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# Principles and Enactment of Rapid Collaborative Knowledge Building in Classrooms

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The authors discuss the notion of Rapid Collaborative Knowledge Building (RCKB) in classroom settings. RCKB seeks to harness the collective intelligence of groups to learn faster, envision new possibilities, and to reveal latent knowledge in a dynamic live setting. It is characterized by the notion of rapid cycles of knowledge building activities in a face-to-face setting. The authors propose nine principles for the design of collaborative learning activities in the classroom that foster RCKB, five of which are adapted from Scardamalia's knowledge building principles (Scardamalia, 2002). The context of their work is design research on introducing RCKB in a classroom with the use of a network technology called GroupScribbles. The technology enables collaborative generation, collection, and aggregation of ideas, and empowers teachers to design new collaborative and group learning activities in a classroom setting. The authors present two actual classroom lessons with collaboration activities which demonstrate some of the design principles at play.

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## Introduction

"Learning efficacy" lies at the heart of the model in Singapore's school educational context. Such learning efficacy can be measured in traditional ways in terms of school assessment and examination results and in non-traditional ways like engagement, motivation, and attitudes in classroom learning and participation, as well as transformed participation in a community of learners (Ng, Looi, & Chen, 2008). Our teachers' (and students') views of the learning efficacy of various modes of classroom interaction both condition their choices of interaction and are conditioned by their experience (Looi & Chen, 2008). Taken together, these views, choices, and confirming experiences inform the traditional pattern of classroom discourse in Singapore schools.

Traditional patterns of classroom discourse have evolved over a long time, with the most typical pattern of classroom interaction being the IRE (initiation–response–evaluation) pattern, which has been shown to account for a possible 70% of teacher–student classroom interactions (Mehan, 1979; Nassaji & Wells, 2000; Wells, 1999). In the IRE, a teacher initiation (I) is followed by a student reply (R), followed by an evaluation of this reply (E) by the teacher. IRE has been criticized for leading to unrewarding and boring classroom discussions. Most of the epistemic agency rests on the teacher; a student's primary, active, role is to respond.

Our challenge has been to explore new choices of classroom discourse, choices that, on the one hand, do not directly challenge teachers' views of learning efficacy but, on the other hand, hold promise for the less traditional measures of learning efficacy. In recent years, some researchers have sought to design interactive technologies to support students' active classroom participation by harnessing the collective intelligence inherent in the classroom. One of the technologies is GroupScribbles (GS 2.0), co-developed by SRI International and the National Institute of Education of Singapore, which enables collaborative generation, collection, and aggregation of ideas through a shared space based upon individual effort and social sharing of notes in graphical and textual form (SRI International, 2006; see also <http://gs.isl.nie.edu.sg>). GS was designed to support students' practices of a collection of important 21st century skills, which we term Rapid Collaborative Knowledge Building (RCKB). RCKB seeks to harness the collective intelligence of groups in rapid cycles of collaborative activities to learn faster, envision new possibilities, and reveal latent knowledge. Its techniques include problem identification, brainstorming, prioritizing, concept mapping, and action planning (DiGiano, Tatar, & Kireyev, 2006).

The notion of KB in RCKB shares the characteristics

of democratized participation as a learning community and idea refinement with the notion of Knowledge Building (KB) as exemplified by the use of Knowledge Forum (Scardamalia & Bereiter, 1996). In particular, the latter's explication of KB principles for design and assessment is a motivation and inspiration of the search for similar principles that can support knowledge building in a face-to-face classroom session.

In this article, we will articulate the RCKB principles for designing and evaluating lessons and activities that tap on the affordances of GS. Over a period of two years, guided by our design principles framework, we have co-designed and implemented more than a hundred lessons in mathematics, science, and Chinese language learning (as learning a second language) with school teachers. This design research has helped to refine our understanding of the RCKB principles.

