Kong, S.C., Ogata, H., Arnseth, H.C., Chan, C.K.K., Hirashima, T., Klett, F., Lee, J.H.M., Liu, C.C., Looi, C.K., Milrad, M., Mitrovic, A., Nakabayashi, K., Wong, S.L., Yang, S.J.H. (eds.) (2009). *Proceedings of the 17th International Conference on Computers in Education [CDROM]*. Hong Kong: Asia-Pacific Society for Computers in Education.

Conceptual, Metacognitive and Collaborative Learning in Computer-Supported Inquiry for Chinese Tertiary Business Students

Ke ZHAO[a], Carol C.K.K. CHAN[b]
[a]*Faculty of Education, University of Hong Kong, China*
[b]*Faculty of Education, University of Hong Kong ,China*
cocochao@hkusua.hku.hk

Abstract: This study aims to design and evaluate a collaborative inquiry learning environment using Knowledge Forum for Chinese business students' project learning and to investigate how collaborative learning takes place. Participants were four intact classes of 102 Year 1 tertiary business students and two tutors. Two classes were experienced in a designed CSCL learning environment and the other two classes were taught in a conventional project-based approach. Data were obtained from surveys, interactions in the forum, writing quality and collaborative learning portfolio. Quantitative analyses indicated that the instructional groups outperformed the comparison groups on approaches to learning, conceptual understanding, and argumentation writing. Students' use of scaffolds on Knowledge Forum was significantly correlated with higher-level performance. Qualitative analyses using contrasting groups illustrate differences in conceptual, metacognitive and collaborative processes in computer-supported collaborative inquiry. The significance and implications of the study are also discussed.

Keywords: CSCL, collaborative inquiry, knowledge building, academic literacy, higher education

Introduction

There are now paradigmatic shifts in learning theory from individual to social views of learning. Advances in current research have deepened our understanding of the social and cognitive processes of collaborative learning (Dillenbourg, Baker, Blaye, & O'Malley,1995; Stahl, 2006). Computer Supported Collaborative Learning (CSCL) in higher education has recently aroused intensive research interest (Goodyear, Jones, Asensio, Hodgson, & Steeples, 2005). Research on CSCL pedagogies has addressed some key issues in higher education, such as alignment of learning, assessment and collaboration (Chan & van Aalst, 2004).

Despite much progress, a major concern in CSCL research remains regarding how technology can be used to enhance learning, metacognition and collaboration in complex classroom settings. Earlier experimental studies evaluated instructional design with technology in a pre-and-post manner, and overlooked the process of collaborative learning and ecological complexity (Dillenbourg et al., 1995). However, recent micro-level analyses of the process suggest that CSCL seems to provide potentials for knowledge construction, whereas beneficial effects on learning outcomes are not always consistent. One key agenda in CSCL research should be to align technology-mediated instructional design with analyses focusing on both learning outcomes and the collaborative learning process and examining both individual and collaborative knowledge advances.

To progress on this agenda, interrelationships of cognition, design and context will inform the design of learning environment and analyses of collaborative processes. Two decades of theoretical advances in technology-enhanced learning examined collaborative knowledge building mediated by Knowledge Forum (KF), a CSCL environment (Scardamalia & Bereiter, 2006; Scardamalia, Breiter, & Lamon, 1994). Students' ideas viewed as *conceptual* artifacts are objects of inquiry. Comparing others' models with their own can enhance *metacognitive* understanding through questioning and explaining in *collaborative* inquiry. How students engage in conceptual, metacognitive and collaborative process mediated by computer forum needs to be examined. In addition, multiple measurements and analytical approaches are needed including both quantitative measures of effect and correlation between the process and product variables, and in-depth qualitative analysis of the process. To capture the multi-faceted learning process, in-depth analysis can be used to characterize the nature of collaborative learning and group patterns can be delineated through comparing quantified variables. Research using group comparisons has indicated that quality of interactions differed successful from less successful groups (Barron, 2003). Group comparisons can further enhance understanding of the interactions between social and cognitive factors as features facilitating or impeding the collaborative discourse flows.

