflow to help other designers or researchers to more effectively design and deploy awareness tools for technology-enabled learning settings by following an UX-based iterative approach.

Even though most of the work in this strand of research has addressed the inter-active phase of the ICLC framework, work in progress is looking at the support that can be provided in design-time to teachers (pre-active phase) to design and re-design the learning tasks to be deployed in the classroom. Alternatively, further work is analyzing the ways in which similar learning analytics tools can be used by teachers to promote reflection after the classes have been enacted in the multi-tabletop classroom in order to drive re-design (post-active phase).

Live content updates and teacher intervention in collaborative groups

Emma Mercier

Parts of the model addressed: Inter-active (monitoring and supporting)

The SynergyNet classroom was designed to allow teachers to manage the networked multi-touch tables from a number of devices, including the shared display and a tablet. The teachers could send content to the tables, move content between the tables and shared display, freeze and clear the tables as necessary and, in some instances, view the work being conducted on the tables and change the parameters of the task. In this contribution, we focus on the use of live updates to the teacher's tablet during a collaborative math activity and ability to change the task demands. This tool was developed in order to allow teachers to more easily assess the contributions of each individual student during the task.

Building on a traditional classroom activity the tool NumberNet was designed to foster the development of mathematical adaptive expertise (Mercier & Higgins, 2013). During this activity, each group receives a target number, and each student works on their own number-pad to create expressions for that number. The number-pad does not allow students to send duplicates to the table, but it does not reject incorrect expressions. Groups work cooperatively or collaboratively to come up with as many correct expressions as they can during a time limit. The teacher's tablet receives live updates from the students, allowing her to see the correct (in green text) and incorrect (in red text) expressions each group or student is creating. In our studies with this tool, the teachers used the live updates to 1) identify a student who was making the same mistake repeatedly and intervene at the individual level; 2) identify groups who were relying on simple expressions and remove certain keys from the number-pad (e.g. the addition sign, the number 5) to make the task harder for the group; 3) identify a group who were struggling and pause the whole activity, using the shared display to conduct a whole class discussion to help prompt the struggling group with new ideas.

These tools allowed the teachers to make informed decisions about intervention at the student, group or whole class level, altering the tasks and providing support as necessary. Although not explored in our studies, the tools also have the potential of being used in the post-active phase of the ICLC framework, where the teacher could use the information gathered during the task to prompt her reflections on the task and adapt the task for future use. Additionally, when paired with tools that support the creation of tasks and allow teachers to monitor the interaction of students, there is the potential to provide teachers with much needed insight into when to intervene at the various levels of learning that occur in the collaborative classroom.

The 3R orchestration cycle: Fostering inquiry discourse in a CSCL classroom

Cresencia Fong, Rebecca Cober, Richard Messina, Tom Moher, Julia Murray, Ben Peebles and James D. Slotta

Parts of the model addressed: Inter-active (monitoring, supporting, consolidating)

We observed exemplary inquiry teachers and found that they employed an orchestration "cycle" of Reflect-Refocus-Release (3R) as a means of managing their CSCL classroom, over a 9-week astronomy unit for 2 classes of grade 5/6 students. To support their inquiry, students used Common Knowledge (CK) – a note-sharing tool that allows for "blended" (online and face-to-face) discourse (Fong, 2014). CK scaffolded students through 3 phases of collaborative astronomy inquiry: Brainstorm, Propose, and Investigate (Fong et al., 2013). Using tablets, students contributed to a community knowledge base that was represented in a public view on the interactive whiteboard (IWB), which persistently and publicly visualized the community's idea flow. Large displays were also created for student groups, on the side walls of the classroom, providing a visual mapping of the spatial distribution of inquiry topic specializations during the Investigate phase. Such public displays enabled learners to sort ideas along socially negotiated categories. Inquiry work done in the CK environment was seen to influence the discourse in teacher-guided classroom discussions, and vice versa (Fong et al., 2014).