### Knowledge Building

Bereiter and Scardamalia (2003) define "knowledge building" as "creative work with ideas that really matter to the people doing the work." An important feature of knowledge building is the process where conceptual artifacts (Bereiter, 2002) like ideas, theories, and problems are explicated and shared with the community and continually worked upon. Traditional classroom learning is contrasted with the learning that occurs in knowledge building communities (Bereiter, 2002; Scardamalia & Bereiter, 1996), like communities of professional scholars in academia that research problems and produce knowledge in the form of publications. The software system in Knowledge Forum allows students to asynchronously contribute artifacts in the form of scaffolded electronic notes. These notes then go through a process of peer review, critique, synthesis, and improvement, in a way similar to what professional communities do.

Scardamalia (2002) identified 12 socio-cognitive and technological determinants of knowledge building. These principles include, for example, that learners must take charge of their own learning (epistemic agency) and that learners' discourse practices must trend towards knowledge transformation and refinement (knowledge building discourse).

Traditionally, knowledge building connotes a process of idea refinement over a protracted period of time, typically weeks or months. Students have access to relevant information sources, and are able to articulate opinions in a considered, reflective mode.

Within such a knowledge building system, there must also be community-based individual knowledge building and knowledge sharing (e.g., more and more individuals in the community can now solve problems of type X—which would be a more traditional measure of learning efficacy) as well as uptake of patterns of collaboration that leverage cognitive diversity of the

community (e.g., when employing pattern of collaboration Y, the community can solve problems of type X, but without it, the community cannot solve them). Even though neither of these more individual and episodic phenomena quite captures the larger knowledge building vision, they are clearly key components of a knowledge building community.

Our notion of Rapid Collaborative Knowledge Building (RCKB), then, refers to those aspects of classic knowledge building that make sense when considering time-limited cycles or activities such as might be possible in a more-or-less ordinary classroom. In live classrooms, RCKB activities would manifest as face-to-face collaborative knowledge building over a duration of, say, less than two hours, and supported by a technological system for lightweight synchronous communication.

### RCKB Principles

In exploring new choices for classroom discourse, we take a design research approach (Brown, 1992; Collins, 1992) to evolving our understanding and theorizing about RCKB. We work progressively towards building our knowledge of implementation best practices, as well as refining our intervention package (including lesson activities, professional development, assessment, and software). The cycles involve theorizing, design, development, implementation, data-collection, evaluation, and theory refinement—starting a new cycle.

Following this paradigm, we have iteratively developed and refined characterizing design principles for RCKB, based on literature searches of knowledge building, collective knowledge construction, and brainstorming, and informed by prior cycles of empirical work in schools. The first four principles, below, originally drew on descriptions of the affordances of the Group Scribbles technology that we are refining to support RCKB (DiGiano, Tatar, & Kireyev, 2006). The next five were adapted from Scardamalia (2002) especially for non-laboratory school settings. Our nine principles are:

- (1) volunteerism—enabling learners to choose what piece of the activity they want to participate in;
- (2) spontaneous participation—designing for quick, lightweight interaction driven by students themselves;
- (3) multimodal expression—accommodating different modes of expression for different students;
- (4) higher-order thinking—encouraging skills like analysis, synthesis, evaluation, sorting, and categorizing;
- (5) improvable ideas—providing a conducive environment where ideas can be critiqued and made better;
- (6) idea diversity—exploring ideas and related/

- contrasting ideas, encouraging different ideas;
- (7) epistemic agency—encouraging students to take responsibility for their own and one another's learning;
- (8) democratized knowledge—everybody participates and is a legitimate contributor to knowledge; and
- (9) symmetric knowledge advancement—expertise is distributed, and advanced via mutual exchanges.

