CSCL and Innovation: in Classrooms, with Teachers, among School Leaders, in Schools of Education

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Abstract: We expand the notion of CSCL to understand how people can become more innovative. Good learning designs in CSCL can provide opportunities for students to co-construct ideas leveraging on cognitive diversity, to be creative and to experience the discipline of innovation while at the same time learning curricular disciplinary knowledge. The adoption of CSCL in the classroom necessitates teachers to be innovators that understand and know how to harness the affordances of CSCL tools for effective classroom learning. CSCL is also predicated on the necessary socio-cultural conditions in schools created by school leaders to foster an environment for teachers to be willing innovators and to be able to manage risks. By studying and expanding CSCL from the innovation perspective, we may shed light on the most important factors in translating the various research studies of successful CSCL to impactful real world adoption of these technologies in classroom practices.

Introduction

CSCL shifts the focus of education from learning as acquisition of knowledge and facts to learning as building shared meaning, enculturation into social practices and participation in valued activities situated within a community of practice. Various research studies and practices in CSCL offer the promising approaches for restructuring interactions in classrooms to accomplish this shift. However, spreading and scaling CSCL approaches is not easy (Roschelle, Rafanan, Bhanot, Estrella, Penuel, Nussbaum & Claro, 2009). In this symposium, we examine how recasting CSCL from an intervention framework to an innovation framework could better facilitate spreading and sustaining shifts from knowledge acquisition to enculturation perspectives.

Educational research typically takes an intervention perspective, in which the components of a new approach are packaged as a "thing" which we ask schools to implement with "implementation fidelity" to researchers' image of "transformed teaching and learning." However, we observe that when teachers enact CSCL designs in the classroom, they are enacting alternative classroom pedagogies, and oftentimes they are challenged to be versatile and to be able to improvise based on the student's interactions in CSCL. To spread and sustain these pedagogies, teachers must take risks as they begin to question the traditional assumptions of teaching and learning. Indeed, experimenting with CSCL practices provides a catalyst with which they might begin to view students' learning and their own teaching in very different perspectives, and reflect on their teaching and facilitation. These observations suggest that in the best CSCL implementations, something different than implementing a packaged thing with implementation fidelity to a researchers' image of transformed teaching and learning is going on.

Alternatively, CSCL research could take an innovation mindset. In an innovation mindset, we view a class and school as an ecological system with the potential force to change. Classroom structure and culture for social interaction are no longer fixed, but can be designed and adapted with careful consideration of multiple dimensions such as cultural beliefs, practices, socio-techno-spatial relations, and interaction with the outside world (Bielaczyc, 2006). From an innovation mindset, new CSCL technological affordances are not a "thing" to be implemented with fidelity, but rather a representational and communication infrastructure that that lowers the threshold for change. School-based leaders do not merely apply a pre-packaged program, but instead must become champions (Carlson, 2006) who lead teams that create new educational value using the infrastructure. The role of researchers is not necessarily "technology transfer" – making things to deliver to the classroom – but can rather serve as contributing innovation guides, who help schools refine the value proposition of their own transformative work, for example, by helping innovation teams better understand how needs, approaches, benefits and alternatives fit together compellingly and cohesively. Indeed, recent educational research suggests that the new resources that make a difference and last in schools are not "simple resources" that are used in school unchanged but rather are "compound resources" that involve substantial configuration, assembling, and elaboration in schools sites (Fishman, Penuel, Hegedus, Moniz, Dalton, Brookstein, Beaton, Tatar, Dickey, & Roschelle, 2009; Looi, So, Toh & Chen, 2010).

Dillenbourg (2009) further substantiates this view by arguing the need for CSCL research on "design for orchestration" in terms of better understanding of what are the supporting and constraining conditions for productive success or failures of CSCL tools and practices. We see the process of "orchestration" as deeply resonant with the role of innovation champions and team – the leaders of the process of innovation in a specific site. What underlies this notion of design for orchestration is the need to "empower teachers", and this starts from enabling deeper understanding of the fundamental challenges and issues that teachers are facing with CSCL ideas, tools and practices. The effective adoption and enactment of CSCL approaches and tools in a classroom requires the teacher to be an "orchestrator." Teachers innovate in the classroom as an orchestrator of a multi-constraint management problem, cognizant of the curriculum, assessment, time, energy, space and safety constraints (Dillenbourg & Jerman, 2009).

