Design for Scaffolding Collaborative Inquiry and Academic Literacy for Chinese Tertiary Business Students

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Abstract: This study investigated how collaborative inquiry and social literacy acquisition took place in a computer-supported collaborative inquiry environment for Chinese tertiary business students. Participants were 102 Year 1 business students in four intact classes. Two classes experienced a principle-based computer-supported environment and two a conventional project-based approach. Data included survey, writing quality, portfolio, focus group interview and online interactions. Quantitative analyses indicated instructional groups outperformed comparison groups on conceptual understanding, inquiry processes and argumentative writing. Interview study characterized change dynamics under four contextual themes-- epistemology, pedagogy, technology, community, pointing to facilitative role of design principles. Micro-level online discourse analysis characterized nature of discourse moves and group patterns suggesting a significant role of socio-metacognitive and explanatory discourse mediated by technology.

Keywords: Collaborative Inquiry, change dynamics, online discourse, business education

Introduction

This study aims to examine the role of a computer-supported collaborative inquiry (CSCI) environment premised on knowledge building principles in fostering collaborative inquiry and social literacy among Chinese tertiary students. Specifically, we examined (a) the effects of the designed CSCI environment on students' conceptions of collaboration, conceptual understanding and academic literacy, (b) change dynamics mediated by the interplay of contextual factors, and (c) the nature of online discourse to understand how changes took place mediated by socio-cognitive and technological dynamics.

Educational reforms in tertiary education now focus on fostering collaborative inquiry and knowledge creation. Innovative models of learning and teaching, such as project-based learning and computer-supported collaborative inquiry learning have become commonplace. However, there is still a dearth of contextual understanding and deep analysis of whether and how these instructional models scaffold students' learning and collaboration in authentic classroom settings.

Computer-supported collaborative learning (CSCL) has received increasing research attention in higher education. Much research has been conducted on designing new computer software systems or examining social and cognitive processes mediated by technology (Koschmann, Hall, & Miyake, 2002; Stahl, 2006). However, a major concern remains regarding how technology can be utilized to enhance learning and collaboration in complex classroom settings. More specifically, deep contextual understanding is called for

of how learning and collaboration are impacted by interactions between pedagogy, technology-mediated design and institutional practices in higher education.

Premised on the knowledge-creation metaphor of learning, knowledge building is an influential model in collaborative inquiry (Paavola, Lipponen, & Hakkarainen, 2004). Although considerable research evidence has shown its role in advancing collective idea improvement (Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007), progress inquiry and social literate skills (Sun, Zhang, & Scardamalia, 2010; Zhang & Sun, 2011), the majority of the research has been conducted in science domains among school-aged children (Hämäläinen, Manninen, Järvelä, & Häkkinen, 2006; Zhang et al., 2007). Little has been known about how students co-constructed ideas and advanced their understanding in other domains, such as business education, among tertiary students. Investigating how Chinese tertiary students construct collective understanding of business concepts using English as a foreign language may extend our understanding of the role of and design for knowledge building in a different cultural context.

In addition, project-based learning is now advocated in tertiary business education (Brzovic & Matz, 2009; Eastman & Swift, 2002; Rooney, 2000), yet it is often considered as task-completion with division of labor. How students approach knowledge building of conceptual ideas integrated with project inquiry will be an important area for examination.

To sum up, this study aimed to examine the role of the knowledge-building inquiry environment, to investigate change dynamics in the designed environment, and to further examine meditational role of technology and social dynamics. Three questions were addressed: 1.What were the instructional effects? Specifically, did students in the designed environment perform better than comparison students in conception of collaboration, conceptual understanding, and academic literacy? 2. How did changes take place mediated by the interactions with the contextual factors in the designed environment? 3. What were the discourse patterns distinguishing high- and low-performance groups?

1. Methods

1.1 Participants

The study included 102 Year 1 English for International Business (EIB) students from four intact classes in a University in Shanghai. The four classes had similar achievement levels, generally at low-average levels compared with the same year students in other programs. A quasi-experimental design was employed: two tutors each taught one instructional class and one regular class. 52 students were in CSCI groups and 50 in PjBL groups.