Another concern in computer-supported knowledge building is the domain of inquiry. While online collaborative inquiry is becoming popular, most research has been conducted in science domains (Hakkarainen, 2003). Although the emerging goals in business education emphasize knowledge creation, collaboration and life-long learning (Eastman & Swift, 2002), yet little is known about the process of computer-supported inquiry learning in the domain of Business education. Further, academic literacy is stressed as another goal in business education, but limited studies have been done concerning the intertwined process of online inquiry and English academic literacy development, especially in English as Foreign language countries. This study aims to extend research on online collaborative inquiry to an under-investigated domain of business examining how conceptual understanding was constructed and academic literacy was developed in CSCL learning. In particular, emphasis was given to how students co-construct their understanding in the context of business project inquiry.

This study reported the design of a collaborative knowledge-building environment implemented in a tertiary business education course in Mainland China. Stemming from current theoretical emphasis on knowledge construction and in line with higher education reform emphasizing collaborative inquiry and academic literacy, and observations of limited collaboration, surface learning, and insufficient academic literacy skills, the study aims to design and evaluate the effects of a CSIL environment on learning approaches and outcomes and to analyze the actual process of collaborative learning. Specifically, three research questions are to be addressed: 1.What is the effect of the designed CSCL inquiry learning environment on students' learning approaches, conceptual understanding and academic literacy? 2. How is participation in the computer-supported learning environment related to learning approaches, conceptual understanding and academic literacy? 3. What are the characteristics of CSCL inquiry discourse, and specifically how do the successful groups learn and collaborate differently from the less successful groups?

1. Methods

1.1 Participants

The participants in this study were 102 Year 1 English for International Business students from four intact classes (Female=57, Male=45) attending 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 using computer-supported collaborative project-based inquiry and regular project-based instruction respectively.

1.2 Design of the learning environment

Setting The research was conducted in a core module of English for International Business to develop students' initial understanding of key concepts in Total Quality Management (TQM), research skills and literacy skills. This 12-week module was originally featured by a group project investigating TQM implementation in a business in Shanghai. Comparison groups did project work after class following the guideline prescribed by tutors in class.
Computer-Supported Learning Environment A CSCL environment was designed for instructional groups using Knowledge Forum. Premised on collective knowledge advances, KF was designed to support deep processing, metacognition and collaborative inquiry. KF provided a platform, where students generated questions, formulated conjectures, designed the project, provided new information, evaluated different perspectives and co-constructed understandings. Students worked in different group views on KF pursuing joint understanding and project inquiry.

The design for CSCL inquiry learning consisted of four components: namely, (i) collaborative learning culture building, (ii) scaffolded collaborative inquiry of TQM-related concepts, (iii) designing and implementing a project, and (iv) reflecting on the process of collaborative learning. Major design differences between KF groups and non-KF groups at the first stage were the build-up of a collaborative inquiry culture in class through using jigsaw reading activities and of an after-class online collaborative learning environment. The KF discussions were featured by use of embedded scaffolds. At the second stage, KF jigsaw reading and writing activities were designed to facilitate inquiry for deep understanding of TQM. Students were encouraged to post ideas and questions after having read materials and to respond to others with explanations or further questions. Concurrent with discussions on key concepts, students were also engaged in project-based inquiry designing a project investigating TQM implementation in companies. Students worked online in their own project group views documenting the process of group inquiry. Throughout online inquiry, students were encouraged to reflect on their understanding.

1.3 Data sources

Language proficiency Students' pre-test language proficiency scores were collected.
Learning approaches To examine the effects of learning environment on learning approaches, we administered a questionnaire survey at the beginning and the end of the program using the 20-item Study Process Questionnaire (SPQ), a well-established measuring instrument, especially for Chinese tertiary students. Cronbach's alpha coefficients of subscales were .74 and .79 for surface and deep approaches, respectively.
Essay To assess conceptual understanding and academic literacy, both groups were required to write an essay on the topic of "Discuss the argument that Chinese business should adopt TQM, if they are to succeed internationally." The essays were analyzed using two rubrics. One rubric, on conceptual understanding of TQM, was constructed by the two teachers while the other, for academic writing, consisting of argumentation, organization and use of language was slightly adapted from the prescribed school marking criteria. All

the essays were rated by the two teachers separately in the aforementioned two dimensions. The inter-rater reliability coefficients were. 80 and .82 respectively based on Pearson's Correlation.

