Examining the Growth of Community Knowledge in an Online Space

Jianwei Zhang[a], Carol K. K. Chan[b]
[a] *School of Education, University at Albany, SUNY, USA*
[b] *Faculty of Education, University of Hong Kong, China*
jzhang1@albany.edu ckkchan@hkucc.hku.hk

Abstract: With theoretical advances conceptualizing learning as a social, distributed and collective process, there is a need to capture and assess community knowledge—knowledge as a social product that has an out-in-the-world existence and has value to a community. There has now been much progress in analyzing collaborative processes and interactions in CSCL, we propose extending the analyses including both collaborative processes and knowledge products. This paper explores the conceptual basis for examining community knowledge and reports on two specific tools for examining the growth of community knowledge: knowledge-building portfolios and inquiry threads analysis. We discuss design and research implications for integrating these two tools that may serve both purposes of assessing and scaffolding community knowledge building.

Keywords: community knowledge, knowledge building, CSCL, electronic portfolio, inquiry threads analysis

1. Introduction

With the advent of computer-supported collaborative learning, a major research field has developed with substantial progress in analyzing and assessing student interaction in computer discourse. Approaches for analyzing the nature of collaboration are most diverse including quantitative methods measuring students' overall participation (e.g., Guzdial & Turns, 2000), community connectedness using social network analyses (de Laat, Lally, Lipponen, & Simons, 2007), length of conversation threads (Hewitt & Teplovs, 1999), community connectedness using social network analyses (de Laat, Lally, Lipponen, & Simons, 2007), and counting key terms and words of special functions (Hong & Scardamalia, 2008; Sun, Zhang, & Scardamalia, in press). Different qualitative approaches include categorizing and rating group interaction and collaboration (e.g., Baker, Andriessen, Lund, van Amelsvoort & Quignard, 2007; Meier, Spada, & Rummel, 2007), detailed tracing of interactions (Suthers, Dwyer, Median & Vatrapu, 2007) and more ethnographic analyses emphasizing interactive meaning making (Koschmann, 2001; Stahl, 2006). Various efforts have also been made to examine multiple methods of analyses (e.g., Hmelo-Silver, 2003). Whereas there has been much progress in analyzing collaborative interactions and processes, little attention has been given to understanding and measuring collaboration as advances in community knowledge.

A learning community is not only defined by collaborative processes that help individuals learn, but also by a focus on advancing collective knowledge and understanding (Bielaczyc & Collins, 1999; Stahl, 2006). Students are not only sharing and refining their personal knowledge represented as mental models, but collectively create community knowledge—knowledge as social product that has an out-in-the-world existence and has value to a community (Bereiter, 2002). Community knowledge is a new construct we need to work with when designing collaborative learning environments. How to capture and assess the growth of community knowledge, as researchers, and likewise how to monitor and make sense of the changing picture of their community knowledge, as learners, represents a deep challenge. The goals of this paper explore the conceptual basis of examining community knowledge; propose designs for characterizing and measuring the growth of community knowledge based on two specific tools: electronic portfolios and inquiry threads analysis; and examines design and research implications in integrating and developing these tools.

2. Conceptualizing Community Knowledge

Traditional education has been working almost exclusively with student personal, mental knowledge—concepts, understanding, and skills represented in their memory. Correspondingly, instructional assessment attempts to infer what students know and think based on their responses to certain tasks, and to detect misconceptions and gaps; the goal of instructional design is to create the pathway of learning to address the identified gaps.

Community knowledge represents a different realm of knowledge: external, public knowledge—e.g., theories, working models, designs—collectively developed and owned by a community, represented in books, journals, technical documents, etc. Advancing community knowledge and making benefits out of it is the life of scholarly communities and knowledge-based organizations. In those contexts, members contribute their ideas—objectified as conceptual artifacts (Bereiter, 2002)—into a shared knowledge space, which are continually examined, improved, synthesized, and used as “thinking devices” (Wertsch, 1998) to enable further advances. This community knowledge space is typically absent from traditional classrooms. Creating this community space, along with various tools to support collaborative learning and knowledge building, has been a major contribution made by the CSCL (computer-supported collaborative learning) research field.