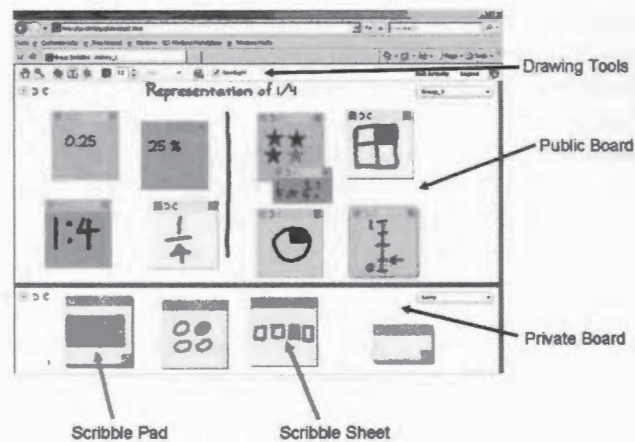
In prior iterations of RCKB principles (Ng, Looi, & Chen, 2008), we had included the principle of distributed cognition, which is about designing for thinking to be distributed across people, tools, and artifacts. In thinking through the enactment of the principles in actual classroom collaborative activities, we have realized that distributed cognition is an encompassing lens to interpret the realization of the other principles instead of being a separate principle by itself.

### RCKB in the Context of GroupScribbles

We will discuss RCKB in the context of our experiences with a collaborative technology called GroupScribbles, which is designed to be lightweight, flexible for collaboration, content independent, and easy-to-improvise by teachers. It attempts to maximize the power of ink, improvisation, and interactive engagement, so that teachers can improvise different patterns of collaborative activities for students without the need for additional software programming (Chaudhury *et al.*, 2006; Roschelle *et al.*, 2007).

We quickly describe the current version of GS 2.0 and its features. The GS interface consists of a multi-pane window. The default configuration consists of two panes—a lower pane and an upper pane—but the user can slide in more panes as desired. The lower pane is usually the private board, or the user's personal work area, with a virtual pad of fresh "Scribble Sheets" or notes on which the user can draw or type (*Figure 1*). The upper pane is usually a public board or group board, into which users can post their Scribble Sheets, position them relative to other's Scribble Sheets, and take items back to the private board for amendments or elaboration. When any Scribble Sheet is posted, moved, or updated, others can see the effect almost immediately. On each pane, there is a drop-down menu to allow users to switch to other boards. Students post anonymously so as to freely express their ideas. *Figure 1* shows a GS activity on fractions in which students in a group participate by posting various possible representations of a fraction, like one-quarter.

The evolution of the design of GS is both shaped by and is reflected in the RCKB principles. GS supports multimodal expression by providing avenues for



**Figure 1.** A screenshot of a collaborative activity from the GS user interface

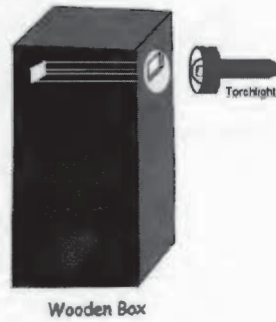
students to express their ideas by scribbling, writing, typing, and drawing. It supports higher-order thinking by enabling the students to freely arrange, sort, and categorize the Scribble Sheets in the group or public boards, and by additional scribbling or marking on the public/group board or inclusion of graphic organizers on the background picture. The shared group or public boards support democratized knowledge and symmetric knowledge advancement. The intentional lightweight nature of Scribble Sheets encourages spontaneous participation.

GS supports improvable ideas, as Scribble Sheets are designed to be overlaid with new sheets or annotated with labels, all the while preserving the integrity of the original idea. The essence of knowledge building is, hence, improvement, not replacement. GS can support volunteerism by, for example, the teacher offering rather than assigning pieces of work (represented by tokens or Scribble Sheets) on a grid and having students choose their own piece of work that they want to do by taking those tokens or Scribble Sheets. Finally, the notion that students will choose their work from the public board, take it to their private board where they alone are responsible for the outcome, and then return the result to the public board is entirely consonant with, and supportive of, epistemic agency.

### A Classroom Lesson that Enacted RCKB Principles

In this section, we will present a brief analysis of one GS-supported lesson to illustrate how the pedagogical design of the GS activity is enacted with good teacher facilitation. We discuss how the lessons manifest the GS principles when enacted. For more complete discussions of qualitative and quantitative evaluations of GS use in the classroom, please refer to Looi, Chen, and Ng (2009) and Looi, Lin, and Liu (2009).

