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Abstract: The goal of the study was to develop and examine a computer-supported knowledge building environment, incorporating e-portfolio assessment to scaffold and assess collaborative knowledge building. It involved a quasi-experimental design in a Chinese tertiary setting to understand the characteristics of and relations among knowledge building participation, collaboration, and collective knowledge growth. Students reflected and documented their knowledge building practice in the e-group-portfolios, which helped to characterize and scaffold knowledge building discourse. Students in the KB environment were found more actively engaged in Knowledge Forum and high-level discourse moves. Future research may place emphases not only on forum participation, but also on how high level discourse moves can be fostered to advance collective knowledge towards knowledge creation.

Introduction

Learning is now conceived as a collaborative endeavor (Cummins, 2002), and assessment, especially formative assessment should be an integral part of the instructional process (Shepard, 2000) and be aligned to enhance learning (Biggs, 2003; Black and Wiliam, 2004; Broadfoot 1996; Rushton, 2005). With the upsurge of information technology, computer-supported collaborative learning (CSCL) has emerged and provides benefits and potential for twenty first century education (Stahl, 2006).

Although the key focus in paradigms of learning has turned to social and collective aspects and assessment is for enhancing learning, important questions regarding how to develop a social constructivist classroom, and how to identify, scaffold, and assess collective learning and collaboration remain to be investigated. CSCL is promising, but putting students in a CSCL environment does not necessarily lead to meaningful collaboration and learning (Kreijns, Kirschner, and Jochems, 2003). There is in general a lack of alignment in learning, assessment, technology and collaboration in higher education. Although there is much calling for developing higher-order thinking in higher education reforms across the world, very little research on how to assess those higher-order competencies has been conducted (Chan and van Aalst, 2004). This study aimed to adopt the knowledge building approach to examine collective learning, formative assessment, and collaboration in the context of higher education.

Theoretical Perspectives

To align learning, collaboration and assessment in a technology-enhanced learning environment, this study is premised theoretically on the knowledge-building model of Scardamalia and Bereiter (2006). As a forerunner of CSCL, knowledge building emphasizes knowledge creation as collective work of a learning community. To support student discourse, Knowledge Forum® (KF) is designed to objectify the creation and improvement of ideas manifested in the form of notes. Scardamalia (2002) has proposed a system of 12 knowledge building principles including *improvable ideas, epistemic agency,* and *collective responsibility* to facilitate and examine the socio-cognitive and socio-technological dynamics of knowledge creation.

Sheperd (2000) has proposed a constructivist framework on assessment which emphasizes the link between assessment and ongoing instruction, and the need for student to develop critical thinking, problem-solving, and meta-cognitive abilities. As a method for formative assessment, a portfolio can be a showcase for a student's best work (Roberts, 2005). When a portfolio is used for assessing students' learning, it usually engages a student in higher order thinking through the use of inquiry and reflection (Johnson et al., 2010).

Recent studies in knowledge building have focused on implementing knowledge building principles and e-portfolio assessment for knowledge building (Lee et al., 2006; van Aalst and Chan, 2007; Zhang et. al., 2007). Lee et al. (2006) selected five key facets of knowledge building principles and guided students to use portfolio to assess individual and community knowledge advances in computer forums. Zhang et al. used principles, but not formative assessment to analyze students' growth in domain understanding. Other studies (Chan and Lam, 2010) used reflective assessment to foster students' conceptual change. Although many studies of knowledge building have been conducted in schools (Chan, 2011; Hakkarainen, 2003, 2004; Zhang et al, 2007), there is a lack of systematic research on knowledge building in tertiary settings. Few studies have addressed assessment for learning under CSCL in Mainland China. Ge (2011) reported a net-based peer assessment for improving Chinese adult learners' English writing ability. The findings showed participants got satisfactory results, yet collaboration was very difficult to foster.