1.2 Design of CSCI environment

The research was conducted in a 12-week core module of EIB to develop students' understanding of concepts in Total Quality Management (TQM) and research and literacy skills. This module was originally featured by a group project investigating TQM implementation in businesses in Shanghai. The PjBL groups mainly did project work after class following the project guideline prescribed by tutors in class.

A CSCI environment was designed for instructional groups to scaffold collaborative inquiry and academic literacy. Knowledge-building pedagogy was considered in the instructional design, as it has been evidenced to promote communal conceptual understanding as well as social-cognitive and social literate skills (Zhang & Sun, 2011). Considering the domain, cultural and instructional specificity of this study, we adapted four of knowledge building principles as design guidelines as follows:

1. *Collective cognitive responsibility*: creating social structures or dynamics for collective knowledge advancement with intentional use of English;
2. *Epistemic agency*: focusing on ideas, problems and co-construction of knowledge and deep understanding, rather than on completion of project tasks;
3. *Authentic problems, improvable ideas*: identifying authentic problems and progressively improving ideas in connection with the broader business community; and,
4. *Community Knowledge*: working together with effective communicative strategies to allows improved ideas and theories to diffuse through the communal knowledge space;

1.3 Data sources

Language Proficiency Students' pre-test English proficiency scores were collected.

Conceptual Understanding and Literacy Students were required to write an essay on TQM. Essays were analyzed using two rubrics; conceptual understanding examined TQM concepts and academic literacy including explanation, organization and mechanics of language. Inter-rater reliability was. 80 and .82, respectively.

Group Learning Portfolio Group portfolios document students' reflection and collaborative learning process. The portfolio was rated on a 6-point scale ranging from fragmentary responses to deep collaborative reflection; the inter-rater reliability was .86.

Collaboration A pre- and post questionnaire survey on conceptions of collaboration was administered using the Collaborative Online Learning Scale (COLS) (Chan & Chan, 2011). Cronabach's alpha coefficients of the COLS were .79 and .76 for collaboration and online-learning respectively.

Focus Group Interview Four successful project groups from both learning environments each participated in a 40-minute interview. Interview questions were designed adapted from Bielaczyc's social infrastructure framework (2006). Four dimensions include: beliefs about learning; pedagogical practices; social-technological dynamics and connection with community. Exemplar interview questions are "*Can you say something about the course design using TQM project? In what way is it different from other courses?*" "*What did your tutor do differently from those in other courses*?" "*How do you like the assessments in this course?*" "*Can you say something about your knowledge Forum (KF) activities?*" "*Did you use any computer technology in doing the project work? (for RPBL groups) What role do you think technology play on your project learning*?"

Online KF discussion note To further examine how collaboration and social literacy acquisition took place in the designed CSCI environment, students' Knowledge Forum discussion notes were analyzed quantitatively and qualitatively. Following current CSCL discourse studies of quantifying verbal data analysis (Broxel et al. 2000; Hmelo-Sivler, 2003), the online discourse analysis in this study took a multilevel and multidimensional approach, combining both qualitative and quantitative analyses to capture both the cognitive and social processes of collaborative project inquiry.

2. Results

2.1 Effects on Conceptual Understanding, Literacy and Collaboration

Descriptive statistics of the COLS, conceptual understanding and academic literacy are presented in Table 1. The results of MANCOVA analysis controlling for differences in language proficiency showed significant differences between groups; univariate analyses showed significant group differences on conceptual understanding (F (1, 97) =6.77, p<.01, η^2=.07) and argumentation,(F (1, 97) =8.03, p<.01, η^2=.08), favoring CSCIL groups.

Table 1 *Means and Standard Deviations (in parenthesis) for the COLS, the SPQ, Conceptual Understanding, Argumentation, Organization and Language Use*

	Collaboration		Online learning		Conceptual Understanding	Academic Literacy		
	Pre	Post	Pre	Post	(Max.=100)	Exp'n	Orga'n	Lang'e
RjPBL (n=49)	3.49 (.80)	3.47 (.56)	4.03 (.89)	3.83 (.78)	47.98 (10.49)	47.59 (10.33)	49.51 (9.89)	48.11 (10.56)
CSCI (n=53)	3.41 (.69)	3.97 (.58)	4.02 (.84)	4.42 (.40)	52.28 (9.10)	52.38 (9.40)	50.48 (10.24)	51.90 (9.40)

Analyses on conceptions of collaboration using repeated measures, controlling for pretest language scores, indicated significant interaction effects. Follow-up analyses indicated significant interaction effects for online learning (F (1, 98) = 8.36, $p < .01$, η^2 = .08) and collaboration (F (1, 98) = 10.43, $p < .01$, η^2 =. 10) favoring CSCI groups. These results suggest that instructional groups obtained better conceptual understanding and argumentation, and their conceptions of collaboration tended to become more sophisticated over time than their counterparts.