Group Learning Portfolio To assess their collaborative project learning, the students in both groups were asked to prepare a group portfolio documenting the learning process. These group learning portfolios were also assessed by the two teachers based on the criteria adapted from Lee et al. (2006) ranging from level 1 (a collection of isolated pieces of required tasks) to level 6 (good demonstration of construction of communal understanding and deep inquiry). All of the group portfolios were rated separately by the two teachers and the inter-rater reliability coefficient was .86.

Analytical toolkit and database participation The Analytical Toolkit provided an overview of student online participation. We employed the quantitative indices of notes created, notes read, scaffold use and note revision.

2. Results

2.1 Effects on Changes in Learning Approaches

Table 1 shows the mean scores and standard deviations for surface and deep approaches for the two groups. To examine the effects of the instruction on changes of surface approaches and deep approaches, Repeated Measures with surface approaches and deep approaches as dependent variables controlling for pretest of language proficiency was performed. The result indicated significant interaction effects between time and environment, $F\ (2, 96) = 64.03$, $p<.01$, $\eta^2=.57$, on changes of surface approaches and deep approaches. Further univariate analyses identified significant interaction effects between time and environment on both surface, $F\ (1, 97) = 105.32$, $p<.01$, $\eta^2=.52$ and deep approaches, $F\ (1, 97)=48.72$, $p<.01$, $\eta^2=.33$, favoring the instructional groups. These results suggested that instructional groups adopted more deep learning and less surface learning approaches than their counterparts in comparison groups after the instruction.

Table 1 Means and SD (in parenthesis) for Approach to Learning, Conceptual Understanding, Argumentation, Organization and Language Use

	Surface Approaches (Max. =50)		Deep Approaches (Max. =50)		Conceptual Understanding (Max.=100)	Academic Literacy		
	Pre	Post	Pre	Post		Argumentation (Max.=100)	Organization (Max.=100)	Language (Max.=100)
Non-KF n=49	30.47 (5.11)	27.96 (5.12)	19.61 (3.13)	21.37 (3.12)	47.98 (10.49)	47.59 (10.33)	49.51 (9.89)	48.11 (10.56)
KF n=53	34.55 (3.64)	22.23 (3.95)	17.47 (3.24)	24.98 (3.56)	52.28 (9.10)	52.38 (9.40)	50.48 (10.24)	51.90 (9.40)

Notes: Non-KF= Comparison groups; KF= Instructional groups

2.2 Effects on Conceptual Understanding and Academic Literacy

The mean scores and standard deviations of conceptual understanding and the three dimensions of academic literacy are shown in Table 1. To examine the general effect of learning environment on conceptual understanding and academic literacy, a MANCOVA (environment X teacher) was conducted controlling for differences in language proficiency in the pretest. Overall MANCOVA results showed significant differences across groups, $F\ (4, 94) = 3.36$, $p<.05$, $\eta^2=.12$. Univariate analyses showed significant differences in conceptual understanding, $F\ (1, 97) = 6.77$, $p<.01$, $\eta^2=.07$ and argumentation, $F\ (1, 97) = 8.03$, $p<.01$, $\eta^2=.08$, favouring the instructional groups. These results indicate that instructional groups outperformed comparison groups in conceptual understanding and argumentation. There were no significant differences in organization and use of language.

2.3 Relation between Participation on Knowledge Forum and Conceptual Understanding

To investigate the relations of student engagement in Knowledge Forum with other measures, knowledge-building indices from Analytic Toolkit (ATK) for Knowledge Forum was used. Four indices were generated to indicate students' participation in KF. The means were 27.91(28.91), 3.84(3.01), 1.00(1.61) and 3.50 (3.71) for notes read, notes created, scaffold use and note revision, respectively. Correlation analyses indicated that among the different knowledge building indices, scaffold use was correlated with conceptual understanding (r=.33, p<.05) and argumentative development of academic writing (r=.36, p<.05). No significant correlations were observed between other indices and conceptual understanding and academic writing.

