Learning With Weblogs: Enhancing Cognitive and Social Knowledge Construction

—HELEN S. DU AND CHRISTIAN WAGNER

***Abstract*—*This study investigated the impact of weblog use on individual learning in the context of university senior-level business education. As an emergent form of personal communication, weblogs enable people to publish their thoughts as webpages, and to share information and knowledge. Recognizing the potential impact of weblogs on knowledge expression and sharing, this research sought to empirically examine whether the continuous use of weblogs as online learning logs would affect student learning performance. The assumption was that effective use of weblogs promoted the constructivist models of learning by supporting both cognitive and social knowledge construction, and by reinforcing individual accountability in learning. Results from an Information Systems undergraduate course with 31 participants indicated that the performance of students' weblogs was a significant predictor of the learning outcome (while traditional coursework was not). Moreover, individuals' cognitive construction effort to build their own mental models and social construction effort to further enrich/expand knowledge resources appeared to be two key aspects of the constructivist learning with weblogs. Our results imply the potential benefit of using weblogs as a knowledge construction tool and a social learning medium.*

***Index Terms*—*Constructivism, learning log, learning theory, online learning, weblog.*

Improving learning effectiveness has long been a research goal and a pedagogical aspiration of the academic community. Universities and other organizations of higher education are facing increased pressure to demonstrate the effectiveness of their educational efforts. Educators need to demonstrate that assessment and learning are aligned (i.e., assessment for learning), that students have a more active role in the learning process (i.e., student centered learning), and that instructors are more aware of students' learning progress (i.e., adaptive teaching). These pedagogical approaches are certainly not new, but nevertheless not easily adopted [1], [2]. After all, many learners appear to address the learning challenge **transactionally**, with targeted learning activities to complete, followed by rush learning for the final exam. Many students rely on instructors to introduce relevant learning materials. Such a transactional and passive learning focus seems to negatively affect the continuity of knowledge acquisition and reinforcement, and hence, reduces the lasting effect of learning.

One approach to mitigate this situation is the use of learning logs, with which students document their learning experience and comprehension alongside their studies in diary form [3], [4]. Learning logs were traditionally paper based, and were shared only between student and instructor. Yet, weblogs offer an online alternative with considerable advantages, even to those users with little technical skill [5]. As a personal publishing and social sharing tool, weblogs are designed to allow simple and fast creation of web content, frequent interaction with posts and commentaries, and instant hyperlinks to the ideas of others. Hence, the use of weblogs as online learning logs has the potential to further enhance the effectiveness of traditional learning logs.

The use of weblogs as "a relatively new form of mainstream personal communication" [6, p. 31] has surged over the last few years to reach over six million weblogs by the end of 2004 (http://www.technorati.com). A recent *Fortune* article identified weblog technology as among the "10 [key] tech trends" to watch for 2005 [7]. In spite of weblogs' increased popularity in professional communities, however, adoption of weblogs for learning has been slow in higher education. For example, two leading course management software products (e.g., WebCT and Blackboard) do not yet include this technology. Reports by experts of weblog technology have been mainly concerned with the use and functional implications of the technology itself [7]; few efforts have been made to formally examine its pedagogical impact. Further, much of the discussion concerning weblog use for education is either based on anecdotal evidence or only focused on its conceptual fit with learning theories [8]–[10].

Based on the constructivist models of learning and the corresponding characteristics of weblog

Manuscript received July 18, 2005; revised March 6, 2006.
The authors are with the Department of Information Systems, City University of Hong Kong, Kowloon, Hong Kong (email: ishelen@cityu.edu.hk; iscw@cityu.edu.hk).
Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.
IEEE 10.1109/TPC.2006.890848

0361-1434/$25.00 © 2007 IEEE

technology, this research argues for the usefulness of weblogs as a knowledge sharing medium and a cognitive learning tool. In particular, it seeks to determine whether WEBLOG PERFORMANCE, defined here as the effective use of weblogs as online learning logs, is a significant predictor of individuals' learning outcome. It also analyses the content of weblogs to further examine whether weblog performance reflects learners' cognitive construction efforts and social construction efforts in the process of learning. The research is based on the empirical analysis of 279 weblog posts written by 31 students in a semester long Information Systems (IS) major course, as well as other coursework performance and final exam performance demonstrated by these students.

The remainder of this article is organized as follows. The next section introduces traditional learning logs and weblogs. The section entitled "Learning with Weblogs: Constructivist Models" reviews research on active knowledge construction and idea sharing to enhance learning, and explores the potential role of weblogs in IT-supported education based on the constructivist learning models. We then explain our research method in section entitled "The Study." The "Data Analysis and Results" section presents the empirical findings, followed by the "Discussion and Implications" section. We also identify limitations and discuss further improvements in the section entitled "Limitations and Future Work," and we draw conclusions in the last section.

LEARNING LOGS AND WEBLOGS

Learning Log Learning logs are written records, where learners document their learning frequently (e.g., daily or weekly) reflecting on understanding, thoughts, and ideas about their study [11]. Traditionally, learning logs were paper-based, but new information and communication technologies enable online learning logs.

Traditional learning logs have previously been used as a learning technique for courses on information systems, allowing students to document their learning experiences and results in a concurrent journal [3]. Wagner proposed a method for turning learning logs into weblogs that are published on the web with anytime and anyplace convenience [12]. Other educators have also started applying weblogs to teaching and learning (e.g., [9], [13]), mostly focusing on journalism and humanistic studies, rather than on technology or business education.

Weblog (Blog) The term WEBLOG refers to a personalized webpage, kept by the author in reverse chronological diary form [14]. As a log on the web, it is kept first and foremost on the web, enabled through blogging software. Most weblogs provide interactive features that allow others to easily comment on, or hyperlink to, the weblogs, thus creating social networks of bloggers. According to blogging pioneer Dave Winer, weblogs have four main characteristics (http://www.scripting.com). They are: (1) personalized—designed to be used by a single person, expressing individual personality; (2) web-based—updated frequently, easy to maintain, and accessible via a web browser; (3) automated—allowing bloggers to present the content in an attractive format without HTML coding; and (4) community-supported—linking to other weblogs or websites, enabling the sharing of information and ideas.

Popular weblog features provide additional opportunities for self-expression and feedback gathering online. They include basic features such as the ability to search or archive past weblog entries by date-posted; hyperlink to other weblogs, or use of BLOGROLLS, defined here as lists of other bloggers, to manage frequently referenced weblogs; as well as to track/ping to and comment on other weblogs. Hence, individuals and groups can communicate in a way that is simpler and easier to follow than emails or discussion forums, while also retaining ownership of their contributions. As such, weblogs differ considerably from other earlier forms of asynchronous computer-mediated personal communication technologies [15]. Table I provides a comparison of weblogs against two other predominantly used technologies for managing information/knowledge sharing, namely emails and discussion forums. It illustrates several desirable characteristics of weblogs as a tool for self-publication of learning logs and a medium for social sharing and collective sense making.