2.2 Change dynamics in the learning environment

This part reports briefly about key findings from focus group interviews. Analyses identified the salient contextual dynamics in the designed environment that contributed to student changes. Four interdependent and interactive contextual themes in the designed learning environment have been identified as impacting students' changes in learning and collaboration. As shown in Figure 1, four contextual themes were identified in the learning environment: 1) ***epistemological beliefs*** in the instructional design; 2) ***pedagogy***, including the role of teachers and assessment practices; 3) ***socio–technological dynamics***; and, 4) their ***connections with the outside business community***.

First, the design facilitated changes in students' embedded beliefs about learning and knowledge from being initial conflict when confronted with uncertainty of knowledge, to collective constructive use of authoritative information, and then to justification for advancing communal knowledge. Almost all students mentioned their epistemological conflicts at the early stage of project work. For example, one student related her conflict over uncertainty about knowledge: *"The difficult part lay in the different definitions of TQM. At the beginning of the semester, we were total confused by so many definitions of TQM and by the abstract principles. We all expected someone to tell us that this was an authoritative definition and these were useful principles. What we need to do is just note them down. You know, the more we read, asked, and searched, the more we felt confused and hopeless, and had no clear direction for the project." (Student #2, Group #2)*

However, CSCI students mentioned how their epistemological anxieties about information processing were lessened by their collaborative inquiry on knowledge forum, which enhanced their justification and changed their conception of collaboration. As one CSCI student pointed out, justification was not about getting an answer; it was about advancing communal understanding: *"Talking on Knowledge Forum (KF) helped us view different information, different perspectives….But when discussing the framework for the investigation, we got different opinions… relating to the first visit (a pilot investigation) and the principles from TQM theories, we articulated different opinions and tried to convince others with some evidence, reasons, examples to support… In most cases, there seems no definite right or wrong idea, but we may have a better idea after weighing over from different perspectives…Yes, this enhanced our understanding of TQM at that stage. When*

reading back our database, we could see the development (of our understanding)." (Student# 1, Group # 2)

These analyses suggested that the design of TQM project learning triggered cognitive conflict and changes in deep-rooted beliefs in certainty and authority of knowledge. Successful students, particularly in CSCI environment, who resolved their emerging epistemological conflicts, were simultaneously able to adopt more sophisticated beliefs about learning and knowledge. The CSCI design facilitated the development of high-level collective inquiry skills that could be transferred to other academic and work contexts, including identifying knowledge gaps, making constructive use of information, and cultivating justification.

Second, changes in pedagogical practices, with particular reference to teacher roles and assessment, were conceptualized as contributing to student change. Specifically, new conceptions of teachers as co-inquirers in the knowledge-building community rather than authoritative sources of knowledge may facilitate changes in beliefs about and strategies for learning and collaboration. Use of alternative, formative and collective assessment approaches matures students' views of assessment; rather than viewing it as the mastery of knowledge through rote memorization, they began to see it as the execution of collective agency and ownership for communal knowledge advancement, thus enhancing their social metacognitive strategy use in collaborative inquiry.

Third, social-technological dynamics scaffolding changes in both the process and the product of project inquiry were unraveled. Designed use of technology went beyond mere communication for knowledge sharing, to a cognitive, metacognitive and collaborative tool. Technology extended knowledge-building discourse through integrating concept learning, project inquiry, and language learning in enhanced socio-technological dynamics.