2.4 Characterizing Online Collaborative Learning

To understand how students learned in the CSCL inquiry environment, two project groups were selected based on group portfolio scores, group composition, and comparable numbers of entries. The successful group had a post-test group portfolio score of 6 whereas the less successful group had a score of 4. All the discussion notes of the two groups were analyzed for illuminating collaborative inquiry processes. A coding scheme was developed with statements coded in three major areas: information processing, metacognition and collaboration (Table 2):

Table 2 Coding Categories and Definitions

Coding categories	Definition
Information processing - conceptual	
Knowledge regurgitating	Copy and paste with processing
Elaborative knowledge telling	Assimilate info and elaborate
Implicit knowledge construction	New info treated problematic for elaboration
Explicit knowledge construction	Evaluate info from different sources for coherent understanding
Information processing – project	
Task-based	Taking project as completion of several mini-tasks
Inquiry-based	Taking project as an extended inquiry into a real business context
Metacognitive-individual	
Monitoring	Checking own progress and understanding
Reflection	Identifying changes by thinking about understanding and actions
Regulating	adapt strategies for the goal at an individual level
Metacognitive-social	
Goal setting	clear goals for group learning
Monitoring collective learning	Checking ongoing project progress and communal understanding
Group reflection	Thinking about communal understanding and identifying changes
Co-regulating	Control and adapt strategies as a result of interactions with group members
Evaluating others	Making judgments over others' opinion and performance
Social dynamics	
Rapport-building	or building up rapport
Facilitating discussion	Statements to facilitate discussion
Task –specific conflict	Statements concerned conflicts
Question types	
Low-level	On basic facts, literal meaning of a sentence or seeking for help
Clarification	For clarification
Support-seeking	For help
Explanation-seeking	Questions identifying sources of inconsistencies for explanation
Self-explanatory	Questions that are explained by oneself
Explanation	
Simple claim with no explanation	Give opinion without explanation or with irrelevant cut-and-paste information; simply repeat a fact or statement
Simple explanation	Make a claim with some relevant supporting information
Elaborated explanation	Make a claim supported with reasons, evidence, and examples
Meta-Explanation.	Further explanation synthesizing different view(s) in the previous discussion

(a) Statements related to information-conceptual processing were categorized in 4 levels ranging from knowledge regurgitating to explicit knowledge construction. Project information processing was categorized into surface task-based and deep inquiry-based levels, (b) Metacognitive statements consist of individual level and social level, (c)

Kong, S.C., Ogata, H., Arnseth, H.C., Chan, C.K.K., Hirashima, T., Klett, F., Lee, J.H.M., Liu, C.C., Looi, C.K., Milrad, M., Mitrovic, A., Nakabayashi, K., Wong, S.L., Yang, S.J.H. (eds.) (2009). *Proceedings of the 17th International Conference on Computers in Education [CDROM]*. Hong Kong: Asia-Pacific Society for Computers in Education.

Collaborative moves includes social dynamics as well as question asking and explanation ranging from simple claims to meta-elaborations synthesizing different views (Table 2)

To examine how groups learn differently in a CSCL environment, all notes from the two selected groups were coded based on the scheme following Hmelo-Silver's notion of multiple coding (2003), which means a statement could be coded under different categories. Comparisons were made based on quantitative measures. For the purpose of comparison, the percentage of the total notes within the category was computed. The descriptive statistics and the comparisons are presented in Table 3.