Research has identified that knowledge building discourse can be distinguished as knowledge sharing, knowledge construction and knowledge creation (van Aalst, 2009); it is useful to see how the discourse patterns may be manifested among students. In addition, earlier studies examined portfolio on individual basis and portfolio in this study are on group basis, which may also be better able to capture the collective work in the community. Therefore, the goal of this study is to design and examine a knowledge building environment and in particular, use portfolio assessment to scaffold, characterize and assess collective knowledge building. The research questions were 1) What are the characteristics of student knowledge building participation, collaboration, and collective knowledge growth in the e-portfolio-augmented knowledge building environment 2) How are such knowledge building dynamics related to one another

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Participants and Procedure

Participants were two intact classes of first year tertiary students in a renowned university in Shanghai, China. It adopted a quasi-experimental design examining the effects of a knowledge-building environment with principle (KB, n= 30) and a non knowledge-building environment (NKB, n = 30). The KB environment was characterized by knowledge building pedagogy, principles, and the technological platform, KF. The NKB environment was a typical teaching environment consisting of teacher's lecture and students' discussion; it was not governed by knowledge building principles, but KF also was utilized. The consideration for employing KF to both classes was that we would examine more closely whether it was merely the novel effects of inclusion of technology or the deeper impacts via knowledge building theory-pedagogy-technology that made changes. Both classes were taught by the same teacher who had 12-year experience of teaching, accessed a huge amount of knowledge building database, and observed knowledge building teachers' meetings frequently. The course was titled *Introduction to Business*, conducted in two semesters of academic year of 2010-11. Each semester lasted 14 weeks and each week had 2 lessons of 1.5 hours. Students had face-to-face discussion and inquiry in class and wrote notes on KF after class. The KB students were taught the knowledge-building principles explicitly, while the NKB students were not taught them but were encouraged to use KF as a new technological medium to communicate and learn.

Design of a Knowledge Building Environment

We designed a leaning environment based on knowledge building pedagogy to facilitate collaboration and deep learning. (1) *Forming a collaborative learning culture*. In the first few sessions, students were provided with learning experiences which familiarized them with the technology and acculturated them into the practices of collaborative inquiry. Focus was placed on making ideas public on KF (Fig.1a). (2) *Developing knowledge-building inquiry*. Students through face-to-face and online discourse, elaborated what they know about the topic, set forth their theories, searched for useful resources, and explored answers in a cyclical and deepening way. (3) *Emergence and rise-above.* Agency was turned over to the students and they were able to define goals and activities as the questions emerged in class or online. They assumed responsibility for their own learning and helped each other for knowledge advancement. The teacher acted as a facilitator, scaffolding the discussion towards a continuous rise above way. (4) *Portfolio assessment*. Formative assessment was used to scaffold as well as to characterize collective knowledge. In class and on KF, students tracked and reflected their inquiry trajectory to identify what were the promising questions, and what needed further inquiry. During semester 2, students in both classes were divided into 6 small groups to do projects; each group was then required to submit 3 e-portfolios (Fig.1b) during week 4, 7, and 9 respectively. Students were suggested to include 4 best clusters of notes from KF into a portfolio and to provide explanations simultaneously to justify their selection. For the KB environment, students adopted knowledge building principles such as improvable ideas, collective responsibility, epistemic agency, and constructive uses of authoritative information to direct their writing on KF, which intended to refine their discourse towards knowledge creation.

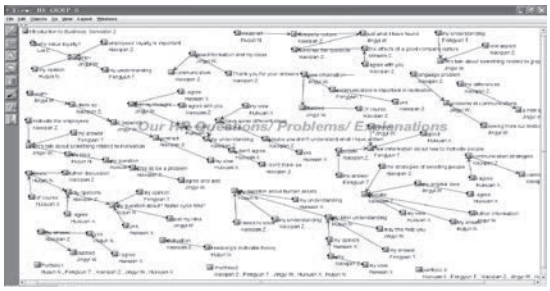

Figure1a. A discussion view of Knowledge Forum (the red tiny icons represent students' notes)

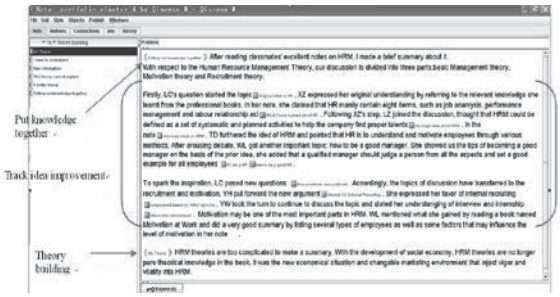

Figure1b. An example of student's e-portfolio (putting our knowledge together)