Weblogs as Online Learning Logs Weblogs further enhance the effectiveness of traditional learning logs in two major aspects. First, weblogs' anytime-and-anywhere access capability and content management features make web publication and organization convenient, while the internet search capability (offered by many online search engines) enables fast retrieval of online information. Second, weblogs' linking, replying, storing, and tracking features enable the users to better exchange knowledge and information, and hence, collectively construct meaning.

LEARNING WITH WEBLOGS: CONSTRUCTIVIST MODELS

The key question in this research is whether the continuous use of weblogs as **online learning logs** can affect students' learning performance. The theoretical foundation on the impact of weblog use for learning is derived from the constructivist learning models.

Constructivism Based on the work of Bruner, Piaget, Vygotsky, and other educational psychologists, Leidner and Jarvenpaa applied learning theories in an IS context through the examination of models of learning and of the impact of IT on learning [16]–[19]. Leidner and Jarvenpaa further postulated the existence of a variety of opportunities for implementing IT in education [19]. CONSTRUCTIVISM focuses on learning as a process of knowledge construction by an individual. Rather than being transmitted through the sequence of instruction, knowledge is developed by learners as they build their own cognitive structures or mental models [20]. Individuals tend to learn better when they discover concepts by themselves than when they are taught [19]. Therefore, learning is better accomplished by engaging students in the continuous process of constructing knowledge through acquiring, generating, analyzing, manipulating, and structuring information [21]. The constructivist learning model shifts from an instruction-oriented to a learner-centered learning and teaching style, where the educator's role is to support rather than to direct. This learning model implies that the curriculum should be organized in a continuous and incremental manner, where students are encouraged to actively engage in learning activities to repeatedly develop new knowledge and to improve their understanding by building upon prior knowledge.

One extension of the constructivist model of learning is COGNITIVE CONSTRUCTIVISM, which concentrates on the conceptualization of the learning processes rather than on the outcomes, and posits that learning is a process which develops, tests, and refines mental models, and transfers new knowledge into long-term memory [19], [22], [23]. Hence, to improve learning, the frequency and intensity of a student's cognitive processing is crucial, and needs to be stimulated [19]. According to Bovy [24] and Brunning [25], one important implication of the cognitive constructivist model is the need for individualized instructional support and prompted feedback, which provides more direct reinforcement, and therefore better learning.

COLLABORATIVE CONSTRUCTIVISM is another dimension of the constructivist learning theory. Extending beyond the cognitive constructivist individualistic learning focus, the collaborative learning model emphasizes sharing and social interaction in the process of learning [26]. Learning emerges through shared understanding, and the construction of shared understanding through interaction with others [19]. For instance, in the context of group support systems (GSS) supported learning, collaborative activities expand and enrich learning by allowing individuals to exercise, verify, solidify, and improve their mental models through interacting with other group participants and sharing their ideas [21], [27].

Cognitive Construction of Knowledge With Weblogs Keeping a log of learning experiences,

TABLE I
TECHNOLOGY SUPPORT TO CONTENT MANAGEMENT AND SHARING

Technology	Communication	Content Organization	Content Revision	Participation	Collaboration
Emails	One-to-one, or one-to-many	Local email archives or index possible; mixed organization (topical or chronological)	Not possible, but a modified email may be resent	Closed only to designated receivers	Possible but has delay (not at web speed compared to discussion forums and blogs)
Discussion Forums	Many-to-many in web-based forums, or repeated one-to-many in listservs; many forums provide alternative channels, such as email and instant messaging	Central repository or index if web-based (local if listserv); topical organization used more than chronological	Posts are not expected to be modified (some forums allow revision after posting)	Open to public, or closed to registered members, but all participants can create posts equally	Flat or threaded model of communication; provided in the form of open or closed set of members, facilitated by administrator(s)
Weblogs	One-to-many; can approach many-to-many (similar to webpages); most blogging tools include multiple channels (e.g., email, chat box, instant messaging)	Local archives or index in each weblog; mostly reverse chronological order	Posts may be edited by contributor(s) only	Open for public to read or comment on existing entries, but restrict posting of new entries only by blog owner(s)	Designed for individual publishing; some blogging tools support team blogs where small groups of people write to a single blog (e.g., www.blogger.com)

insights, and reflections has long been accepted by educators as an effective pedagogical practice to enhance students' learning. Weimer demonstrated the use of learning logs to encourage students' exploration of course content and association with individual experiences [4].

Similar (but not limited) to the use of traditional learning logs, the continuous use of online learning logs potentially increases students' learning involvement. Ferdig and Trammell [10], for instance, provide a conceptual overview of how weblog technology fits with the constructivism learning theory, and argues that a weblog is a useful online tool for students to reflect and publish their thoughts and understanding. New ideas or knowledge that is unique to the individual student is developed in the process of knowledge construction and sense making. Some researchers regard blogging as "a more constructive manner" to "thinking by writing" [28, p. 44]. Therefore, we argue that continuous use of weblogs potentially facilitates cognitive knowledge construction of the learning process in the following ways:

Active knowledge construction and representation: Keeping weblogs requires students to actively construct meaning and organize their thoughts. Students learn through constant engagement in mental exercises to analyze and interpret knowledge and information from what they have learned in or outside of the classroom.

Incremental improvement: The on-going use of weblogs promotes continuous learning instead of being exam-focused. Students build their own understanding and knowledge over time.

Self-direction and flexibility: Blogging exercises help students identify what they have learned and the areas in which they need to improve through self-reflection. The self-directed study and (re)search allocates more control and freedom to students, allowing them to expand learning beyond the classroom.

Given the constructivist view of learning, both weblog use and traditional learning log use may potentially enhance the lasting and incremental effect of learning by increasing students' involvement of knowledge construction and sense making in the process of learning.

Social Construction of Knowledge with Weblogs

Based on the collaborative constructivist model, learning is achieved more effectively through social interaction and collaboration with others than through individual effort alone. Several studies have shown that collaborative learning results in better learning outcomes compared with individual-oriented learning [29]–[31]. Weblogs' less formal conversational nature and interaction-supporting features, such as hyperlinks, blogrolls, and instant feedback/comments, produce an ideal medium for sustained, specific, informal, and comparative student-to-student conversations. With the use of weblogs, a community of student bloggers creates an interactive social learning environment, as students learn from the ideas of others, as they share knowledge resources, and compare/compete with the work of each other. This indicates that "blogging create[s] a sense of community that would be less likely to emerge in a conventional classroom setting" [28, p. 45]. In addition, the unique reverse chronological diary-form of web publishing, as well as the organizing and archiving features of weblogs, may serve as a useful repository for easy and up-to-date access to specific information and knowledge. Moreover, weblogs provide opportunities for diverse perspectives, and can enrich and expand students' learning experiences [10].

More than traditional learning logs, weblogs offer students the opportunity and encouragement to actively participate in the continuous learning process of social knowledge construction in a number of ways:

Knowledge sharing and social networking: Students can easily post their thoughts, ideas, and opinions, and interact with other students right from the start of the exercise. An online social network is established among the student participants as they interact and exchange information and resources, compare their output, and compete with others.