This symposium brings together researchers and scholars from Singapore, Spain and USA to expand the perspective of CSCL to studying how people orchestrate innovation in education using collaborative tools. As orchestration occurs at multiple levels, we have organized a series of presentations that begin with orchestrating innovation in classrooms, then continue to discuss orchestration when researchers work with teachers, followed by a discussion of innovation at the level of school leaders, and finally considering how a more innovation-oriented CSCL perspective could be applied at the institutions that train teachers and school leaders. Before introducing each of the presentations, we provide an overview of the challenge and opportunity of linking innovation and CSCL. Our discussants Roy Pea and Tak-Wai Chan will consider how this layered view of educational innovation can in turn inform successful conditions and strategies for CSCL expansion throughout classrooms and schools. By focusing on linking innovation with the practice of CSCL and to the need for transformative policies in educational systems, we aim to contribute to a vibrant discussion of the conference theme of CSCL's impact on practice and policy.

Challenge: The Imperative for Innovation in Schools

Incorporating an innovation perspective into CSCL could be powerful because CSCL researchers who attempt to impact collaborative learning practices in school often face cultural and epistemological challenges to transform classroom practices and cultures. Dominant cultures in classrooms are still teacher-centric and individual performance based, and collaborative learning practices are not naturally cultivated with the mediation of CSCL technologies alone. This issue would be more prevalent and important in the Asian countries than other western countries, since much of Asian school culture is based on individual performance, competitive assessment, and ability-based grouping. Our interaction and conversation with Singapore teachers shows that they tend to be risk-averse and tend to hold deep concerns and doubts about pedagogical approaches promoting greater student agency and social interaction. They are also specifically concerned with whether such pedagogical approaches would work for academically low-achieving students.

Yet, Asian countries are also very concerned with not just standardized academic achievement but also in cultivating the dispositions and abilities of their human resources to be more innovative. For example, Singapore faces the unique challenge of transforming its disciplined culture into a culture of disciplined innovation. Over the past century and especially the last 40 years, Singapore has been a stellar over-achiever among the high-flying Asian economies. In the Global Competitiveness Index 2010-11, Singapore was rated third, following only Switzerland, and Sweden, with USA coming in fourth (World Economic Forum, 2010). The success Singapore has realized in its education system is exemplary of this competitiveness as evident in its performance in TIMSS in 1999, 2003, and 2007 and in PISA 2010. But as Singaporeans have catapulted their island nation to first world status with accomplishments in a variety of fields of endeavour, they are beginning to question whether the strategies and mindsets that were critical for catching up with the first world will continue to serve them as well in their next challenge: taking leadership in a global exponential economy that demands innovation. Doing so requires radical changes throughout that foster a spirit of risk-taking and openness to people and new ideas. An environment must be created that also encourages tolerance of the missteps that naturally occur in value creation. This challenge presents an important opportunity to Singapore: namely to spearhead the methodical application of innovation practices throughout its education system.

Hence, a focus on linking innovation and CSCL is especially relevant to policy considerations in the Asian region which hosts this year's CSCL, as the link may serve to highlight CSCL not merely as an intervention for boosting academic scores, but also a potential shift in mindset that opens the door to transforming schools as exemplary sites of innovation. Relating to a dominant policy theme of preparing students to be future knowledge workers, the CSCL approach of knowledge building views learners as workers in a knowledge society, sharing intentionality in wanting to move the communal knowledge base progressively forward. Students in knowledge building classrooms engage in a communal process of creating and improving ideas, and providing rise-above views (Scardamalia, 2002). They can be innovators in the classroom by advancing ideas forward as a learning community. In pedagogies enabled by connected classroom technologies such as the GroupScribbles system, the students are involved in a process of brainstorming and generating ideas which can be then collectively built upon in a process of rapid collaborative knowledge improvement. By doing

so, the students both can learn existing subject matter more deeply, become participants in 21st century knowledge building practices, as well as developing the dispositions that allow them to experiment with CSCL practices in the classroom. In the learning sciences literature, there is much focus on learning environments for students to prepare them to be a community of knowledge workers. Student learning is still our ultimate goal, but in this symposium, we want to foreground the role of educators who play a prominent role as gatekeepers to unlocking the potential for students to be innovators.