Throughout the inter-active phase of the ICLC framework, teachers used these public knowledge visualizations as formative assessment of the community's knowledge state, to inform their monitoring of collaborative, cognitive, and metacognitive activity in the classroom. Students' CK notes displayed on the IWB were used by teachers to ground and spur face-to-face rounds of *reflective* classroom discourse, by which teachers supported and guided their knowledge communities' cognitive and metacognitive activity towards knowledge consolidation, which often led to further inquiry trajectories. Such discourse usually culminated in teachers' instructions that *refocused* the community's subsequent inquiry and cognitive activity, scaffolding students towards productive trajectories; at which point, students were *released* to pursue their inquiry collaboratively – resulting in further note contributions to the community knowledge base. This "3R" cycle figured prominently in teachers' orchestration of their enactments. Formative assessment of the community's publicly displayed knowledge state informed teachers' small-group interactions with students during Release, enabling them to provide timely support to students whom they deemed were in need. Reflective community discourse was pivotal in helping students develop awareness of their community's state of knowledge, achieve knowledge convergence, and receive teacher guidance towards productive inquiry.

Content analysis of students' CK notes examined their congruity with ideas that had emerged in previous inquiry phases. The primary goal of such analyses was to determine if the collective inquiry was progressing, by uncovering the extent to which teachers' Refocus statements were indeed driving students' inquiry progress, and to determine if CK was able to support the carriage and application of knowledge from one inquiry phase to the next. Average scores for both classes were above 1.6 (out of maximum score of 3.0), suggesting that proposals (i.e. from the Propose phase) were somewhat inspired by direct reference to Brainstorm notes (i.e. from the Brainstorm phase), and Reports (i.e. from the Investigate phase) were influenced by the corresponding proposals to which they were linked.

CK technology was designed to guide knowledge communities through a phased inquiry progression while enabling students to drive their own inquiry trajectories. Its technology and script design assumed an important role for the teacher, in the orchestration of the technology and inquiry activity. Future CK design will aim to decrease this teacher orchestration load – especially the monitoring of students' collaborative and cognitive activity (i.e., during Release phase) in the inter-active phase of the ICLC, so that teachers could devote more of their attention to supporting and consolidating students' cognitive and metacognitive activity (during Release and Reflect). To this end, using technology to increase teachers' awareness of the community's ongoing state of knowledge, in terms of "where they are" and "where they are going", can better equip teachers in their scaffolding of the community inquiry (i.e. Refocus).

Exploring teacher behaviour prior to the initiation of mini-plenaries during collaborative group work

Andrew Joyce-Gibbons

Parts of the model addressed: Inter-active (monitoring, supporting, consolidating)

Classroom orchestration requires that teachers resolve a number of inherently contradictory imperatives (Dillenbourg, 2013). They must balance the need to maintain disciplinary norms, keep to time and manage classroom resources, with the need to stimulate dialogue (Perrotta & Evans, 2013). This study looked at teachers' use of transitions from group-level interaction to whole-class interaction returning to group-level interaction in the context of these contradictory imperatives. Whilst such transitions are a common feature of a teacher's repertoire, the orchestration tools developed by the SynergyNet project enabled a more rapid shift in register, giving teachers the ability to freeze and unfreeze all tables simultaneously (Mercier et al. 2012).

Two teachers working with 10 and 11 year-old children were observed prior to the initiation of nine transitions. Each showed distinct behaviours in the minute prior to initiation of a transition. One teacher interacted with a single group and then called the whole class together after observing issues that that group was encountering, using the whole class discussion as a time to identify the issue and prevent all groups from going down the incorrect path. The other observed all groups silently for an extended period and then started a classroom conversation based on a group who appeared to be working well, using their correct moves to model the appropriate problem solving activities to the class. These behaviours indicate the processes of reflexive judgment by teachers that take place in the interaction phase of the ICLC framework.