How would you let the plant receive some light without removing it from the box?  
Post your ideas in your group board.  
(10 minutes)



**Figure 2.** A diagram on students' group boards given for their group activity.

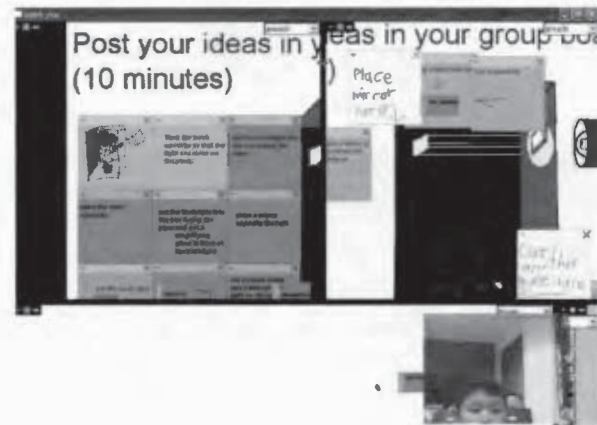
In one classroom context targeted, students were to learn science topics in the Primary grade 4 standard curriculum syllabus—the circulatory system, energy, light, and heat. According to the syllabus, each lesson has specific learning objectives. The GS activities were co-designed by the researchers and the teachers to achieve these objectives, albeit in non-traditional ways. They were designed not for the convenience of research, but were integrated tightly with the science curriculum topics. In this Primary 4 science lesson on light (for students about 10 years old), the lesson objectives were to enable students to learn about light travelling in a straight line, apply what they have learned about the properties of light, and learn that objects can cast shadows of different shapes depending on the position of the light source.

In the first GS activity of this lesson, students were presented with a diagram of a plant in a tall, deep, dark box which has an opening at the top right side to let in light, and they were asked how to direct light to the plant (**Figure 2**). In the second GS activity, the teacher showed a set of objects on the public board. Drawing on their prior knowledge that different shapes of the shadows can be formed due to the different positions where the light source is placed, students in each group (of four students each) were asked to draw all possible shadows of these objects (**Figure 3**).

Volunteerism is manifested, as instructions and tasks given by the teacher to the class were meant for a group, so each student can decide and carry out his or her own sub-task (for this case, each student picks any object given to draw the respective shadow). The drawing tools (from type to draw mode) from GS provide a platform for multimodal expression, as every student can freely express their ideas in the mode(s) which they are comfortable with (**Figure 4**). With the design of the activity to make it lightweight (asking for



**Figure 3.** GS Screenshot of activity to predict shadows.

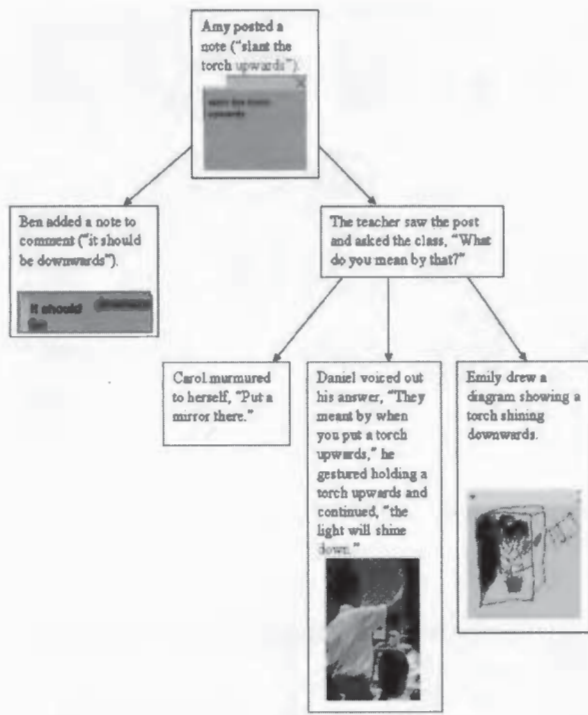


**Figure 4.** Multimodal expressions from students' work were observed from the two group boards

students to draw different shadows and come up with brief suggestions to direct light to the plants instead of asking for long, in-depth answers), every student can spontaneously participate and offer a diversity of ideas as much as they could at a short period of time given.