Teaching for the innovation economy must be improvisational because if the classroom is scripted and overly directed by the teacher, students cannot co-construct their own knowledge (Sawyer, 2000). CSCL approaches and tools offer the potential to transform the classroom experiences from IRE patterns (a teacher initiation (I) is followed by a student reply (R), followed by an evaluation of this reply (E) by the teacher) to more participative patterns. Changing such deep-seated traditional patterns of classroom discourse poses a considerable degree of challenge for classroom reform.

Opportunity: Engaging with Teachers and School Leaders as Innovators

To address this challenge, school leaders need to provide conducive conditions for teachers to enact CSCL practices by reducing the risks of failure. They also have to entangle with different stakeholder concerns on the performances of the student, hence they need to innovate too. They have to explore the space of possibilities as well as constraints so that they can provide the conducive environment for teachers to innovate in the classroom. A culture of social practices for collaborative meaning making has to be enculturated, and teachers play critical roles orchestrating such endeavors in this enculturation process.

In the last 20 years, scholars of innovation have discovered that innovation is not based on a few brilliant and creative inventors and entrepreneurs, that it is rarely a solitary individual creation (Sawyer, 2006). The most important creative insights typically emerge from collaborative teams and creative circles (Farrell, 2001; John-Steiner, 2000; Carlson, 2006). Further, innovations come in part from "users" (such as teachers and students) as well as from "developers" (such as research groups) and "suppliers" (such as technology manufacturers). The pressing problems in the world are large in scale and complex in nature. Problems in schools are also multi-faceted in nature. School leaders require innovative mindsets to participate in transforming teaching and learning. They need collaborative approaches to develop innovative solutions to such problems. Sawyer has argued that today's most innovative companies have successfully tapped on team collaboration throughout their organization in which staff is encouraged to improvise. In the corporate world, disciplines of innovation have been advocated as a process with which anyone can learn to be an innovator (Carlson, 2006). These disciplines and processes of innovation are believed to be of general applicability to anyone interested in value creation or enhancement. Hence it is advocated that such disciplines are also applicable to creating value in education.

Presentation 1: Innovation while Scaling Group Scribbles in Singapore

Chee Kit Looi & Wenli Chen

In Singapore, we use the Group Scribbles (GS) in real classrooms to support rapid collaborative knowledge improvement (RCKI) by harnessing the collective intelligence that typically lies latent in the classroom. GS is a collaborative platform that enables students and teachers to share and organize ideas through virtual sticky notes which can be posted and moved in private, small-group, and full-classroom display spaces. RCKI seeks to harness the collective intelligence inherent in the classroom to learn deeper and faster, envision new possibilities and reveal latent knowledge. Towards the goals of supporting GS-based teaching and learning innovation, we envisaged nine principles for RCKI in the design of lessons, and worked with teachers to co-design lesson plans and apply these principles (Looi, Chen & Ng, 2010).

In 'traditional' classroom protocols, teachers usually do most of the talking, and students are supposed to be listening. The teacher–student ratio in Singapore (typically 1:40) favours a centralised management structure which tends to constrain the classroom discourse (Scardamalia, 2002). In the GS class, the students benefited from being able to fully express their ideas because of the opportunity given to every student to post which helps to democratise the class discussion. The anonymity of the postings in GS helps to create and maintain a safe environment in which differences can be exposed and worked with in a non-threatening way, with reduced personal fears of embarrassment or ridicule. This is especially beneficial for those passive learners and shy students. As the students' learning interactions are constructed in real time through GS interactions, this provides the foundation for knowledge being evolved as a product of interpersonal meaning making. The construction of knowledge becomes much more of a group achievement, resulting from the intricate semantic intertwining of postings and references rather than being attributable to individuals (Stahl, 2009).