While only CSCI students had access to the KF online learning platform, most regular project groups reported spontaneous using computer technology such as QQ online instant messaging, MSN Messenger in their project learning. Analyses of interview data characterized their views of computer technology as knowledge-sharing and superficial procedural decision-making. In contrast, In addition to seeing technology as a medium for knowledge sharing or participation, some CSCI students commented on the impact of Knowledge Forum's scaffolding role on conceptual understanding, collaborative inquiry and literacy development. Their viewed Knowledge Forum as: 1) a cognitive tool for scaffolding thinking and collaborative writing; 2) documenting collective knowledge advancement and enhancing reflection and collective cognitive responsibility; 3) extending knowledge-transforming space linking concept learning and project inquiry; and, 4) expressive space for developing social literacy and group dynamics. Here are some excerpts: *"Unlike our face-to-face discussions, our KF discussions were recorded for future checks or reflection. At the end of the program, we were all glad to see our evolving TQM understandings at the different stages." (Student # 3, Group# 2); "Writing on KF may help us think and express ourselves in English. It is good practice. … Reading others' notes and responding to others, though sometimes difficult, is what we did on Knowledge Forum. We noticed that some groups just put on new notes but interactions were quite limited. We tried to respond to, comment on and build on others. …We valued all contributions to the discussion in democratic atmosphere." (Student # 2, Group# 2)*

Fourth, connections to the business community facilitated the development of students' beliefs in learning from the simplistic of knowledge assimilation and application, and further to the sophisticated views of knowledge transformation and collective knowledge building.

All the change dynamics under the four identified contextual themes point to underlying knowledge-building design principles, with particular emphasis on epistemic agency, authentic problems and ideas, collective cognitive responsibilities, and knowledge

building discourse. These finding explains why CSCI groups experienced more positive changes than their counterparts in PjBL in conceptions of collaboration, collective advances of conceptual understanding and academic literacy. Meanwhile, it identifies social-technological dynamic as a key contextual theme influencing students' changes. Thus CSCI online discourse was examined to unravel how changes in collaboration and learning are mediated by the interplay of social, cognitive, technological dynamics.

2.3 Characterizing Discourse Patterns and Processes

To understand how student engagement in computer-supported inquiry-based learning would promote student's knowledge advances and understanding, contrastive group analyses (group of 5) were conducted; eight groups were selected based on group project learning performance, yet with a comparable number of entries. All the computer notes were analyzed for illuminating collaborative inquiry processes.

Drawing on the theoretical framework of social and cognitive processes of knowledge construction in general (Hmelo-Silver, 2003), and informed by knowledge building notions of questioning and explanation (Hakkarainen, 2003) and meta-discourse (van Aalst, 2009), empirically induced categories were refined. Five major themes emerge including: (a) information-processing in concept learning, (b) information-processing in project inquiry, (c) metacognition, (d) question-explanation and (e) social dynamics (see Table 2). All the notes from the selected groups were multiple-coded based on the scheme illustrated in previous section. To obtain inter-rater reliability, Cohen's Kappa was computed. All the Cohen's Ks in this study were above.75, indicating a very good coding inter-reliability.

Table 2 *Online Notes Coding Categories and Definitions*

Coding categories	Definition
1. Information processing – conceptual learning	
Knowledge telling	Copy and paste from text with little processing
Elaboration	New info treated problematic for elaboration
Collective advance	Evaluate information from different perspectives to advance collective understanding
2. Information processing – project inquiry	
Surface task-based	Take project simply as completion of several mini-tasks
Information-sharing	Provide useful information for project work
Problem-solving	Design project as a problem-driven inquiry into a real business context
3. Epistemic Questioning	
Factual / clarification	Questions on basic facts, literal meaning of a sentence, for help or for clarification
Identifying inconsistencies	Questions identifying inconsistencies for explanation
Explanation-seeking	Questions raised for deep explanation or to seek to address the problem
4. Epistemic Explanation	
Simple claim	Give opinion without explanation or with irrelevant cut-and-paste information
Elaborated explanation	Make a claim supported with reasons, evidence, and examples
Meta-Explanation	Further explanation synthesizing different view(s) in the previous discussion
5. Metacognitive Processing	
Metacognitive-individual	Checking own progress and understanding; Identifying changes by reflecting on understanding and actions;
Co-regulation	Control and adapt strategies as a result of interactions with group members; learn in context with others

Collective regulation	Check ongoing project progress and communal understanding; identify changes and emerging key problems from the discussion discourse; synthesize different ideas and generate new coherent understanding
6. Social dynamics	
Rapport-building	Statements for building up rapport
Facilitating discussion	Statements to facilitate discussion
Making contributions	Statements to make suggestion to project inquiry