The students viewed others' boards and made comments (demonstrating the principles of improvable ideas and higher-order thinking). They learned to understand that objects cast different shadows depending on where the source of light is coming from. Finally, all groups did a "gallery walk" to view the solutions represented on other group boards (Fasse & Kolodner, 2000; Kolodner, 2004). They went back to their own boards to view the comments and suggestions from other groups and made improvements on their own postings accordingly. For the lesson closure, the teacher commented on the boards.

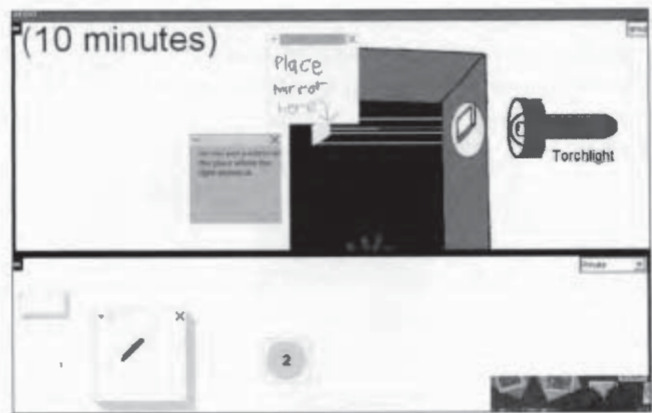
When GS is used in a one-person-to-one-computer configuration, students generate freely as many



**Figure 5.** A flow diagram to show the different interpretations of the same idea.

individual ideas as possible in the comfort of their individual private workspace. Hence, the shared public boards from GS serve a space for students and teacher to share and see different perspectives and ideas. Any unclear and vague answers can trigger another flow of diverse ideas, such as the different interpretations of a certain idea. **Figure 5** shows how a note “slant the torch upwards” would lead to several interpretations of that idea, which were surfaced via the use of GS and class verbal discussions. When Amy posted “slant the torch upwards,” Ben placed a comment note saying “it should be downwards.” Subsequently, in the class discussions during the first GS activity, the teacher was skillful in her role as a facilitator, thus enabling the students to be more participative by weaving class discussion.

In looking for vague, unclear answers, like the post from Amy, she pressed on for clarifications or explanations, and encouraged idea diversity from the rest. Carol made a soft remark that an additional mirror had to be placed, which meant that she thought that Amy was shining the torchlight through the hole, towards the top part of the box. The mirror was suggested by Carol to reflect the light downwards to the plant. While Daniel and Emily concurrently demonstrated the common interpretation of the positioning of the torch, their expression modes were different. Daniel expressed his interpretation verbally with some physical gesturing while Emily chose to adopt



**Figure 6.** A student first placed a position-specific note on a group board.

drawing to illustrate her point and immediately posted to the public board, knowing that her note could be projected to the rest of the class.

GS, being a public space for sharing ideas on Scribble Sheets, creates an environment that makes the need for higher-order thinking visible and explicit. This is surfaced when ideas shared on the public GS board are diverse and numerous, which makes the students feel the need to organize them. Knowing that the ideas have to be shared publicly on GS, some students moved one step further by making their own posts clearer for the rest to understand better, which makes further organization of more incoming posts more explicit later.

During this GS activity, where students were required to brainstorm certain ideas from the diagram, Ben placed his note “place a mirror here” with an arrow drawn specifically to the position in the diagram given (**Figure 6**). Subsequently, in **Figure 7**, the rest of the members in that group followed Ben and organized their ideas by placing their notes according to the specific positions on the diagram where they wanted to implement their ideas as well. Some notes were noticed to be position-specific in linking similar ideas, where they were placed side-by-side. The following shows the teacher-student discourse which happened during the GS activity:

Teacher: Who says place a mirror here? Whose, whose idea? I saw a number of you had post “place a mirror.” Can you explain? I saw a number of you did it. Terry?