Based on a design research approach, we have worked with more than 10 teachers and more than 200 students from 1 primary school and 3 secondary schools over a period of 3 years to co-design lessons in science, math, English, and Chinese language learning. The teachers and students have routine use of GS technology (at

least 1 hour GS lesson per week) in the classrooms. Thus, our design is not just to introduce GS technology into the classroom, but to transform the classroom to adopt the socio- constructivism pedagogy enabled by GS. We have found that "Design for orchestration" (Dillenbourg, 2009) does not come naturally by introducing GS technology to classroom. Teachers play a key role to make the classroom innovation effective. Most teachers are not trained to be orchestrators with CSCL practices. To empower teachers to innovate to become "orchestrators", we first need to understand the challenges and issues they are facing with CSCL ideas, tools and practices such as:

1. The effective design of RCKI practices by appropriating the GS principles in real classrooms (integrating specific learning objectives, considering existing classroom culture and students' ability)
2. The effective enactment of RCKI and GS technology in a classroom
3. The assessment of students' RCKI practices

To nurture innovative CSCL practices in classrooms, we have further found that design principles (RCKI in our study) are very important. It is much more difficult for teacher to understand RCKI principles than learn how to use the GS tool. Adapting from Ertmer's (1999) framework on barriers to technology integration, we see there are 2 types of barriers in classroom innovation: first-order extrinsic barriers such as lack of technology access, support and time; second-order intrinsic barriers which include teachers' beliefs which play an important role in influencing teachers' instructional decisions and classroom practices (Cohen 1990; Calderhead 1996; Ertmer 1999, 2005). The second order intrinsic barrier for innovation is harder to overcome than the first-order barriers. In many Asian countries teachers believe that having a good exam scores to demonstrate good content understanding is the most important goal for their teaching. For some teachers, understanding, designing and enacting RCKI practices is not their "core business". Aguirre and Speer (2000) argue that beliefs play a central role in a teacher's selection and prioritization of goals and actions in her teaching. So many teachers consider the goal of RCKI as "add-on" rather than as the primary goal and action. This will make the innovative classroom activities less effective. In our research we found that those teachers who hold more constructivists beliefs and good pedagogical knowledge on CSCL tend to be more innovative and effective in RCKI practices design and practices than those who held more teacher-centred beliefs and have less CSCL pedagogical knowledge.

Thus we see the need to have a new kind of professional development for teachers which does not aim merely to give teachers skills, lessons plans or projects. Rather it aims to develop teachers' potential as innovators. To develop this potential, researchers can provide appropriate technical, pedagogical and psychological support in the course of the project, in order to accelerate upward growth of the teachers' innovation in classrooms.

Presentation 2: Innovation through Attention to Successful Patterns of Use

Patti Schank and Luis Prieto

Many CSCL studies focus on teachers' implementation of innovations; we focus here on tools to help teachers innovate. The need for adaptation of tools to the local classroom context is fundamental, yet the concern of many educational technology researchers remains on demonstrating fidelity of implementation to researchers' designs (Mills & Ragan, 2000; O'Donnell, 2008). Support for innovation requires avoiding techno-centric approaches and thinking about how integrated conceptualizations of technology, content and pedagogy knowledge (TPCK) would help teachers and researchers to better understand teaching with educational technologies (Mishra & Koehler, 2006). We attend to how teachers can use technologies like GS (deBarger et al, in press; Dimitriadis et al., 2007; Looi et al., 2010) to enable student-centered learning and knowledge building while addressing teachers' needs for a repertoire of teaching strategies to select from and adapt as they make ongoing, creative adjustments to their practice, especially in reaction to a variety of rich, constructed student responses.

Two research projects in the United States and Spain have been seeking to support teachers' enactment of highly interactive, contingent teaching that leads to deeper collaborative knowledge building. Both projects have employed GS, pedagogical patterns, and professional development workshops, not only to promote activities that use this kind of teaching, but also to build their own capacity to develop other innovations. Using a largely bottom-up approach, researchers at the University of Valladolid in Spain introduced GS into early primary school classrooms and helped teachers transform their lesson ideas into GS activities, documenting practices such as common design and enactment patterns and improvisational adjustments to instruction. Using a combination of researcher-developed and co-developed materials, researchers at SRI International in the U.S. introduced GS along with interactive activities and pedagogical patterns, documenting implementation challenges and how teachers adjusted instruction within the provided structure.