Data □our□es

Data included assessment applets and Analytic Toolkit (tools embedded with KF) indices that utilize server log data to represent students' participation patterns on KF. □ther important data were students' e-group-portfolios submitted on KF based on the approach developed by van Aalst and □han (2007) and □ee et al. (2006). In both the KB and NKB classes, students formed into small groups and wrote group portfolios. Each portfolio consisted of four clusters of best notes from KF. A cluster of notes refers to notes addressing the same principle topic or problem in the communal space; they are put together to form an inquiry thread (□hang et al. 2007). In preparing their group portfolio, students documented knowledge advances in the community; they developed meta-discourse to reflect on the collective knowledge growth. The e-portfolios were employed as data sources to track collective knowledge building. In the present study, group rather than individual portfolios were employed. According to the design, each of the KB and NKB class produced 1□ e-group-portfolios, totaling 36 portfolios.

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We employed two KF Applet indices □ Notes □ead Density and Notes Build-on Density to measure student involvement in knowledge building community. The assumption is that if a student reads more of others' notes, he or she may develop stronger community awareness, and the same is true regarding building on others' notes and community connectedness. By the end of instruction, applet data showed □ead Density and Build-on Density for both environments (Fig 2a)□91.2□ and 63.4□ for KB; and □7.□□ and 22.2□ for NKB. The results, especially the Build-on Density, were encouraging compared to those of previous studies (□han and Fu, 2011; van Aalst and Truong, 2011). It indicated the KB environment (Fig 2b) students responded more directly and actively than the students in the NKB environment (Fig 2c).

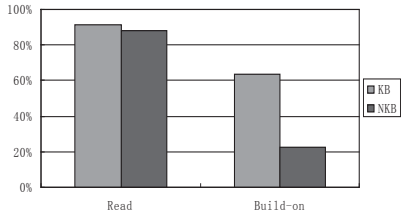

Fig 2a. Read & Build-on Density (KB & NKB)

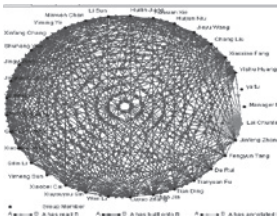

Fig 2b. Build-on (KB)

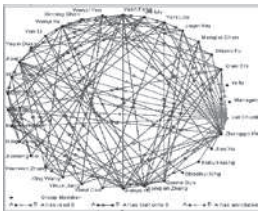

Fig 2c. Build-on (NKB)

KF participation and Engagement

We then examined students' overall participation and engagement in KF via Analytic Toolkit (ATK), which provides sever log information on *notes written, notes read, notes linked, notes revision, keywords scaffolds used,* etc. The knowledge building literature suggests that these quantitative indices indicate students' collaboration and meta-cognition for intentional learning. The results of ATK indices for both KB and NKB environments were as follows: number of notes written, *57.8 (18.9)* and *24.4(9.8)*; notes revisions, *16.8 (12.8)* and *7.6(9.1)*; scaffolds used, *42.5 (26.5)* and *5.9 (8.5)*; percentage of notes linked, *78% (11%)* and *52%(16%)*; notes read, *47% (15%)* and *24% (13%);*and keywords*,56%(23%)* and*36%(20%)*. According to previous studies on computer-supported learning in higher education, fragmented contributions and limited thread growth are common (Hewitt, 2005). The present data indicated both KB and NKB classes had high levels of contribution and connectedness. To provide more coherent analysis, six ATK indices were combined using factor analysis (see Lee et al., 2006). Two factors emerged – productivity (write, read, revision, scaffolds) and collaboration (linked, keywords). Statistical analysis indicated significant differences between two environments, for ATK Productivity, $F(1,58) = 73.7, p<.001$ and for ATK Collaboration, $F(1,58) = 44.5, p<.001$.

Characterizing Knowledge-Building Dynamics

To better understand the knowledge building process and characterize the dynamics of students' collective work, students' e-group-portfolios were analyzed. Portfolio discourse objectified their perspectives about knowledge and knowledge building. For example, at the lower level, they might think it's just fine to reproduce what others' think and draw some notes together to finish a task. Or at the middle level, they might want to understand what other people say and if possible, join in the discussion and enrich their personal minds. While at the much higher level, they needed to demonstrate higher order abilities to synthesize and evaluate, to assume collectives responsibilities and view the class as a learning community; therefore, discourse was geared to address collective knowledge gaps and dedicated to something new and meaningful for the community. Qualitative analyses were conducted on the portfolios to identify and characterize collective knowledge building dynamics, nine categories of discourse processes with descriptions and examples were listed below (Table 1).