Terry: Oh, we have put the mirror at the angle so that the lights from the torch will be reflected to the plants.

Teacher: “Reflected,” oh, very good idea. Reflects



**Figure 7.** Subsequent position-specific notes were seen in other members' work.

the lights. Alright, good. Torch lights in the box, ok next one. Are there any different ideas or not?

### Discussion and Conclusion

We have set out design principles for RCKB activities in the classroom and have found that, at least with GS support, collaborative activities can be designed that manifest the intent of at least a subset of these design principles. The principles can also be used as criteria for assessing the enactment of the collaborative activities: Were the collaborative goals and tasks designed and communicated to students in ways that support their belief that each group member's efforts are required and indispensable for the group? Did the collaborative activity promote interaction among the group members to achieve common goals by building on each other's ideas, by communicating and sharing, by negotiation, by argumentation, or by achieving consensus? How was the enactment mediated by resources around them, such as the tools, the artifacts, and the collaborative learning environment? Did parallel processing, positive interdependence, and group interaction, mediated by tools and artifacts, lead to group meaning making, as predicted?

As depicted in the lesson described above, the classroom discourse coupled with the GS artifacts showed examples of distributed collaborative processing, idea diversification, and phases of increased emphases on explanation, clarification, and reasoning. As typical of GS-based activities, once the activity is started, the mode of communication

changes from the serial simplex of traditional classroom discourse to massively parallel duplex. The students can talk and send and receive messages instantly all at the same time. They are forced to think on the spot and justify their reasons verbally and electronically. They become accountable not only to the teacher, but to one another—so their explanations have to be good and must make sense.

The spatial-temporal proximity of the classroom setting in tandem with GS affordances supports making the next rapid contribution readily in response to a verbal utterance or a posted GS note. GS also affords multimodal expression and allows students to do inscriptions of their understanding. The teacher can see what students actually have learned. Inappropriate ideas are also surfaced and are often immediately addressed or improved upon. The representations on GS provide a means for a teacher to mediate the discussion based on what the students have produced, and to weave students' collaborative talk with her classroom talk, thus accommodating her traditional view of learning efficacy with a very different choice of classroom discourse.

This work is situated in our perspectives of learning sciences research towards understanding how people learn and collaborate. We do it with a strong design orientation, bringing design interventions to the classroom and studying them to explore new choices of classroom discourse. Grounded in research in actual school practices, our work contributes to various designs of collaborative activities undergirded by the RCKB principles, and seeks deeper understanding of the conditions and premises in which the principles are enacted in real classrooms. The cognitive and social evaluation of the processes and outcomes of the collaboration enables us to develop and articulate a theory of RCKB, thus characterizing the contribution of this work to learning sciences research. □

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# Digital Storytelling as an Interactive Digital Media Context

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Digital storytelling involves the creation of short, personal narratives combining images, sounds, and text in a multimedia computer-based platform. In education, digital storytelling has been used to foster learning in formal and informal spaces worldwide. The authors offer a critical discussion of claims about digital storytelling's usefulness for supporting various types of learning and conceptualize it as a context rather than a tool. Drawing on examples from digital storytelling workshops, their research team has designed for Secondary English classrooms in Singapore, the authors discuss the role that digital storytelling as an interactive digital media (IDM) context can have in shaping youths' opportunities to be active authors and participants in a media production culture, which is a growing focus of education across the globe. Wrapped up in ideals of 21st century learning, digital literacies, and new media lies a dual mandate to resonate with and draw upon youths' everyday media practices as well as foster critical thinking dispositions, and the authors offer brief recommendations to these ends as they relate to digital storytelling-as-context and the learning sciences.

## Introduction

Digital storytelling began in the late 1980s as a movement to promote democratic media production aimed at personal expression. Then, digital technologies were just beginning to be affordable and user-friendly to the extent that, with limited guidance, individuals could easily produce a multimedia digital story. Workshops to

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