To generate deeper understanding of productive discourse moves and online social cognitive dynamics, contrastive analysis was conducted between high-performance (HP) and low-performance (LP) groups. Quantitative analyses were conducted, based on the coding scheme for discourse moves, to examine the groups' differences in the identified discourse moves. To ensure valid comparison of discourse moves across groups, the frequency occurrence was divided by the total number of group notes written to reveal the percentage of notes in which each discourse move occurred. Due to limited sample size and for coherence, the group comparison analyses were only conducted on the higher-level discourse moves for the major categories, namely collective advance in conceptual information processing, problem solving in project inquiry information processing, higher-level epistemic questioning (a combination of questions of identifying consistency and explanation-seeking), higher-level epistemic explanations (including both elaborate explanation and meta-explanation), collective regulation in metacognition and making contribution in social dynamics.

Analyses were made by assigning each individual his or her group percentage score for the various high-level discourse types. Group percentage scores were employed based on the notion that discourse moves emerge collectively in a group rather than belonging to each individual (Stahl, 2006). Mann-Whitney U tests were conducted to examine differences between HP and LP groups on the above-mentioned six discourse moves. Significant group differences were detected in collective advance (Z = -4.83, p <0.01), problem-solving inquiry (Z = -4.22, p <0.01), higher-level epistemic questioning, higher-level explanation (Z = -4.83, p <0.01), collective regulation (Z = -4.83, p <0.01), and making contribution (Z = -4.83, p <0.01).

The results indicate that HP groups more actively involved in knowledge construction and in collaborative project inquiry than were LP groups. HP groups used more individual and social metacognitive strategies to advance collaborative inquiry. During the inquiry process, they showed a higher level of collective epistemic agency by posing explanatory questions and providing elaborated explanations or meta-explanations. Moreover, they demonstrated lively social dynamics conducive to collective knowledge building.

3. Discussion and Conclusion

The study examined the role of CSCI environment for promoting collaborative inquiry in the context of project-learning and identified the nature of change dynamics interacted with social-metacognitive, pedagogical and technological factors and the scaffolding role of principle-based use of technology.

Earlier work related to this research project reported the observed effect of the designed CSCI environment on changes in learning approaches, conceptual understanding and literacy skills. The study extended the inquiry line by identifying the design effect on changes in student conceptions of collaboration. Drawing on focus group interview data, it provided deeper analysis on the change dynamics under the four contextual themes-epistemology, pedagogy, technology and community. More important, all the

dynamics reflected the importance of knowledge-building principle-based design emphasizing collaboration. Similarly, online discourse study corroborated evidence highlighting students' engagement in high-level socio-metacognitive discourse moves and meta-explanation contributes to collective advancement of communal understanding and higher-level collaborative inquiry strategy use. These findings from different data sources converged that student changes in CSCI environment are consistent with knowledge building model and epistemology. CSCI design informed by knowledge building principles is evidenced to foster students' development in sophisticated conceptions of collaboration and epistemological beliefs as well as higher-level collaborative inquiry strategy and to cultivate meta-explanation discourse that advanced both individual and collective conceptual understanding.

This study contributes to current literature of promoting student learning and collaboration in CSCL environment in higher education by investigating both the impact of innovative instructional practices and the change dynamics in relation to the innovative learning experience. Moreover, the study highlights the alignment between design, cognition, technology and context. Drawing on knowledge-building principles, this study designed a CSCI environment using Knowledge Forum to enhance collaborative knowledge building inquiry, examined the design effect on learning and collaboration, and investigated contextual change dynamics through analyzing student experience and online collaborative inquiry discourse.

This study has important pedagogical implications. It documents the effectiveness of a principle-based knowledge-building approach to designing an innovative model within the social cultural context of higher education in China. Pedagogically, it sheds light on how social constructivist learning theories can be transformed to promote changes in conceptions and strategies of collaboration and achieve both individual and collective gains among Chinese tertiary students. It provided an example of knowledge building with positive effects in a different domain of business study in a new cultural context. Further investigation will include deep analyses of connected KF discourses at different phrases to unravel how collective conceptual understanding was advanced and academic literacy was appropriated mediated by social-technological, cognitive and linguistic dynamics.

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