In a knowledge building community, members carry out a variety of activities to advance their community knowledge: experiment, design, reading, reflection, and writing, and presentation, etc. Essential among these activities, knowledge builders engage in transformative, progressive discourse—both written and oral—to critically examine existing ideas based on information collected through various activities, identify gaps and barriers, and contribute new or refined ideas to help the community move forward (Bereiter, 1994). The knowledge building discourse thus becomes “a screen onto which everything else is projected and from which the success of the community may be read.” (Bereiter, 2002, p. 84)

There are two characteristics of community knowledge that make it especially hard to capture and assess. First, community knowledge is abstract: It represents “the state of the art” cutting-edge understanding of a community in a knowledge domain (Zhang, Scardmalia, Lamon, Messina, & Reeve, 2007). In a dynamic knowledge building community, what counts as “cutting-edge” is subject to judgment and interpretation, and is constantly updated through new contributions of the members. Second, community knowledge is distributed, embedded, and emergent: The collective understanding emerges from individual diverse inputs made over extended discourse and inquiry, thus often cannot be attributed to any specific entry. Analysis and assessment of community knowledge needs to work with the above two characteristics, to integrate the insiders' perception of their highpoint, cutting-edge work with researchers' ("outsiders") review of their advances, and to capture the shared, evolving themes of knowledge work based on distributed, diverse contributions. In our recent work conducted in a collaborative knowledge building environment supported by Knowledge Forum (see Scardamalia, 2004 for an introduction), we developed and tested two specific methods to measure community knowledge growth, with promising potentials. These are electronic portfolios of knowledge building and inquiry threads analysis of knowledge building discourse.

3. Knowledge-Building Portfolios

The electronic knowledge-building portfolio design was developed over the course of several years that sought to characterize knowledge building through assessing and scaffolding community knowledge. Within the tradition of design studies, the development of knowledge-building portfolios underwent some evolution. In earlier years, teachers working with the Knowledge Building Research team at University of Toronto often asked students to write portfolio notes of what they had learned from the discourse. While this was useful to teachers and students, the portfolio notes focused more on individual learning and how it changed over time. A new line of research on student-directed assessment of knowledge building emerged several years ago [14, 23]. van Aalst & Chan designed new and different ways of using knowledge-building portfolios first with graduate students. Specifically they asked participants of the community to identify their work that would reflect knowledge-building principles including "cutting edge", "progressive problem solving". Most interestingly, these researchers found that students did not merely identify their own notes; they spontaneously included notes from other participants in the discourse to show how their collective knowledge has developed over time. Knowledge building, to our participants, was primarily a community process.

Over the years, these researchers refined the design of knowledge-building portfolios iteratively as tools to both *measure* and *scaffold* community knowledge [14, 23]. Different from most approaches of analyses directed by researchers, students had the responsibilities of assessing their own knowledge advances in the community. Specifically, students were asked to prepare a portfolio of several sets of notes on Knowledge Forum in which they provided evidence for knowledge building principles. In their selection, they needed to include their own notes as well as others' notes in the communal database. They also needed to write an explanatory statement for why these clusters of notes best demonstrated evidence of knowledge building. To help them recognize knowledge building, they were provided with a set of several knowledge-building principles. Scardamalia [17] has developed a set of knowledge-building principles for characterizing the dynamics of knowledge building. Working on student-directed assessment, van Aalst & Chan [23] developed a modified set of principles more accessible for teachers and students including (i) working at the cutting edge; (ii) progressive problem solving, (iii) collaborative effort, (iv), monitoring own understanding; and (v) constructive uses of information. Researchers worked closely with the teachers in providing prompts to help students identify clusters/threads of notes reflecting knowledge building guided with the principles.

To illustrate further, a knowledge-building portfolio consists of several portfolio notes; a portfolio note is a ‘rise-above’ note that includes links to other computer notes providing evidence for the knowledge building principles (Figure 1). As an example, the student noted that she has identified a cluster of notes about X or Y that illustrates a knowledge-building principles. She then articulated how these ideas have improved over time. In doing so, the student documented and reflected on the progress of community knowledge. A reader could toggle between the explanation and the referenced notes; the icons within the content window of the note represent links to other notes. Scaffolds were also designed in ways to support students’ articulation of the ideas and principles.

The knowledge-building portfolios were rated on the explanatory statement in relation to the selected cluster of notes. Earlier the entire portfolio was coded for the occurrence of each of the four principles on a 6-point rating scheme; (1-2: little evidence; 3-4: some evidence; 5-6: strong evidence) [22]. Later, scoring was more refined to articulate these levels and rating was conducted for each cluster of notes and related explanation. At the lowest level (1-2), students only identify some notes involving questions-answers. In the explanation statement, they refer to a near-verbatim repetition of guidelines on the principles, or they merely consider answering others’ questions as progressive problem solving. At level 2, students identify a cluster of related notes and discuss what different members have contributed and how that has furthered their understanding. There is clearer evidence relating to the criteria of the principles. Whereas level 2 responses focus on what the notes describe, level 3 responses focus on the evolution, development, and improvement of the ideas in the community discourse. Students identify clusters of notes that illustrate knowledge-building advances and they describe the ‘life-stories’ of certain ideas that are refined and improved as inquiry continues. They also point out “markers” or “milestones” of idea development; the focus is on “rise-above” and “meta-discourse” that attempts to capture community knowledge.