Collaboration and group work: Students have the opportunity to comment/respond, track other students' latest updates, and possibly write a log jointly as a group. They can easily link group members' or friends' weblogs in their blogrolls. Weblogs also offer alternative communication channels (such as instant messaging, chat box, voting) for students to voice their opinions about the work product of others and interact with each other.

Sustainable knowledge stock: Student weblog posts are not only shared but also stored as the community's knowledge asset for all participants to revisit and reuse.

Given the collaborative constructivist view of learning, weblog use may potentially enhance learning by fostering social engagement of knowledge sharing and resource expansion in the process of learning.

Reinforcement of Individual Accountability with Weblogs Consistent with the cognitive constructivist view of learning which recognizes individual differences in cognitive processing, weblogs' diary-like personal and conversational nature further supports personalization of the learning process and provides an informal channel for student-instructor communication, hence stimulating the frequency and intensity of knowledge conceptualization. In addition to the interactive advantage for peer-supported learning, weblog use enhances learning by reinforcing both group collaboration and individual accountability of the learning process in the following ways.

Non-anonymity: Learners take ownership of their individual weblogs and publish the logs with their authenticated identity. They are aware that the published weblog entries are immediately visible to the bloggers' community and other online visitors. When people's identities are known, they tend to be more committed [32]. Since each learner is responsible for his or her own blog keeping, the assessment can be based on individual output. The personal nature of weblogs counteracts "free riding" that often occurs with other forms of collaborative learning and knowledge creation. Studies of social dilemmas have shown that free riding is the norm rather than exception in anonymous social groups [33]–[35]. This has been observed repeatedly in GSS research, where anonymous participants contribute less than their fair share to a **common task** (e.g., group assignment), relying on the effort of others [7], [36], [37].

Individualized feedback: Instructors' personalized diagnosis or feedback, as well as other students' comments or responses can also be published instantly, allowing subsequent revision and viewing by all participants. In the study of Nardi et al., many participants valued weblogs' less formal conversational setting, which encouraged them to post/reply their thoughts "without the intensive feedback associated with other forms of communication" [28, p. 46]. Personalized feedback is similarly possible for traditional learning logs, but the anytime and anyplace availability and reduced formality of weblog interactions improves the delivery of feedback and receptivity. Comments and feedback may even become an integral part of the weblog content (many blogging software tools offer this capability). Briggs et al. indicated (in a GSS context) that such immediacy and frequency of feedback, cooperative learning, plus its well-structured exposition enhance the learning process [38].

Benchmarking and self-assessment: Students, who can compare their work against that of others, can determine the general performance level of their peers, can easily adopt good practices of others, and can become more aware of bad practices. Some e-learning researchers point out the motivating and informing benefits of an open learning environment (supported by web technologies) as compared to mere one-way transmission characteristic of traditional instruction [39]. Our observation also suggests that weblogs as a social medium provide social cues to signal success/failure and reinforce awareness, thus stimulating individual effort without direct pressure from the educator.

Weblog Support for Constructivist Learning Models Consequently, as a knowledge construction and presentation tool, and an idea sharing and social learning medium, weblogs may potentially support and cultivate both the cognitive and collaborative constructivist learning models. Table II summarizes arguments in favor of weblog support for constructivist learning models. The interactive and engaging features of weblogs appear to make publishing and organizing people's thoughts a more interesting task, and hence, may lead to more effective interactive learning. This line of thinking is consistent with Thorndike's Law of Intensity, which postulates that vivid learning teaches more than routine experience [40]. Moreover, the ongoing reflective practice of learning logs (both traditional and weblogs) may not only increase students' awareness of their learning, but also may serve as a good gauge for the instructor to continuously assess and quickly detect individual students' learning progress and comprehension throughout their learning activities [3].

Proposition and Hypotheses Drawing on the constructivist model of learning with its two dimensions—cognitive constructivism and collaborative constructivism—we may assume that individuals should be actively engaged in constructing or creating knowledge, and be socially involved in the learning process, as well as individually responsible for their learning, in order to become effective learners and obtain good results. Based on these insights, we formulated

the following general proposition: The continuous use of weblogs as online learning logs enhances the effectiveness of learning by facilitating cognitive knowledge construction, by fostering social knowledge construction, and by reinforcing individual accountability.

Since learning is a complex concept, measuring the impact of IT on learning involves consideration of multiple dimensions [19]. We began with an assessment of learning outcome from the performance aspect through the following hypothesis:

H1. Effective use of weblogs as online learning logs is positively associated with learning performance.

Our proposition is consistent with Kimble's widely adopted definition of learning as a process of knowledge construction and an enduring behavior change resulting from practice and reinforcement [41]. Here, PRACTICE refers to the internal effort to cognitively and socially construct knowledge. REINFORCEMENT refers to the external force to further stimulate practice, such as making individuals accountable for their learning. The continuous use of weblogs as online learning logs allows the learners to actively engage in the process of reflecting on and communicating their learning experiences, through (internal) practice and (external) reinforcement. Therefore, we argue that individuals' **cognitive construction effort** when using weblogs to build mental models and their **social construction effort** to further enrich/expand knowledge resources are two important behavioral dimensions of weblog use. Consequently, two more specific hypotheses were formulated:

TABLE II
OVERVIEW OF WEBLOG SUPPORT FOR CONSTRUCTIVIST LEARNING MODELS

	Definition	Major Assumptions	Keys to Effective Learning	Weblog Support for Learning
Constructivism	"Learning is a process of constructing knowledge by an individual" [29, p. 270]. Knowledge is developed by learners as they build their own cognitive structures or mental models [25]. Cognitive development requires continuous process of adaptation engaging learners [41].	Shift from instruction oriented learning to learner centered active learning. Individuals learn better when they discover concepts themselves, and when they have control over learning pace [29].	Promoting active learning and mental construction of knowledge is crucial. Learning curriculum should be organized in a continuous and incremental manner. To encourage self-directed learning, teacher's role is to support rather than to direct.	Using blogs to write learning logs requires students to actively construct meaning and organize their thoughts., Continuous use of blogs for learning helps students develop their own understanding and knowledge over time, rather than being exam-focused. Self-reflective blogging exercises help students identify what they have learned and areas in which they need to improve.
Cognitive Constructivism	Learning is an active process of constructing new ideas or concepts based on learners' experience [12]. Learning is the processing and transferring of new knowledge into one's long-term memory [29]. Learning is a recursive process, which develops, tests, and refines mental models [49].	Focus on individuals' conceptualization of the learning process and mental effort [53]. Prior knowledge and differences in learning or cognitive processing require different levels of instructional support [9], [12].	To avoid free-riding and encourage non-anonymous learning effort, individual accountability is important and should be recognized. Provide personalized instructional support and prompted feedback. Stimulate the frequency and intensity of mental cognitive processing by benchmarking and self-assessment.	Blog's personal nature reinforces individual accountability as students publish their online learning logs with authenticated identity. Instructor's individualized feedback/response is done with more ease (than paper-based methods) and is delivered to the corresponding student instantly (more convenient than some other electronic methods). Web publishing of learning logs gives students opportunities to compare and compete and to be more aware of bad practices so they can easily adopt a good one.
Collaborative Constructivism	"Learning emerges through shared understandings of more than one learner," and the construction of understanding builds upon interaction with others [29; p. 270]. Social interaction plays a fundamental role in cognitive development [58].	Emphasis on group oriented and collaborative learning. Learning is better achieved through interaction with others than by oneself [2], [50].	Promote knowledge sharing and collective learning. Encourage participation in collaborative activities, and provide opportunities for diverse perspectives. Provide convenient access to information and knowledge of particular interest.	Students can easily post their thoughts, ideas, and opinions as blog entries, and interact with others online. The interactive features of a blog allow hyperlinking to other student bloggers and instant publishing of commentaries, all without a great deal of technical skills. All blog entries and comments can be archived for later retrieval and review.