The teacher's task as orchestrator of a CSCL activity is to continually balance progress being made by their students towards task completion, while engaging in deep collaborative discussion and knowledge convergence. Maintaining both sufficient progress for all groups in a classroom, and supporting all groups in collaborative knowledge building may represent a mini-ICLC cycle of pre- inter- and post-active phases within the lesson. Further research is needed to study this cyclical process by observing the impact of the transition on groups of students once they resume their tasks.

Further research is also needed to explore the collaboration management cycle and identify and evaluate the indicators that lead teachers to conclude that groups have deviated from the desired model of interaction sufficiently to warrant an intervention. A challenge for future CSCL classroom design is to provide teachers with a set of real-time indicators that enable them to make better-informed judgments as to the necessity or direction of intervention.

Supporting collaborative interactions during computing in K-5 classrooms

Maya Israel

Parts of the model addressed: Inter-active phase (monitoring and supporting).

Computing education is spreading quickly with initiatives such as Code.org's Hour of Code emerging. One of the advantages of computing technologies has been the focus on student collaboration and problem solving with peers. In this way, students can engage in computational *thinking* and computational *participation* that results in a connected learning community (Kafai & Burke, 2014). Computing environments such as Scratch rely on highly social processes in which students are encouraged to share their work with peers during the creation process. However, Good (2011) explained that despite the social aspects of these programming environments, we have yet to fully understand the types of collaboration that exist between learners and the types of benefits that students gain through these collaborative computing experiences.

This contribution will highlight findings from a school-wide computing study that examined the use of the Collaborative Discussion Framework (Lash, Park, & Pitcher, 2014) for encouraging collaborative computing. The Collaborative Discussion Framework was created to help teachers facilitate collaborative problem solving during the computing process because although collaboration is widely discussed within the computing literature (Kafai & Burke, 2014), students often did not naturally collaborate effectively. Research questions included: (a) How do teachers promote collaboration within the context of computing instruction? And (b) How does teaching students how to collaborate influence their interactions and behaviors during collaborative problem solving? Data was collected through the Collaborative Computing Observation Instrument (C-COI), in which students' computing experiences were captured using Screencastify (an open source screen capture software that also records audio). In this way, we could observe the on-screen behaviors of the students as well as the conversations that they had while they completed computing tasks. The aim of using the C-COI was to measure how teachers promoted collaborative computing as well as the process of collaborative problem solving during difficult computing tasks. The C-COI was used to measure how teachers monitored interactions among their students and facilitated collaborative problem solving, persistence, and positive help seeking. The ICLC framework identifies the importance of students' collaborative interactions, and the teacher's role in supporting these interactions throughout the three phases of the framework. This study provides insight into how teachers can prompt students to engage in particular forms of interaction and discussion and highlights the importance of proactive planning for collaborative discussions within the context of CSCL instructional practices.

Ready, Able, and Willing to Adopt CSCL Practices

Karin S. Forssell

Parts of the model addressed: Professional knowledge and teacher beliefs

Designing and implementing computer-supported collaborative learning activities requires teachers to learn new tools, new techniques, and new tasks. It requires both a pedagogical facility with collaborative activities, and an understanding of the technological tools that support them. In many studies of CSCL, the availability of the technologies, the teacher's pedagogical competencies, and the willingness of teachers to engage in these tasks are taken as a given. This contribution seeks to 1) position the competencies identified in the ICLC framework in the broader context of the prerequisites for successful implementation of CSCL, and 2) explore what it might mean to be willing and prepared to engage in CSCL activities.

This study draws on data from a survey of accomplished secondary teachers in the US to examine the role of teacher competence in the adoption of new technologies and practices in classrooms. We make a distinction between being ready, able, and willing to use new tools. We define *ready* as self-perceived competence. *Able* is represented by access to the required external resources. *Willing* is operationalized as a belief in the value of using computers with students. We explore these three constructs in relation to two outcome variables: exploration of new computer-based activities with students, and frequent use of computers in the classroom. Results suggest that the teacher's self-perception of competence is the largest predictor of both exploration and repeated use of new technologies. The external resources available, in this study represented by computers available in the classroom, play a large role in frequent use of technology, but are not a significant contributor to exploration of new activities. Finally, beliefs about the value of technology in teaching and in the discipline contribute to both frequent use and to exploration.