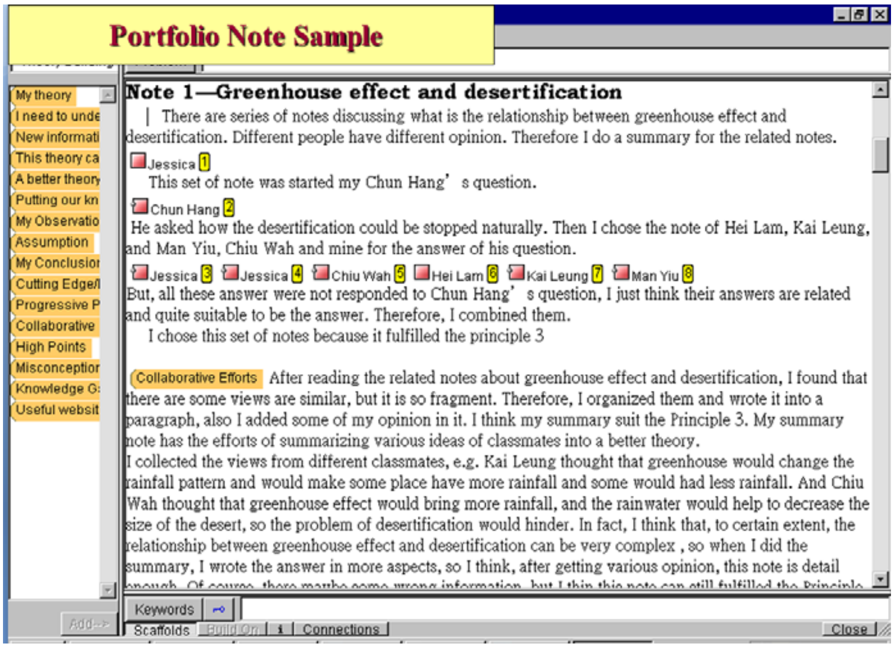

Figure 1. A portfolio note as a rise-above note to capture growth of collective knowledge

Several research studies have been conducted to examine the construct validity of such knowledge-building portfolios. Across different studies, results show that higher scores of knowledge-building portfolios were related to quantitative indices of participation on Knowledge Forum, level of questions asked, and depth of conceptual understanding [14, 22, 23]. Furthermore, analyses of the selection of portfolio notes indicated that students tended to identify similar clusters of notes as representing where the community has developed in knowledge building [14].

To reiterate, these portfolio notes are not the creation of individual students; they demonstrated the collective work and contributions of different members in the community. With the use of knowledge-building principles, there is an emphasis focusing on the trajectory of knowledge growth, thus possibly addressing the challenge of examining emergent collective knowledge. Apparently, students' characterization of their knowledge advances may not be similar to researchers' analyses. Yet this approach of student-direct assessment may help students to recognize knowledge building and thus engage more in knowledge building. As well, researchers may use these knowledge-building portfolios as pointers to help them identify community knowledge advances.

3. Inquiry Threads Analysis

Similar to knowledge-building portfolios, inquiry threads analysis also looks into the growth of community knowledge based on discourse data. But it needs the researcher to read through the discourse, and conduct content analysis to trace idea development over time. Inquiry threads analysis maps out the evolution of the community knowledge space by clustering student discourse into unfolding conceptual streams and tracing progresses in each stream [25, 26].. An inquiry thread can be defined as a series of discourse entries that address a shared principal problem and constitute a conceptual stream in a community knowledge space. A related but different measure in the CSCL literature is conversation threads—analysis of conversation turns (e.g., question-answer or opinion-comment) in a discussion forum, defined based on physical markers such as a link of reply or build-on [9, 12]. Instead of focusing on formal conversation turns consisted of physically linked entries, inquiry threads focus on discursive activities that have various conceptual intentions [15]. It attempts to understand what students, as a community, are trying to achieve, by looking at objects of their discourse. An inquiry thread represents a conceptual line of discussions—which may involve multiple conversation turns—that address a shared focal problem.