H2. Given the same level of reinforcement, an individual's higher cognitive construction effort corresponds to more effective weblog use in the learning process.
H3. Given the same level of reinforcement, an individual's higher social construction effort corresponds to more effective weblog use in the learning process.

THE STUDY

The study was conducted as part of a regular course where the researchers only observed, recorded, and analyzed the teaching and learning activities of a university senior-level undergraduate course for IS majors, without any interference. During a 13-week semester, a total of 279 weekly weblog posts written by 31 students were examined. First, to empirically evaluate the relationship between online learning logs and the performance aspect of learning outcomes, learning assessment variables of the course were used. In addition to a general analysis of performance, we employed a more specific analysis of weblog content to further investigate key behavior aspects in the continuous learning process using weblogs.

Study Design During one semester, all students were asked to maintain weekly online learning logs, describing their past week learning, articles read, personal reflections, as well as opinions on learning logs kept by other course participants. Thus, students needed to frequently revisit their own and others' learning log contents and then read and even comment on others' work. The online learning log exercise also challenged students to search for reference materials in addition to those provided by the instructor.

Students used the Blogger (www.blogger.com) software to maintain their personal weblogs on a weekly basis. Appendices A and B contain examples of two student weblogs. The university provided each student with space to store files, and a shared weblog directory that listed all weblogs for convenient access. Students were instructed in the use of the software during the first week of class. All of them had experience in webpage development since their first year at the university, as well as programming skills in various languages. Hence, use of the weblog software was well within their capabilities. Table III gives an overview of participant demographics.

TABLE III
DEMOGRAPHICS

Gender	12 female and 19 male (total 31 participants)
Age	20-25 years old
Weblog & Computer Experience	No one had prior experience in using weblogs, but all had taken computer courses such as webpage development and programming.
Class Standing	Course title: Virtual Organizations (a senior-level undergraduate course offered only to IS majors) Course duration: One semester (13 weeks)

The weekly weblog exercise was one of several coursework activities students had to complete during the semester. Other coursework included written assignments and class participation. Coursework overall counted for 65% of the final grade (24% for weblog exercises, 41% for other coursework activities), while the final exam contributed to the remaining 35%.

Operationalization of the Variables Three performance assessment variables were used to measure the overall learning effect: (1) WEBLOG PERFORMANCE (BLOG), a coursework performance variable operationally defined as the effective use of weblogs as online learning logs in the process of learning; (2) other (nonblog) coursework performance (COURSE), a comparable assessment of the learning process that is commonly used; and (3) final exam performance (EXAM), intended to measure the performance aspect of learning outcome. Although EXAM may not be the best single measure of students' learning outcome, it is a generally accepted and widely used **summative** assessment in the education context [42], [43].

Further, WEBLOG USE, defined as the effective use of weblogs as online learning logs in the process of learning, was measured in terms of the two behavior-based dimensions identified earlier: (1) CCE, COGNITIVE CONSTRUCTION EFFORT (in using weblogs to construct knowledge), operationally defined as the number of self reflections on the key concepts taught in class; and (2) SCE, SOCIAL CONSTRUCTION EFFORT (in using weblogs to further enrich and expand knowledge resources), operationally defined as the frequency of referring to the work of others. While CCE reflects LOWER-ORDER LEARNING, defined as the awareness and general understanding of concepts, SCE reflects HIGHER-ORDER LEARNING, defined as the exploration and linkage to other concepts or ideas [44]. Lower-order learning and higher-order learning are common measures in learning contexts of this nature [19], [45].

Measurement and Data Collection Table IV gives an overview of the operationalization and measurement of all variables in the study. Weblog performance assessment criteria were similar to Weimar's four criteria to grade students' learning logs: (1) completeness, (2) evidence of thoughtful responses, (3) support provided for observations, and (4) relevance to course content [4]. The first criterion was changed from evaluating "completeness" to "richness," considering that there was no absolute value of completeness in learning log exercises. A fifth criterion, "technical sophistication," was added to assess the purposeful use of weblog technology for better representation and organization of (online) learning logs. Each of the weekly weblog exercises was evaluated qualitatively following the above five criteria. All weblog exercises were graded by an instructor with considerable experience in coursework evaluation (neither of the researchers). Weblog grades ranged between 4.0 and 0.0 on a continuous scale, with the value of 4.0 representing excellent performance and 0.0 representing failing performance. Students had to write nine weekly posts ("BLOG1" to "BLOG9") during the 13-week semester, excluding the first and last week as well as two other weeks that coincided with other coursework deliverables. BLOG measured the average of the nine weekly weblog scores. In addition, two other performance assessment variables were directly measured, namely COURSE and EXAM.

Two content-based variables assessed the behavioral aspects of learning process with weblogs. SCE was measured by the average number of UNIQUE HYPERLINKS used; these are defined as dynamic links embedded in the weblog content which connect to other student weblogs or other websites in the content of each weekly weblog post. The weekly SCE scores ("SCE1" to "SCE9") were simply an objective count of the number of unique hyperlinks. Meanwhile, CCE was measured by the average number of distinct key concepts discussed in the content of each weekly weblog post. Weekly CCE values ("CCE1" to "CCE9") were determined against a list of key concepts used in the coding process (see Appendix C). The list originally consisted of keywords extracted from the subheadings of the weekly lecture slides. Initially, there were a total of 66 codes in the list. After a first-round independent coding by two research assistants (both with good knowledge of the course and the use of weblogs), more keywords were identified. In the end, a list of 104 key concepts was generated (including one "miscellaneous" item and one "other" item), with the consensus of both raters. Such an approach, where some initial codes are adopted and others are added or modified during the process, is a typical practice [46]. After this refinement process, the final list of key concepts was used for the second-round independent coding. We opted to use the average of the two raters' scores as the weekly CCEs, namely CCE1 to CCE9.