Table 1: Categories, Description, and □xamples of Discourse □oves

Category	Description	□xamples (excepts from e-portfolios)
□1. Listing or Paraphrase (LP)	Copy information from others' notes or repeat the information in a very close way; put notes together without explanations	And □BW said □□□ *trainin□is not only□ □ut also…*".* * copy of ZBW's note info.
#2. Brief Summary (BS)	Summarize a few notes shortly and incompletely	A good manger must have these principles. *First,… Second,. Third,…*
#3. Interpretation or Elaboration (IE)	Interpret others' notes information with different wording or extend information by examples or evidence	LW got some info *indicating that* more than half people believe…*That is to say* it is ….
#4. Problem or question-based (PB)	See the discussion as problem-based and a deepening process of seeking answers or solutions to questions/problems	FXX *brings forward her question,* how to establish a system…. LCh *gave her answer*…then WY *gave an answer in another situation*…YIM *brings an idea* which is *totally different from others*…CXB *gave us some info.*
#5. Emergent Questions (EQ)	Keep asking related questions, showing doubts or seeking clarification; responses and explanations are intertwined progressively in the discussion	The *main question* was raised by JHL…many students *took part in the discussion actively*. ZLY said and *summarized* her idea … However, CXB seemed to [*differ*] *with* her. She thought…and put up *a further question* …This *problem* was intractable. CJR gave *a general answer* …this answer *didn't respond to the question directly,* we work on this later. Another *chain* began with …WY was *confused about* …CXB gave *another aspect* of …
#6. Constructive use of Information (CI)	Use information, either from experts, books, internet, or other related courses, life experience, etc. to justify or deepen their ideas	There is *a chain of* notes began with LW's question…L built on and asked… *CMW* answered the question… she used the *knowledge learnt from the Market Leader course, which shows…*
#7. Meta-Cognition (MC)	Realize high points in the discussion; and self-define goals and tasks of exploration	At the beginning of this semester, *we knew little about* HRM …We now showed a *great understanding of* it. …This topic is comp up with XB, I think it's interesting when she wrote a note Let's start a new topic! *This is like a class without a teacher.*
#8. Theory-Building (TB)	Focus on theories while developing the discourse; use theories to explain business phenomena with an attempt to create new theories	She studies *some HR theories* and tries to justify her ideas *by these theories. Theory Y* is one of the most appropriate… Based on these expanded ideas, we actually have *created a theory on* what makes an excellent manager…
#9. Meta-Discourse (MD)	Reflect on discourse goals and directions; adopt a collective "we" perspective to show collective responsibility in advancing knowledge and tackle difficult/ important issues which may be neglected by the community	L raised *new questions*…W didn't answer them immediately; *instead, 5 other students gave their explanations to the questions*… Two of the 5 notes are *even further discussed*. …LC thought WQ's theory can't explain her questions. I hope *we classmates can solve the problems*… This topic has *not been widely discussed yet*…it is quite *new and interesting*… Ultimately, *we* arrived *at a new conclusion …*

Using this coding scheme, we examined discourse patterns in 36 group portfolios. Following the procedures of quantifying qualitative data (Chi, 1997), we computed the mean scores for different categories of discourse processes for the two classes (Table 2). Multivariate analyses conducted indicating significant results followed by univariate analyses. Significant differences were obtained on: Listing & Paraphrase, $F(1,58)=25.0$, $p<.001$; Brief Summary, $F(1,58)=17.7$, $p<.001$; Emergent Question, $F(1,58)=72.5$, $p<.001$; Theory Building, $F(1,58)=14.8$, $p<.001$; Meta-discourse, $F(1,58)=38.4$, $p<.001$; and Meta-cognition, $F(1,58)=3.4$, $p<.08$; while no significant difference on Interpretation and Elaboration, Problem or Question Based, and Constructive Use of Information. These results suggested that NKB students were more involved in activities such as listing, paraphrasing and briefly summarizing when conducting the e-portfolios; while KB students were more engaged in high level processes of offering explanations, reflecting directions of their discourse, addressing collective knowledge gaps and attempting to create new knowledge or theories.