Figure 2 shows a network of inquiry threads that maps out the knowledge building discourse of 22 fourth-graders investigating colors and light over a four-month period, supported by Knowledge Forum [26]. Six conceptual threads emerged from the discourse, addressing issues related rainbows, prisms, colors of opaque objects, primary and secondary colors, after-images, and Northern Lights, respectively. Each square icon in a thread represents a note contribution (Notes created on the same date in a thread stack over one another in this figure). The numbers following the title of a thread represents the number of notes contributed, and authors and readers involved.

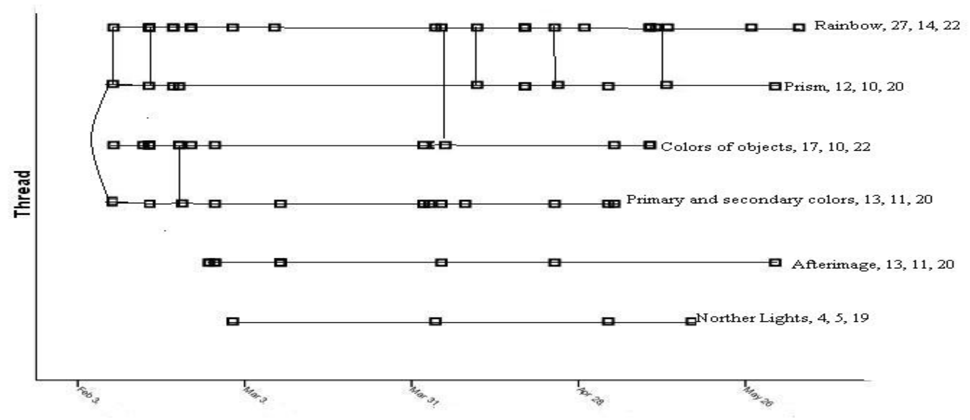

Figure 2. A network of inquiry threads emerged from a class of fourth-graders' discourse on colors and light.

The defining feature of an inquiry thread is its principal problem. It is equivalent to "issue at hand" that defines an action episode in a situated activity [2]. In the above example, students wrote 27 notes in an extended discourse on the nature of rainbows. This inquiry thread involved a number of build-on structures or trees that addressed the same principal problem: How are rainbows made? Identification of inquiry themes as such was aided by semantic markers created by the students. As an effort to rise above their discourse, students identified major knowledge advances in each view (work space) and clustered their notes accordingly in a two-dimensional space. In some cases, students addressed multiple issues in a single note (e.g., rainbows, how prisms work, primary and secondary colors), helping to connect up different lines of inquiry.

An inquiry thread involves a temporal dimension: It extends across a certain time span. It starts from the first and ends at the last discourse entry, possibly involving multiple cycles of intensive discussions within this time period. An inquiry thread has its social dimension: It is important to understand who initiated a line of inquiry (e.g., contribute the first entry), who contributed to the discussions, as authors, and who participated as readers.

Advances in an inquiry thread can be further elaborated through content analysis of the major inputs: what kinds of questions were raised? How were new ideas introduced and examined (e.g., experiments, reading)? Was there progressive problem solving and idea improvement? How far did students go in a domain? In the discourse about rainbows shown in Figure 2, students initially asked how rainbows are made, leading to the understanding that the raindrops split sunlight to make a rainbow. Based on this understanding, students generated further problems, such as: How can a big thing like a rainbow "be activated by mere raindrops"? "There are lots of colors of the rainbows, why are they always in the same order"? "Why do rainbows always take the shape of a semicircle"? The progressive questions generated in a community knowledge space represent students' epistemic moves to deepen their collective understanding. Tracing student ideas generated in each inquiry thread (problem space) and rating the scientific sophistication—from pre-scientific to scientific—of each idea demonstrates significant improvement. The scope and depth of student discussions was additionally benchmarked by comparing the themes of the inquiry threads and associated domain-specific concepts to the expectations of the curriculum, showing that the students had addressed almost all the curriculum topics of their current grade and many deep contents expected for upper grades (e.g., after-image and color vision).

Research shows that inquiry threads that involve more contributors in extended and intensive discourse, address deepening questions, elaborate and refine ideas through experimentation and critical reading are associated with more dynamic knowledge advances [26]. Most recently, the generation of inquiry threads has been partly automated through semantic analysis and visualization, so that it can be implemented more easily by researchers and teachers.