Validation of the Variables

Reliability: Following the technique adopted by [47] and [48], two independent raters were hired to evaluate the weekly SCE and CCE scores from the participants' weblog contents. For the objective count of SCE scores, the raters' double verification

TABLE IV
SUMMARY OF VARIABLES OPERATIONALIZATION AND MEASURES

			Operational Definitions	Measures
Performance-based Variables	*Learning Outcome*	EXAM	**Final exam performance**, as proxy for learning performance.	Direct measure of a 2-hour comprehensive written test at the end of semester.
	Learning Process (coursework)	BLOG	**Weblog performance**, a coursework performance variable, defined as the effective use of weblogs as online learning logs in the process of learning.	Average score of 9 weekly weblog entries. Each entry was qualitatively evaluated in terms of five weblog assessment criteria (cf. [60]).
		COURSE (without weblog use)	**Other coursework performance** excluding weblog performance.	Aggregated score of written assignments and class participation.
Behavior-based Dimensions	*Weblog Use*	CCE	**Cognitive construction effort** in using weblogs to construct knowledge, defined as the number of reflections on the key concepts taught in class (i.e., in the lecture materials).	Average number of distinct key concepts discussed per weblog post. A list of key concepts was used for coding (see Appendix C).
		SCE	**Social construction effort** in using weblogs to further enrich and expand knowledge resources, defined as the frequency of referring to the work of others (in addition to the lecture materials provided by the instructor).	Average number of unique hyperlinks used per weblog post (which dynamically refers to other student weblog posts and other websites).

served to ensure the correctness of the count. Further, intraclass correlation coefficients (ICCs) were used to assess the **interrater** reliability of the weekly CCE scores. This technique, first introduced by [49] and further improved by [50], is effective in determining the extent to which raters are **interchangeable** [51]. The two-way mixed effect model with single measure (ICCs) (3,1) (cf.) were all greater than 0.87, indicating acceptable interrater reliabilities for each pair of the weekly CCEs [50]. The performance-based variables were determined by a single rater as we adopted the actual course assessments. While this introduces the possible danger of single rater bias, several factors favored this approach. First, the rater was intimately familiar with the course and the learning goals. Second, the rater was highly experienced in teaching and evaluation. Third, a peer-evaluation (performed by all students in the class) was consistent with the rater's. After the first week, students were asked to rank the best weblogs. Their assessment for the best weblog was the same as the rater's, and the six weblogs that received the most student votes were also the six weblogs rated the highest by the rater (although rankings were slightly different). Fourth, the single rater used analytic scoring with rubrics (categories) to structure the assessment process. This method has been found elsewhere to increase rater reliability (e.g., [52]–[54]). Klein et al. also finds it an efficient and reliable method for individual rater assessments [55]. Thus, we considered the ratings to be reasonably reliable. We then averaged the nine weekly scores resulting in measures of BLOG, SCE, and CCE variables, their respective Cronback's alpha values were 0.90, 0.88, and 0.68, indicating that the multi-itemed measures had acceptable **interitem** reliability.

Content validity: The variable CCE, defined as the cognitive construction effort in using weblogs to construct knowledge, was measured based on number of verbalized key concepts within the weblog content. This measure reflected the effort involved to conceptualize meanings from what had been taught in class. According to cognitive constructivism, learning is a process of knowledge conceptualization (e.g., [23]); therefore, the number of self-reflections on the key concepts taught in class represents the variable CCE. SCE, the social construction effort in using weblogs to further enrich and expand knowledge resources, was measured by the number of unique hyperlinks in the content. Consistent with collaborative constructivism, which emphasizes knowledge sharing and social interaction in the process of learning (e.g., [26]), the frequency of referring to the work of others through hyperlinking to other students' weblogs or other website resources demonstrated the effort in social construction of knowledge, or the variable SCE. Although one item was used to represent each of these variables here, such single-item measures have been used in prior research, and are considered acceptable where the variable measured is unidimensional [56]–[58].

Control Checks As a field study which observed technology-enhanced constructivist learning in a natural setting, gender was used as a control variable to determine a potential contaminating or confounding effect. A t-test revealed that gender had no significant influence on EXAM (Female: $M = 57.58$, $SD = 13.72$, Male: $M = 53.26$, $SD = 6.29$), COURSE (Female: $M = 69.93$, $SD = 4.90$, Male: $M = 70.72$, $SD = 4.10$), BLOG (Female: $M = 2.88$, $SD = 0.62$, Male: $M = 2.52$, $SD = 0.66$), SCE (Female: $M = 3.50$, $SD = 2.21$, Male: $M = 2.40$, $SD = 3.05$), and CCE (Female: $M = 2.75$, $SD = 0.84$, Male: $M = 2.62$, $SD = 0.82$). Other demographic variables (see Table III), such as age, weblog or computer experience, and class standing were checked to tease out their potential influence.

DATA ANALYSIS AND RESULTS

To provide more information about the data collected and measured, we show the means, standard deviations, and correlations (see Table V) of all variables studied, before reporting on the hypotheses.

BLOG as a Predictor of Performance (H_1) Our main concern for this part of the analysis was whether there was a positive relationship between BLOG and EXAM performance. We also compared this finding to the potential relationship between COURSE and EXAM performance. First, we analyzed the correlations of these variables (see

TABLE V
MEANS, STANDARD DEVIATIONS, CORRELATIONS ($n = 31$)

			Correlations				
	m	*sd*	EXAM	COURSE	BLOG	SCE	CCE
EXAM	54.94	9.87	-				
COURSE	70.42	4.36	.09	-			
BLOG	2.66	.66	.41*	.27	-		
SCE	2.79	2.78	.43*	.36	.77**	-	
CCE	2.66	.81	.47*	.34	.76**	.78**	-

**p < .01; *p < .05

Table V). As shown in the correlation matrix table, BLOG was significantly correlated with EXAM ($r = 0.41$, $p < .05$) but COURSE was not.

Then, two regression analyses were performed, each in a univariate setting (see Table VI). This was done to further determine whether weblog performance would be a better predictor of student learning outcome than traditional coursework, such as written assignments and class participation. As a result, BLOG emerged as a significant predictor of EXAM variance ($F = 5.84$, $p < .05$). In other words, weblog performance was able to account for 17% of exam performance variance. Students who performed well on their weblogs therefore likely also demonstrated better exam performance ($\beta = 0.41$, $t = 2.42$, $p < .05$). In contrast, performance on other coursework (excluding weblogs), namely COURSE, was **not** a significant predictor of EXAM ($F = 0.21$, $p = .65$). These results suggest that weblog performance (BLOG) and other coursework performance (COURSE) did not have a common cause, and therefore could be used as independent measures of overall student learning performance.

Effective Use of Weblogs for Learning (H_2, H_3) Further, to determine the effective use of weblogs as online learning logs, we also analyzed the nonstructural elements of each student's weblog content. This analysis reveals to what extent students' learning behavior is related to the effectiveness of weblog use, such as BLOG. In particular, we examined individual learners' CCE in using weblogs to build mental models, and their SCE in using weblogs to further enrich and expand knowledge resources. In addition to analyzing the correlations (see Table V) of the two behavior-based dimensions of weblog use, CCE ($r = 0.76$, $p < .01$) and SCE ($r = 0.77$, $p < .01$), with the BLOG performance, we also used multivariate regression to test the relationship model. Table VII shows that the relationship is significant ($F = 21.99$, $p < .001$), and explains 67% of the variance in the effective use of weblogs for constructivist learning. CCE ($\beta = 0.41$, $t = 2.12$, $p < .05$) is weighted almost the same as SCE ($\beta = 0.45$, $t = 2.32$, $p < .05$) in the regression model.