Table 2: Comparison of Discourse Patterns between KB and NKB

	1.LP	2. BS	3. IE	4. PB	5. EQ	6. CI	7. MC	8. TB	9. MD
KB *M(SD)*	*.17 (.38)*	*.67(.76)*	*1.2(1.1)*	*.83(.70)*	*2.3(.76)*	*1.2(1.1)*	*1.2(.91)*	*1.2(.91)*	*1.8(.70)*
NKB *M(SD)*	*1.0 (.83)*	*1.5(.78)*	*1.2(.70)*	*1.2(.91)*	*.67(.76)*	*.83(1.1)*	*.83(.38)*	*.33(.76)*	*.76(.75)*

Note: 1.Listing or paraphrase; 2.Brief Summary; 3 Interpretation or Elaboration; 4. Problem or Question-Based; 5. Emergent Question; 6. Constructive use of Information; 7. Meta-Cognition; 8. Theory-Building; 9. Mate-discourse

Relations between KB Participation and Discourse Moves

To further understand knowledge building dynamics, we investigated the relationships among different variables in the learning environments. We obtained students' high-level discourse move scores by combining categories #4 to #9. Pearson correlation analyses showed significant positive relations among the measures (Table 3). ATK productivity was correlated with collaboration. It indicated that students contributed more notes to KF were also likely to interact more with the community members. Importantly, there was strong positive relationship between students' high level discourse move and forum engagement. It suggested that students more engaged in KF might also be able to move to higher level of discourse, thus directing themselves towards emergent knowledge creation.

Table 3: Correlations among ATK Productivity, Collaboration and High Level Discourse Moves

	1	2
1.ATK Productivity		
2.ATK Collaboration	.400**	
3. High Level discourse Moves	.386**	.392**

Note: N=60, **p<.01;

Conclusion and Implications

This study developed a computer-supported knowledge building environment, augmented with e-portfolio assessment, to scaffold and assess collective knowledge building. By adopting a quasi-experimental design, this study showed students in the KB environment were more connected to one another and more engaged in the knowledge building process. Technology such as KF did help students in both classes, but it was the underlying knowledge building principles and pedagogy that had contributed to the different effects.

E-portfolio assessment helped to scaffold and assess collaborative knowledge building, revealing more knowledge building dynamics and the way students were engaged in the knowledge building process. We developed a new coding scheme to characterize and assess e-group-portfolio discourse in the area of business studies, enriching the knowledge building literature on differentiating knowledge (van Aalst, 2009). Positive correlations were found between knowledge building engagement and high-level discourse moves. Therefore, future research might lay emphases not only on forum engagement, but also on how high level discourse moves can be fostered to advance collective knowledge towards knowledge creation.

References

Chan, C. (2011). Bridging research and practice: Implementing and sustaining knowledge building in Hong Kong classrooms. *International Journal of Computer-Supported Collaborative Learning, 6*(2), 147.

Cummins, J. (2002). Foreword. In P. Gibbons (Ed.), *Scaffolding language, scaffolding learning: Teaching second language learners in the mainstream classroom* (pp. v-viii). Portsmouth, NH: Heinemann.

Lee, E. Y. C., C. K. K. Chan, et al. (2006). Students assessing their own collaborative knowledge building. *International Journal of Computer-Supported Collaborative Learning* 1: 278-307.

Hewitt, J. (2005). Toward an understanding of how threads die in asynchronous computer conferences. *The Journal of the Learning Sciences*, 14(4), 567-589.

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.), *Liberal Education in a knowledge society* (pp. 67-98).

Scardamalia, M., & Bereiter, C. (2006). Knowledge building. In R.K.Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 97-115). Cambridge: Cambridge University Press

Shepard, L.A (2000). The role of assessment in a learning culture. *Educational Researcher*, Vol.29, No. 7, pp. 4-14.

van Aalst, J. (2009). Distinguishing knowledge-sharing, knowledge construction, and knowledge-creation discourses. *International Journal of Computer-Supported Collaborative Learning (4),* 259-287.

van Aalst, J., & Chan, C. (2007). Student-directed assessment of knowledge building using electronic portfolios in Knowledge Forum. *The Journal of the Learning Sciences, 16*(2), 175-220.

Zhang, J. W., M. Scardamalia, et al. (2007). Socio-cognitive dynamics of knowledge building in the work of 9 and 10-year-olds. *Education Tech Research* Dev. 55: 117-145.