4. Towards an Integrated Framework

The above two approaches for examining collective knowledge building were developed separately but both address the problem of community knowledge supported with construct validity [23, 26]. Knowledge-building portfolios engage students in actively assessing and rising above their knowledge advances by identifying and documenting highpoints. Inquiry threads analysis involves in-depth coding of student discourse and provides detailed accounts of the evolution of the community knowledge space. An integration of these two approaches will help to augment both and inform effective strategies for assessing and bootstrapping community knowledge building. We propose a framework that integrates the two approaches, and integrates assessment with knowledge building design (Figure 3).

In a knowledge building community, students engage in metacognitive conversations to rise above knowledge building discourse about specific ideas and problems in a domain. They review and reflect on the emergent knowledge building goals and themes; and frame, mark, and index their knowledge space to direct their inquiry into productive directions. The social, metacognitive markers and collective efforts created by students can aid them in creating knowledge-building portfolios to document collective knowledge advances and personal growth and identify emergent challenges to be addressed by the community. With reference to the markers, indices, and documentations created by students, researchers—and teachers, aided by automated technological tools—can profile the knowledge building progresses using inquiry threads, and conduct in-depth analyses of idea development. The maps of inquiry threads coupled with knowledge advances documented by student portfolios can be turned into objects of classroom discourse to help students monitor collective progresses and individual participation and create better documentations of their knowledge work. They can discourse which inquiry threads may represent more productive areas, how to synthesize and document such community advances in their portfolios, and how to make advances in relatively weak areas. Data needed for the above analyses are naturally generated by the community in its knowledge building work, and fed back to the community for transformative assessment and continual improvement [17].

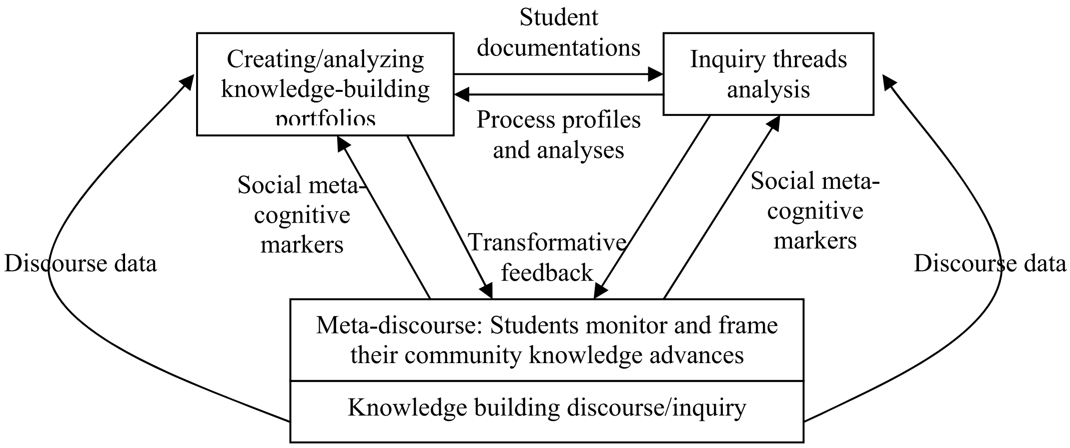

Figure 3. An integrated approach to examining and scaffolding community knowledge

The integration combines "insider" with "researcher" perspectives: Researchers can see which ideas students see as important, what constitute the key milestones for the growth of the community, and which ideas tend to be neglected. Further investigations can be conducted to examine (a) how students' views of knowledge building reflected in portfolios correspond to researchers' analyses of inquiry threads; (b) how using inquiry threads in classroom talks may help students produce better portfolios, and (c) how the discourse on ongoing portfolios may stimulate more growth in inquiry threads.

References

[1] Baker, M., Andriessen, J., Lund, K., van Amelsvoort, M., & Quignard, M. (2007). Rainbow: A framework for analyzing computer-mediated pedagogical debates. *International Journal of Computer-Supported Collaborative Learning, 2*, 315-357.

[2] Barab, S. A., Hay, K.E., & Yamagata-Lynch, L.C. (2001). Constructing networks of action-relevant episodes: An in situ research methodology. *Journal of the Learning Sciences, 10* (1&2), 63-112.