Among many lessons learned, both projects highlight the need to complement a focus on patterns with attention to micro-level discourse moves for supporting contingent teaching and to the style with which teachers enact them. The projects have progressed toward more atomic, actionable moves as a way to help teachers to

bridge the gap between theory and practice so that they can innovate more productively in the classroom. For example, researchers in Spain observed that teacher lesson designs, despite being high-level and often implicit in nature (i.e. not exhaustively specified on paper), followed a limited set of atomic design patterns when analyzed (Prieto et al., 2010). Teachers' enactments of those designs also followed a further set of atomic pedagogical patterns. The patterns shared a common trait in that they were more easily translatable to concrete actions with the GS tool and in the classroom. Research efforts that tried to modify teachers' practices by exposing them to researcher-made abstractions (e.g. in training sessions, or through web 2.0 platforms) without direct relationship and immediate benefits to their everyday practice generally did not succeed. However, the use of the uncovered atomic patterns elicited from teachers' practice proved much more successful. For example, in a professional development workshop in which patterns elicited from teacher practice were presented, the teachers were better able to use these patterns as a starting point, design new activities with GS that used these patterns, and reflect on how the activities could be enacted in their classrooms and which ones may be more useful from a pedagogical standpoint.

Researchers in the U.S. found that the teachers enacted most of the provided GS activities and patterns, and that the teachers also created several of their own GS activities based on the provided patterns. However, teachers experienced many tensions around classroom management, such as technical issues sidetracking lesson flow, figuring out the "right amount of time" to allow students to answer questions, and keeping students on task during group work. Further, the quality of the student participation, and the contingent teaching observed, were limited. Teachers often asked students to explain their ideas, but the teachers did most of the intellectual work of building on and connecting ideas and rarely actively engaged students in discussion one another's ideas. We concluded that the teachers needed a broader suite of tools to improve the quality of enactment of patterns in classrooms. Technologies designed for collaborative discussion, even when complemented with patterns designed to provide opportunities for students to share their thinking with others, do not necessarily yield rich discussion; a dialogic style research (O'Connor & Michaels, 2007) in which teachers attempt to respond to a student's contribution from the student's perspective and use their response to invite additional student responses is a critical component of teaching that enables student agency and productive collaborations. To support a more dialogic style in such enactment, the project developed a set of classroom norms for participation, discourse moves for discussion, and decision rules for contingent teaching (Penuel at al., 2010). Preliminary indications suggest promising uptake and outcomes of these additional supports.

By providing a set of building blocks and strategies that can be easily called forth, recombined, and recontextualized in the improvisation of practice, teachers are empowered to implement their own innovative activities. This kind of technological and pedagogical knowledge scaffolding is especially useful in the context of classrooms in which teachers have strong content knowledge but their technological knowledge is segregated from its pedagogical applications. Moreover, a language of moves and patterns can be useful for researchers as a way to better understand how teaching and learning change when technological innovations are put into practice.

Presentation 3: CSCL and Innovation Among School Leaders

Charles Patton and Anwar Chan

Educational institutions, especially successful ones, all face the innovator's dilemma (Christensen, 1997): the very formula for their success, at some point, limits their ability to make continued improvements or to respond to changing conditions. Progress becomes uni-dimensional by definition: either you are headed in the right direction or the wrong direction, and the very novelty of innovation is understood (often rightly) as risk. This is a completely natural, indeed predictable, pattern repeated at many levels from the individual to the organizational. But a growing body of research on innovation (Christensen & Overdorf, 2000; Christensen, Horn, & Johnson, 2008; Owston, 2003) suggests that the pattern is not inescapable There appears instead to be a constellation of factors – from organizational alignment to clear understanding of what innovation is and how it works to a particular collection of individual knowledge, skills, and abilities (KSAs) – whose presence is arguably essential for meeting the challenge of continued innovation.