We use these findings to explore what it would mean to prepare teachers to be ready, able, and willing to implement CSCL in their own classrooms. Specifically, we explore the important educational beliefs that motivate teachers' use of CSCL (Pajares, 1992). In our study, beliefs about the impact of technology in the classroom are explored based on key elements of Pedagogical Content Knowledge (Magnusson, Krajcik, & Borko, 1999): knowledge and beliefs about curriculum, about students' understanding of specific topics, about assessment, and about instructional strategies. For this contribution we explore beliefs inherent in the ICLC framework, and how they relate to the identified competencies. After exploring the application of these findings to the ICLC framework, we suggest areas in which the framework provides important insights, and areas in which it could be extended.

Teachers' reflections on implementing collaborative learning in classrooms

Saadeddine Shehab

Parts of the model addressed: Issues identified in Implementing Collaborative Learning in Classrooms

One of the key features of the ICLC framework is an emphasis on the capacities that teachers bring to the classroom when they orchestrate collaborative learning experiences. Understanding more about these capacities, and the issues that teachers encounter across the three phases of collaborative learning is essential to our understanding of how to develop tools to support teachers during CSCL activities. Prior research has indicated that teachers identify issues related to time management and preparation of students to engage in collaboration (Gillies & Boyle, 2010) and issues relating to institutional norms, pedagogical practices and contextual constraints of school systems (Ruys, Van Keer, & Aelterman, 2014). To further extend our understanding of the issues encountered by teachers who are actively using collaborative learning in their classrooms, we designed a survey to explore the experiences of middle and high school science teachers using collaborative learning in one US state. The survey was completed by 69 middle and high school science teachers. For the purpose of this symposium, we will report on teachers' responses of three open-ended questions that aimed at exploring their definitions of collaborative learning, their reasons for not using it, and their comments on its implementation. The open-ended answers were coded using an emergent coding scheme to identify the different themes that emerged in the answers.

When asked to define collaborative learning, teachers' responses were coded into the categories: describing the purpose of collaboration, the interaction process, the outcome of collaboration, their roles as teachers, and the influence of the task. The majority of definitions included the first three codes but reflected understandings of collaborative learning that was coded as naïve, moderate, or robust. Only one response was coded as referencing the role of the teacher and the influence of the task. In response to a question asking for reasons that they did not use collaborative learning the teachers listed reasons that are coded as related to students such as age and disciplinary problems and related to teachers such as stress, health, and lack of resources. Other factors that were identified included time constraints and unequal participation of students when working on collaborative tasks. In response to the open-ended item asking for any other comments about collaboration, most responses were general positive or negative reactions to using collaborative learning or specific issues that the teachers had encountered. A small number of responses were coded as relating to a need for professional development, the role of technology in fostering collaborative learning, and a need to explicitly address collaborative learning skills before, during, and after implementing it with students.

These findings shed light on teachers' understandings of collaborative learning, and the real or perceived barriers to the use of collaborative learning in classrooms. These provide an important understanding of real teachers, their experiences and competencies in implementing collaborative learning and possible areas for intervention and development. The responses identified the issues such as time management, resources and outcomes or assessment issues, as well as needing to prepare students to engage in collaboration and participate equally. Drawing on the ICLC framework, there are a number of design opportunities at each phase that could be implemented to allow teachers to more easily design, monitor and assess collaborative learning and CSCL activities in their classrooms. In the design of CSCL tools, identifying the problems encountered by teachers ensures that the tools created provide useful solutions that ease the issues related to orchestrating collaborative learning in classrooms.

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