Table 3 Category frequencies and subcategory percentages

	Successful Group		**Less Successful Group**	
	Frequency (Percentage)		Frequency (Percentage)	
Number of notes	**36**		39	
Information processing-conceptual	**24**	**(66.67)**	**19**	**(48.71)**
Knowledge regurgitating	1	4.17	8	42.10
Elaborative knowledge telling	3	12.50	5	26.32
Implicit knowledge construction	15	62.50	6	31.58
Explicit knowledge construction	5	20.83	0	0
Information processing-Project	**7**	**(19.44)**	**12**	**(30.77)**
Task-based	3	42.86	12	100
Inquiry-based	4	57.14	0	0
Metacognitive-individual	**23**	**(63.89)**	**6**	**(15.38)**
Monitoring	13	56.53	4	66.67
Reflection	7	30.43	1	16.67
Regulating	3	13.04	1	16.67
Metacognitive-social	**24**	**(66.67)**	**13**	**(33.33)**
Goal setting	4	16.67	0	0
Monitoring collective learning	8	33.33	4	30.77
Group reflection	4	16.67	3	23.08
Co-regulating	4	16.67	3	23.08
Evaluating others	4	16.67	3	23.08
Social dynamics	**14**	**(38.89)**	**9**	**(23.08)**
Rapport-building	9	64.29	3	33.33
Facilitating discussion	5	35.71	5	55.56
Task–specific conflict	0	0	1	11.11
Question types	**25**	**(69.44)**	**19**	**(48.72)**
Low-level	2	8.00	5	26.32
Clarification	1	4.00	5	26.32
Support-seeking	1	4.00	1	5.26
Explanation-seeking	11	44.00	3	15.79
Self-explanatory	10	40.00	5	26.32
Explanation	**28**	**(77.78)**	**27**	**(69.23)**
Simple claim	6	21.43	16	59.25
Simple explanation	7	25.00	10	37.04
Elaborated explanation	11	39.29	1	3.70
Meta-explanation	4	14.28	0	0

Note: The percentages of notes in these main categories are shown as bold numbers in parenthesis. Other percentages were computed based on total numbers of notes within the major categories

Both groups wrote similar numbers of notes (36 for the successful and 39 for the less successful group). The successful group employed more conceptual processing than the unsuccessful group, with more manifestations in advanced levels of constructing deep understanding. Although the successful group generated less notes discussing project learning, half of the statements were devoted to inconsistency or problems from empirical studies while nearly all the statements related to metacognition, both at individual and social level, and social dynamics were observed in the successful group. They also asked more questions, with nearly half of them seeking explanations than did their counterparts, whose questions were mainly fact- based or clarification-oriented.

Interestingly, both groups seemed to give similar numbers of explanations (27 vs. 28). However, the distribution of the types of explanations between groups was noticeably different. The successful group gave much more elaborated explanations, accounting for

39.29% of the total, with the less successful group having a low percentage of 3.57%. In contrast, the less successful group tended to give brief answers to questions (57.14% of the total explanations). Further, there was very little evidence observed of effort made by the less successful group to provide meta-explanations. However, 14.28% of explanations presented in the successful group endeavored to do this. This indicates that while the two groups did not differ much in the quantity of their explanations, quality and distribution were remarkably different.

3. Discussion and Conclusion

Our goal in this study was to evaluate the effects of the designed learning environment on learning approach, conceptual understanding and academic literacy and to analyze how collaborative learning takes place in the computer-supported discourse.

Role of computer-supported learning environment The present findings from analyses of questionnaires and essay writings provided evidence that the online collaborative learning design fosters deep learning approaches, conceptual understanding and argumentation. However, compared with comparison groups, instructional groups did not show much difference in organization and language use. This is consistent with the previous research concerning relation between collaborative inquiry, deep learning and conceptual understanding (Hakkarainen, 2003). Earlier work focuses on science domains. Some work with elementary school students has measured conceptual understanding and literacy using standardized tests. This study extends the inquiry into Chinese tertiary students' business studies and academic literacy, indicating positive effects when integrating project learning, online inquiry and concept learning. Students in CSCL learning environments also showed advantages in changing more towards deep approaches to learning compared with their counterparts.

Furthermore, ATK results for student engagement on the forum showed significant correlation between scaffolds and conceptual understanding and argumentation. Students who utilized more scaffolds in Knowledge Forum such as "I need to understand", "my theory" benefited more in conceptual growth and argumentation. This further supports the important role of metacognition in collaborative inquiry and conceptual understanding in previous research but also suggests its potential role on argumentation development in a technology-enhanced environment.