In particular, research in innovation practices by Drucker (1985) and others has identified the innovation capacity skills that contribute to, catalyze, or inhibit individuals' ability to innovate. These innovation capacity skills form an interconnected and mutually reinforcing web (see Table 1).

Table 1. Six innovation capacity skills.

Skill	Description
Being Empowered	The skill to recognize opportunities, to look at a situation and imagine other possibilities.
Being Connected	The skill to build up social networks (especially with "weak ties").
Being a Quick Study	The skill to acquire necessary background knowledge quickly.

Being Forward Thinking	The skill to organize, to synthesize, to generalize, and to project.
Being Influential	The ability to reason, argue, and present with linguistic, computational, and technical skill.
Being Aware	The skill to connect general knowledge with the "real world."

Recently, a combined team from the U.S. and Singapore developed and offered four-day workshop for teachers, school leaders, and Ministry of Education officials in Singapore. The workshop was designed to develop innovation capacity skills among 6 school-based innovation teams in attendance. The workshop drew upon innovation workshops designed for corporations which were developed by SRI CEO and Innovator-in-Chief, Curt Carlson based on his book (Carlson, 2006). The workshop was further based upon a project in collaboration with Girl's Inc. in which SRI developed, tested, and propagated an after-school curriculum for middle-school girls focused on development of these innovation capacity skills through engagement in technology design. As neither of these approaches seemed entirely apropos for school leaders in Singapore, a new approach that incorporated both CSCL and innovation was developed. The objective was to build the educators' capacity in adopting innovation as a systematic and robust approach to creating new value and solving existing issues in a coherent manner understood by both the practitioner and stakeholder. The participants are exposed to a systematic framework that helps to articulate clearly the value that they wish to create to their stakeholders. They are trained in techniques that enable them to draw valuable ideas and perspectives from the richness of their cognitive diversity and from awareness of the inherent resources and opportunities they have in creating and sustaining innovation in schools.

The central theme linking CSCL and Innovation in this new framework was nurturing "cognitive diversity." Cognitive diversity is both a CSCL principle – creating shared meaning by bringing together diverse perspectives – and an innovation principle – achieving insightful problem solutions by leveraging the collective intelligence of a small group. In his book, Page (2007) poses and proves a fundamental theorem on collaborative problem solving:

> These four conditions – the problem has to be hard, the people have to be smart, the people have to be diverse, and the group size has to be bigger than a handful and chosen from a large population – prove sufficient for [cognitive] diversity to trump ability. They are not the only conditions under which the result holds, but if they're satisfied, diversity trumps ability.
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> **The Diversity Trumps Ability Theorem:** *Given these four conditions, a randomly selected collection of problem solvers outperforms a collection of the best problem solvers.*

We found that by applying the skills and techniques taught during this workshop, the participants were able to iterate their ideas over several rounds in order to further refine the value propositions they developed. Examples of the value propositions are: team teaching in schools, creative use of non-classroom space for teaching and learning real-world concepts, enriching the school grounds with ubiquitous computing, and other equally innovative ideas that are very feasible and aligned with their organizational objectives. CSCL tools such as GS and CSCL techniques such as organizing participants in a jigsaw pattern proved highly relevant to unleashing the innovation potential of the workshop participants.

While the programme is still in its seeding stages, we are already receiving positive responses through the schools' participation and their teachers' subsequent initiatives within their schools. The workshop validated our view that educators need to engage with innovation at three levels: supporting organizational innovation, engaging in innovative teaching practices, and fostering innovation capacity in their students. They therefore need a framework for understanding, practicing, and supporting innovation that can unify rather than compartmentalize these three perspectives. As next steps, we are exploring how to sustain the support for learning the discipline of innovation beyond a single workshop through a more continuous model of professional development.

Presentation 4: Innovation and CSCL for Schools of Education

Jeremy Roschelle and Charles Patton

As conservators of "what works" it would seem natural that Schools of Education should tend to be far from innovative in the pedagogies they use to train future teachers and school leaders and thus tend to prepare teachers to replicate traditional models rather than pioneering new forms of teaching and learning. Schools of Education are also service organizations with a tightly scoped mission and have limited options for reorganizing time and resources. In a related project, we are looking at how replacing a textbook with an interactive resource as a basis for courses for teacher candidates can open up possibilities for innovation, even under these circumstances.