TABLE VI
UNIVARIATE REGRESSIONS: BLOG VERSUS COURSE (DEPENDENT VARIABLE: EXAM)

	R^2	df	F	Sig.	β	t
BLOG	.17	1	5.84	.02	.41	2.42
COURSE	.01	1	.21	.65	.09	.46

DISCUSSION AND IMPLICATIONS

Building upon the constructivist viewpoint, this study empirically examined the impact of weblog use on learning. To assess this impact, first we analyzed the course performance-based variables, BLOG, COURSE, and EXAM, and second we performed content analysis of the participants' weekly weblogs to assess the behavior-based variables, CCE and SCE. The results support our hypotheses, and suggest that weblog performance can be a significant predictor of the students' learning outcome (i.e., exam performance) and possibly a better predictor than traditional coursework measures. The results also imply that weblog contents represent the learning characteristics of student bloggers, more explicitly their cognitive construction effort to form knowledge and social construction effort that further enriches and expands learning.

Learning Continuity Our observation of the weekly weblog performances suggests that students had little difficulty in handling the technology, but needed to become accustomed to this relatively new practice of writing (online) learning logs. Some students' first few weblogs were functional and competently put together, but were not necessarily insightful. The early-week weblogs appeared to be part of an experimentation and learning phase, where students learned to master the process of writing online diaries. This was not a technology issue, but rather a process of learning to organize and present knowledge, and a process of learning from best practices of others.

Learner Centered Environment Weblogs let students become more active outside the classroom, such as reviewing course materials, explicating knowledge, and seeking external knowledge resources. In the end, we observed that nearly one-third of the students wrote more weblog posts than the coursework required.

Alternative Measures of Learning Our results show that students with higher weblog performance were more likely to do well in their final exam than

TABLE VII
MULTIVARITE REGRESSION MODEL (DEPENDENT VARIABLE: BLOG)

Model				Predictors			
R^2	df	F	Sig.		β	t	Sig.
.67	2	21.99	.000	CCE	.41	2.12	.04
				SCE	.45	2.32	.03

those with lower weblog performance. This suggests that weblog performance may be used as one of the course evaluation instruments to "formatively" assess student learning [42].

Adaptive Teaching The weekly weblog exercises not only allowed the instructor to have an early detection of student learning progress and comprehension, but also enabled personalized instructional support and prompt feedback. Thus, the learning process becomes more interactive with enhanced instructor–student or student–student communication. The course instructor expressed that the on-going learning assessment facilitated an adjustment of the teaching pace and content.

Overall Impact Driven by the practical need to broaden the range of pedagogical practices, and based on the theory of constructivism, this study examined the potential benefits of using weblogs for learning. From the perspective of implications for action, it provides practical guidelines to the implementation of weblogs in the learning context. From the perspective of implications for theory, this study extends the constructivist learning models into the use of online learning logs. It reveals useful insights for both research and practice in IT-supported teaching and learning, particularly in the context of senior-level university business education, where students' participations and interactions are being more emphasized.

LIMITATIONS AND FUTURE WORK

Sampling The sample was not random, but reflected the selection of a specific situation to extend the constructivist learning theories to a board range of pedagogical practices. The number of course participants evaluated was relatively small, 31 students, with 9 weekly weblogs each. Since learning is a continuous process, studying the impact of learning should ideally be for a longer term then just one semester. Also, the impact of weblog use on learning performance was not high ($R^2 = 0.17$). Future research with more participants involved over a longer period of time will hopefully lead to stronger results and unfold more insights.

Control We could have used two groups (with versus without weblog adoption) to compare the learning outcome. We could have used other forms of learning logs (e.g., paper based or electronic but not shared) to determine the impact of different levels of treatment. We could have also varied the other coursework activities to measure the predictability of other types of coursework. We did none of the above manipulations in the study to avoid any expectation of "experimentation" upon the course participants. The objective was to provide students with the best possible learning treatment congruent with the course objective, while also observing and measuring the impact of the treatment in a realistic manner. Nevertheless, the within subject comparison (BLOG versus COURSE) and the BETWEEN (GENDER) GROUP COMPARISON, defined here as the performances of male versus female participants, helped to improve the validity of our study.

Variable Operationalization Coursework scores (BLOG and COURSE) and EXAM grades are single-dimensional variables for complex constructs such as the cognitive learning process and learning outcome. Another limitation to be pointed out is that EXAM results may not truly reflect the students' learning performance, even it is often used to assess learning outcome in the academic (and business) world. Moreover, non-structural elements of weblog content, such as key concepts and dynamic hyperlinks, were not the only measures of SCE and CCE, respectively, for constructivist learning with weblogs. Other content elements, for example, length (per weblog post) or frequency of posts (which was fixed in this study), may be used to measure CCE, whereas static hyperlinks (e.g., friends' weblogs or useful links) may be used to assess SCE. However, the univariate regression results indicate that key concepts ($R^2 = 0.59$, $p < .000$) and dynamic hyperlinks ($R^2 = 0.60$, $p < .000$) can each explain about 60% of weblog performance variance, sufficient and better than length ($R^2 = 0.50$, $p < .000$), and static hyperlinks ($R^2 = 0.45$, $p < .000$). The relatively high predictive validity supports the appropriateness of our selection criteria. Nevertheless, future research may incorporate other measures of learning (process and outcome) including self-reported variables (e.g., self-efficacy, affection, and motivation).

Generalizability The study was based on a specific situation: a senior-level IS major undergraduate course. Therefore, it may not be completely applicable to or replicable in other learning situations such as business organizations or other academic disciplines without modification. The measures of CCE and SCE in the study reflected the efforts of self-knowledge conceptualization/organization, and further knowledge construction through external sources. These concepts and measures were derived from and consistent with the constructivist models of

learning. Therefore, we argue that under similar circumstances, that is, when the process of learning can be improved through continuous/constant cognitive construction and social construction of knowledge, using weblogs as online learning logs has potential benefits and the measure of its impact should be similar.

CONCLUSION

Although the principles of interactive and student centered learning have been recognized for decades, their implementation in the classroom has remained limited in practice. Weblogs, as a relatively new form of personal communication, offer educators promising opportunities to employ an adaptive instructional approach, and to facilitate student centered active learning through continuous practice and reinforcement. The results of our study suggest that the adoption of weblogs is likely to enhance individual learning since it integrates the traditional (offline) learning logs teaching technique (to promote cognitive knowledge construction) with the online social construction of knowledge. Most of all, our study reveals that weblog performance can be used as an alternative measure of learning, in addition to traditional learning assessments.

Yet, in the use of weblogs for constructivist learning, we need to balance between individualism and collaboration. While reinforcing individual effort and accountability, the learning curriculum should be organized to also encourage and recognize collaboration and group effort. Hawkins suggests that individual assessment should be used to track student development, and that students need to learn cooperatively [59].