Online collaborative inquiry and productive discourse An important goal of the study was to illuminate conceptual, metacognitive and collaborative learning processes in the context of computer-supported inquiry-based project learning. We compared successful and unsuccessful groups from instructional groups. This study has developed a multi-dimensional scheme identifying three key dimensions of information processing, metacognition, collaboration. The dimension of information processing consists of two related aspects: conceptual and project-inquiry. Different levels of conceptual knowledge processing were identified ranging from knowledge regurgitation, elaborate knowledge telling, knowledge construction and knowledge transformation when students were working on new ideas. Furthermore, there were also differences in project inquiry with some students focusing on completing the tasks as assigned by the teacher while others were involved with deepening inquiry. The less successful group failed to see connections between conceptual development and the empirical project; in contrast, the successful group regarded the project as an extended inquiry into the authentic business context. This study extends the dual-space model of content and the social relational context as interdependent aspects of problem-solving (Barron, 2003), identifying project-inquiry as an extending space enhancing the interactions between content, contextual and social factors.

The second dimension of metacognition also suggests two aspects: individual and social levels. The successful group made more metacognitive statements, which matches ATK findings on the significant role of scaffold use. Further, our analysis also identified social dimensions of metacognition including collective monitoring, co-regulating, and group reflection. These findings indicate that metacognition is important not only for individual but also for collaborative inquiry learning. Consistent with the important role of explanation (Chan, 2001; Hakkarainen, 2003), our analysis demonstrated that it is the intricate relations between deep explanations and questions that move discourse forward.

Various limitations of the study, including using the use of a quasi-experimental approach and contrastive analyses, should be noted. As pointed out by Solomon (1993), it is difficult to assess the role of technology in a complex classroom with many intervening classroom factors that cannot be controlled easily. Nevertheless, it is useful to have a comparison to provide background, however the results need to be interpreted with caution. The contrastive group analyses were preliminary and current ongoing inter-rater reliability will help validate the coding. Current analyses conducted on other groups also indicated a similar pattern. Additional statistical analyses on group differences will be conducted. This study has designed and evaluated a learning environment for promoting collaborative inquiry examining student learning and collaborative processes. Quantitative findings have shown the benefits, and qualitative analyses of the discourse identified interrelated dimensions of conceptual processing, metacognition and collaboration, suggesting productive discourse moves shifting from knowledge sharing to knowledge transformation, from elaboration to explanations intertwined with questions, and widening from individual to social metacognition. The study also shows project inquiry as going beyond task completion and extending space enhancing interactions between content, context and social dimensions. This study enhances our understanding of cognitive and social dynamics in EFL contexts that would enrich CSCL analyses. Discourse moves need to be further investigated to inform the design of the learning environment.

References

[1] Barron, B. (2003). When smart groups fail. *Journal of the Learning Sciences, 12*(3), 307-359.

[2] Chan, C. K. K. (2001). Peer collaboration and discourse patterns in processing incompatible information. *Instructional Science, 29*, 443-479.

[3] Chan, C. K. K., & van Aalst, J. (2004). Learning, assessment, and collaboration in computer supported collaborative learning. In P. K. J. W. Strijbos, & R. Martens (Ed.), *What we know about CSCL and implementing it in higher education* (pp. 87-112): Kluwer Academic Publishers.

[4] Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1995). The evolution of research on collaborative *interdisciplinary learning science* (pp. 189-211). Oxford: Elsevier.

[5] Eastman, J. K., & Swift, C. O. (2002). Enhancing collaborative learning: Discussion boards and chat rooms as project communication tools. *Business Communication Quarterly, 65*, 29-41.

[6] Hakkarainen, K. (2003). Emergence of progressive inquiry culture in computer-supported collaborative learning. *Learning Environments Research* (6), 199-220.

[7] Hmelo-Silver, C. (2003). Analyzing collaborative knowledge construction: multiple methods for integrated understanding. Computers & Education, 41, 397-420

[8] 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*, 278-307.

[9] Scardamalia, M., Bereiter, C., & Lamon, M. (1994). The CSILE project: Trying to bring the classroom into World 3. In K. McGilley (Ed.), *Classroom lesson: Integrating cognitive theory and classroom practice(pp.201-228)*. Cambridge: MIT Press.

[10] 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.

[11] Stahl, G. (2006). *Group cognition: Computer support for building collaborative knowledge*. Cambridge, Mass: MIT Press.