[3] Bereiter, C. (1994). Implications of postmodernism for science, or, science as progressive discourse. *Educational Psychologist, 29*(1), 3-12.
[4] Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: Erlbaum.
[5] Bielaczyc, K., & Collins, A. (1999). Learning communities in classrooms: A reconceptualization of educational practice. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 269-292). Mahwah NJ: Lawrence Erlbaum Associates.
[6] Chan, C.K.K., & Lam, I. C. K. (2008). Facilitating conceptual and epistemological changes using knowledge building. *Proceeding paper presented at the International Conference of Learning Sciences,* University of Utrecht, Netherlands.
[7] de Laat, M., Lally, V., Lipponen, L., & Simons, R.J. (2007). Investigating patterns of interaction in networked learning and computer-supported collaborative learning. *International Journal of Computer-Supported Collaborative Learning, 2*, 87-103.
[8] Guzdial, M. & Turns, J. (2000). Computer-supported collaborative learning in engineering: The challenge of scaling up assessment. In M. J. Jacobson & R. B. Kozma (Eds.), *Innovations in science and mathematics education: Advanced designs for technologies of learning* (pp. 227-257). Mahwah: NJ: Lawrence Erlbaum Associates
[9] Hewitt, J., & Teplovs, C. (1999). An analysis of growth of patterns in computer conferencing threads. In C. Hoadley (Ed.), *Proceedings of CSCL'99: The third international conference on computer support for collaborative learning* (pp. 232-241). Mahwah, NJ: Erlbaum.
[10] Hmelo-Silver, C.E. (2003). Analyzing collaborative knowledge construction: Multiple methods for integrated understanding. *Computers & Education, 41*, 397-420.
[11] Hong, H. Y., & Scardamalia, M. (2008). Using key terms to assess community knowledge. Paper presented at the Annual Meeting of American Educational Research Association, New York.
[12] Howell-Richardson, C., & Mellar, H. (1996). A methodology for the analysis of patterns of participation within computer mediated communication courses. *Instructional Science, 24,* 47-69.
[13] Koschmann, T. (2001). Revisiting the paradigms of instructional technology. Proceedings of the 18th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education. Melbourne.
[14] Lee, E.Y.C., & Chan, C.K.K., & van Aalst, J. (2006). Students assessing their own collaborative knowledge building. *International Journal of Computer-Supported Collaborative Learning, 1*, 277-307.
[15] Lipponen, L. Rahikainen, M., & Hakkarainen, K. (2002). Effective participation and discourse through a computer network: Investigating elementary students' computer supported interaction. *Journal of Educational Computing Research, 27*(4), 355-384.
[16] Meier, A., Spada, H., Rummel, N. (2007). A rating scheme for assessing the quality of computer-supported collaboration process. *International Journal of Computer-Supported Collaborative Learning, 2*, 63-86.
[17] Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Eds.), *Liberal education in a knowledge society* (pp. 67-98). Chicago, IL: Open Court.
[18] Scardamalia, M. (2004). CSILE/Knowledge Forum®. In A. Kovalchick, & K. Dawson (Eds.), *Education and technology: An encyclopedia* (pp. 183-192). Santa Barbara, CA: ABC-CLIO, Inc.
[19] Stahl, G. (2006). *Group cognition: Computer support for building collaborative knowledge*. Cambridge, MA: MIT Press.
[20] Sun, Y., Zhang, J., & Scardamalia, M. (in press). Knowledge building and vocabulary growth over two years, Grades 3 and 4. *Instructional Science*.
[21] Suthers, D., Dwyer, N., Medina, R. & Vatrapu, R. (2007). A framework for analyzing interactional processes in online learning. Paper presented at the annual meeting of the American Educational Research Association.
[22] van Aalst, J., & Chan, C.K.K. (2001). Beyond "sitting next to each other": A design experiment on knowledge building in teacher education. In P. Dillenbourg, A. Eurelings, & K. Hakkarainen (Eds.), European perspectives on computer-supported collaborative learning: Proceedings of the First European Conference on Computer-supported collaborative learning. Maastricht, Netherlands.
[23] van Aalst, J., & Chan, C.K.K. (2007). Student-directed assessment of knowledge building using electronic portfolios. *The Journal of the Learning Sciences, 16* (2), 175-220.
[24] Wertsch, J.V. (1998). *Mind as action*. New York: Oxford University Press.

[25] Zhang, J. (2004). The growing networks of inquiry threads in a knowledge building environment. Paper presented at the Knowledge Building Summer Institute. University of Toronto.
[26] Zhang, J., Scardamalia, M., Lamon, M., Messina, R., & Reeve, R. (2007). Socio-cognitive dynamics of knowledge building in the work of nine- and ten-year-olds. *Educational Technology Research and Development, 55*(2), 117–145.