The Dynabook Project has started from carefully observing the practice of leading teacher educators in two settings, a general math teacher preparation program at San Diego State University and a special education program at San Francisco State University. We found that teacher educators in these two settings spur innovation among teacher candidates by two basic techniques. First, they use videos and other interactive media elements to richly problematize the challenge of helping students learn foundational mathematics concepts, such as ratio. In particular, they use media to engage prospective teachers in examining students at work, exhibiting both misconceptions and various "correct" strategies. Second, they use interactive technologies to engage preservice teachers in broadening their perspective on how to do mathematics, from "one right way" to solve each problem to exploring multiple means of representation, of engagement, and of action and expression. A further principle in the project, arising from mathematics education research, is to help prospective teachers see mathematics as deeply connected (rather than an isolated series of unrelated topics and procedures).

To further foster these dimensions of innovation, we are designing an interactive mathematics resource that incorporates these insights while addressing a foundational mathematics topic that many new teachers struggle to teach well: the concept of proportionality. This resource, called Proportionality "DynaBook," incorporates several layers of novel features as teacher candidates work across three strands of proportionality: proportionality in number (ratio), proportionality in geometry (similarity), and proportionality in algebra (linear function). One basic feature is that for each mathematics topic, there are three prominently different routes to engagement: exploring video cases of student thinking, doing a richly interactive lesson with embedded virtual manipulates, and solving challenging mathematical problems. A second layer of features incorporates principles of Universal Design for Learning (Howard, 2004) to support trainee teachers' deep engagement in mathematical thinking. For example, a "stop and think" feature prompts teacher candidates to reflect more deeply on their activity. Likewise, a "how do I say it?" feature helps teacher candidates think about mathematical communication – an oft-neglected but critically important aspect of mathematics teaching and learning.

In addition, the Dynabook includes "social media" features that aim to engage cognitive diversity as preservice teachers and their instructors do exercises as part of their courses. These features have much in common with the GroupScribbles platform discussed earlier. For example, one social media feature can capture how diverse candidates solve the same challenging mathematics problem while sharing these anonymously. Examining these different solutions (which can use different tools and approaches) can create awareness of the many different strategies for the same mathematics problem. Another social media feature allows candidates to create and share "tours" through the dynabook. Different tours can highlight different possible progressions of learning activities and the class might consider the merits of different tours for different students or teaching situations. A third social media feature allows participants to share how they have highlighted or taken notes on the same Dynabook pages. For example, different highlighting can reveal teachers' varying perspectives on what students might find challenging on a Dynabook page or notes might suggest possible strategies for supporting students who are struggling with that page.

We are presently using the Dynabook in design research in both university settings as well as with colleagues in Singapore. We are taking a co-design approach, where teacher educators are co-innovators with us in designing ways to use the new resource that fit their existing courses, yet open up new pedagogical possibilities. Early findings suggest that teacher candidates find the resource engaging and readily discover situations that require deepening their mathematical understanding in order to teach effectively. Likewise, we are finding that preservice instructors are finding the Dynabook both challenging, in that it makes video and interactive media more salient that familiar printed resources and also inspiring in their ability to formulate new lesson plans and strategies for the classroom.

Discussion Guide

Our two discussants, Roy Pea and Tak-Wai Chan, are familiar with the school and education context in USA and Asia, respectively. Questions they will consider in their discussion include:

1. What new insights and possibilities does expanding CSCL to include innovation open up? Are there any important downsides to expanding CSCL to include innovation?
2. Does framing the adoption of CSCL in terms of "disciplines of innovation" reveal useful commonalities at the different levels considered in this symposium, such as the classroom, teacher, school leader, and school of education levels? How do we recognize innovation in these varied contexts?
3. Is linking CSCL and innovation a good strategy for speaking more strongly and cogently to policy and practice audiences both in Asia and throughout the world?

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