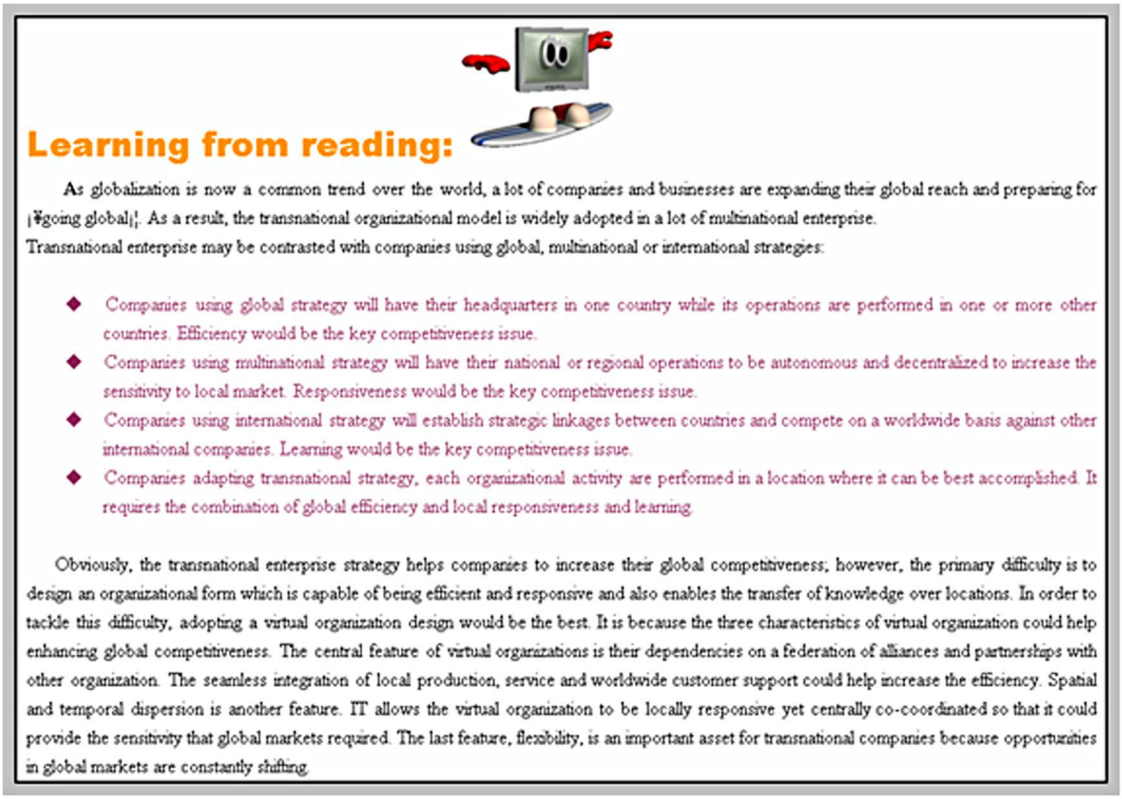
Much work still needs to be done to better incorporate weblogs into the learning process. Course software companies will need to include blogging tools into their suites, ideally with some diagnostic functions (e.g., to count and check hyperlinks or check for duplication of content). Further empirical research will also be needed to identify best methods of using weblogs, such as best frequency of required weblog updates, or best level of peer involvement. With improvements in the software, the process and the measurement of weblogs (as online learning logs) may become key elements in student centered interactive learning.

APPENDIX A

MATTHEW'S WEBLOG OVERVIEW

APPENDIX B

EXCERPT FROM KARINE'S WEBLOG



Learning from reading:

As globalization is now a common trend over the world, a lot of companies and businesses are expanding their global reach and preparing for ¡¥going global¡¦. As a result, the transnational organizational model is widely adopted in a lot of multinational enterprise.
Transnational enterprise may be contrasted with companies using global, multinational or international strategies:

- Companies using global strategy will have their headquarters in one country while its operations are performed in one or more other countries. Efficiency would be the key competitiveness issue.
- Companies using multinational strategy will have their national or regional operations to be autonomous and decentralized to increase the sensitivity to local market. Responsiveness would be the key competitiveness issue.
- Companies using international strategy will establish strategic linkages between countries and compete on a worldwide basis against other international companies. Learning would be the key competitiveness issue.
- Companies adapting transnational strategy, each organizational activity are performed in a location where it can be best accomplished. It requires the combination of global efficiency and local responsiveness and learning.

Obviously, the transnational enterprise strategy helps companies to increase their global competitiveness; however, the primary difficulty is to design an organizational form which is capable of being efficient and responsive and also enables the transfer of knowledge over locations. In order to tackle this difficulty, adopting a virtual organization design would be the best. It is because the three characteristics of virtual organization could help enhancing global competitiveness. The central feature of virtual organizations is their dependencies on a federation of alliances and partnerships with other organization. The seamless integration of local production, service and worldwide customer support could help increase the efficiency. Spatial and temporal dispersion is another feature. IT allows the virtual organization to be locally responsive yet centrally co-coordinated so that it could provide the sensitivity that global markets required. The last feature, flexibility, is an important asset for transnational companies because opportunities in global markets are constantly shifting.

APPENDIX C

EXAMPLES OF KEY CONCEPTS CODED BY WEEK

Week 2 Topic – Virtual Organizations	
Code No.	**Description**
12	Virtual Organization Characteristics
13	Virtualization Problem
14	Value Chain
15	Outsourcing[1]
16	Core Competency
17	Coordination[1]
18	IT Facilitating Coordination[2]
19	Attitudes and Behaviors[3] (e.g., Open Communication, Trust, Entrepreneurship, Attitude)
20	Success Factors[3] (e.g., Understanding Needs, Infrastructure, Monitoring and Measuring, Rewards)

1. Initially coded into one item as "Outsourcing and Coordination"
2. Not in the initial list
3. Initially coded into one item as "Success Factors, Attitudes, and Behavoirs"

Week 6 Topic – Knowledge, Knowledge Management, and Organizational Memory	
Code No.	**Description**
41	Decision Intelligence (e.g., EXCO case)
42	Knowledge Repository Types (e.g., Employees Brain, Paper, Electronic Documentation)
43	Organizational Memory System
44	Knowledge Management Process
45	Text Mining[1] (e.g., Nina Wang Case)
46	Data Mining[1] (e.g., Tax File Data Analysis)
47	Brain (e.g., e-Knowledge Portal)
48	Collaborative Knowledge Management[2] (e.g., Wikis, Wikipedia)
49	Weblog for Knowledge Management[2] (e.g., K-logs)

1. Initially coded into one item as "Text Mining and Data Mining"
2. Initially coded into one item as "Knowledge Sharing: Wikis and Weblogs"

ACKNOWLEDGMENT

This work was supported by CityU SRG Grant 7002051.

REFERENCES

[1] R. E. Clasen and W. E. Bowman, "Toward a student-centered learning focus inventory for junior high and middle school teachers," *J. Edu. Res.*, vol. 68, no. 1, pp. 9–11, 1974.

[2] R. M. Felder and R. Brent, "Navigating the bumpy road to student-centered instruction," *College Teaching*, vol. 44, no. 2, pp. 43–47, 1996.

[3] J. H. Baker, "The learning log," *J. Inf. Syst. Edu.*, vol. 14, no. 1, pp. 11–13, 2003.

[4] M. Weimer, *Learner-Centered Teaching: Five Key Changes to Practice*. San Francisco: Jossey-Bass, 2002.

[5] H. S. Du and C. Wagner, "Weblog success: Exploring the role of technology," *Int. J. Human-Comput. Stud.*, vol. 64, no. 9, pp. 789–798, 2006.

[6] A. Rosenbloom, "The blogosphere," *Commun. ACM*, vol. 47, no. 12, pp. 31–33, 2004.

[7] F. Vogelstein, D. Kirkpatrick, D. Roth, and A. Lashinsky, et al., "10 tech trends to watch in 2005," *Fortune*, vol. 151, no. 1, pp. 43–55, 2005.

[8] W. J. Reagin, "Theoretical and practical applications of emergent technology in ELT classrooms; how the 'Blog' can change English Language Teaching," in *4th Int. Symp. ELT in China*, 2004 [Online]. Available: http://earth.prohosting.com/wjreagin/eltblogs.htm

[9] E. M. Wiltse, "Blog, blog, blog: Experiences with web logs in journalism classes," in *Int. Symp. Online Journalism*, 2004 [Online]. Available: http://journalism.utexas.edu/onlinejournalism/blogs.pdf

[10] R. E. Ferdig and K. D. Trammell, "Content delivery in the 'Blogosphere'," *T.H.E. Journal* February 2004 [Online]. Available: http://www.thejournal.com/magazine/vault/articleprintversion.cfm?aid=4677

[11] J. Moon, *Learning Journals: A Handbook for Academics, Students and Professional Development*. London: Kogan Page, 2000.

[12] C. Wagner, "Put another (B)log on the wire: Publishing learning logs as weblogs," *J. Inf. Syst. Edu.*, vol. 14, no. 2, pp. 131–132, 2003.

[13] G. Stanley, "Introducing your students to blogs," *IATEFL Issues*, Apr./May 2004.

[14] J. Barger, "Weblog resources FAQ," *Robot Wisdom Weblog* 1997 [Online]. Available: http://www.robotwisdom.com/weblogs

[15] D. Huffaker, "The educated blogger: Using weblogs to promote literacy in the classroom," *First Monday* 2004 [Online]. Available: http://firstmonday.org/issues/issue9_6/huffaker/index.html

[16] J. Bruner, *The Process of Education*. Cambridge, MA: Harvard Univ. Press, 1960.

[17] J. Piaget, *Judgment and Reasoning in the Child*. London: Routledge, 1928.

[18] L. Vygotsky, *Mind in Society*. Cambridge, MA: Harvard Univ. Press, 1978.

[19] D. Leidner and S. Jarvenpaa, "The use of information technology to enhance management school education: A theoretical view," *MIS Quart.*, vol. 19, no. 3, pp. 265–291, 1995.

[20] D. H. Jonassen, "Thinking technology: Context is everything," *Edu. Tech.*, vol. 31, no. 6, pp. 35–37, 1991.

[21] M. Alavi, "Computer-mediated collaborative learning: An empirical evaluation," *MIS Quart.*, vol. 18, no. 2, pp. 159–174, 1994.

[22] A. D. Thompson, M. R. Simonsen, and C. P. Hargrave, *Educational Technology: A Review of the Research*, 2nd ed. Washington D.C.: Association for Educational Communications and Technology, 1996.

[23] T. J. Shuell, "Cognitive conceptions of learning," *Rev. Edu. Res.*, vol. 56, no. 4, pp. 411–436, 1986.

[24] R. C. Bovy, "Successful instructional methods: A cognitive information processing approach," *Educational Commun. Technol. J.*, vol. 29, no. 4, pp. 203–217, 1981.

[25] I. L. Brunning, "An information processing approach to a theory of instruction," *Educational Commun. Technol. J.*, vol. 31, no. 2, pp. 91–101, 1983.

[26] R. E. Slavin, *Cooperative Learning: Theory, Research, and Practice*. Englewood Cliffs, CA: Prentice Hall, 1990.

[27] C. K. Tyran and M. Shepherd, "Collaborative technology in the classroom: A review of the GSS research and a research framework," *Inf. Tech. Manag.*, vol. 2, no. 4, pp. 395–418, 2001.
[28] B. A. Nardi, D. J. Schiano, M. Gumbrecht, and L. Swartz, "Why we blog," *Commun. ACM*, vol. 47, no. 12, pp. 41–46, 2004.
[29] M. Alavi, B. C. Wheeler, and J. S. Valacich, "Using IT to reengineer business education: An exploratory investigation of collaborative telelearning," *MIS Quart.*, vol. 19, no. 3, pp. 293–312, 1995.
[30] P. B. Lowry, J. F. Nunamaker, Q. E. Booker, A. Curtis, and M. R. Lowry, "Creating hybrid distributed learning environments by implementing distributed collaborative writing in traditional educational settings," *IEEE Trans. Prof. Commun.*, vol. 47, no. 3, pp. 17–189, Sep. 2004.
[31] G. Piccoli, R. Ahmad, and B. Ives, "Web-based virtual learning environments: A research framework and a preliminary assessment of effectiveness in basic IT skills training," *MIS Quart.*, vol. 25, no. 4, pp. 401–426, 2001.
[32] G. R. Salancik, "Commitment and the control of organizational behavior and belief," in *New Directions in Organizational Behavior*, B. M. Staw and G. R. Salancik, Eds. Chicago, IL: St. Clair, 1997, pp. 1–54.
[33] N. S. Glance and B. A. Huberman, "Dynamics of social dilemmas," *Sci. Amer.*, vol. 270, no. 3, pp. 76–81, 1994.
[34] B. A. Huberman and N. S. Glance, "Beliefs and cooperation," in *Modeling Rational and Moral Agents*, P. Danielson, Ed. Oxford: Oxford Univ. Press, 1996, pp. 210–235.
[35] S. M. Murphy, S. J. Wayne, R. C. Liden, and B. Erdogan, "Understanding social loafing: The role of justice perceptions and exchange relationships," *Human Relations*, vol. 56, no. 1, pp. 61–84, 2003.
[36] J. Jung, C. Schneider, and J. S. Valacich, "The influence of real-time identifiability and evaluability performance feedback on group electronic brainstorming performance," in *38th Hawaii Int. Conf. System Sciences*, 2005 [Online]. Available: http://ieeexplore.ieee.org/iel5/9518/30166/01385291.pdf
[37] J. F. Nunamaker, A. R. Dennis, J. S. Valacich, D. R. Vogel, and J. F. George, "Electronic meeting systems to support group work," *Commun. ACM*, vol. 34, no. 7, pp. 40–60, 1991.
[38] R. O. Briggs, V. Ramesh, K. Basu, and J. P. Carlisle, "Exemplar: Improving the college classroom with group support technology," in *Proc. 13th Int. Conf. Inf. Syst.*, 1992, pp. 276–277.
[39] G. Greenberg, "Distance education technologies: Best practices for K-12 settings," *IEEE Technol. Soc. Mag.*, vol. 17, no. 4, pp. 36–40, Winter 1999.
[40] E. L. Thorndike, *Fundamentals of Learning*. New York: Columbia Univ. Press, 1932.
[41] G. A. Kimble, *Hilgard and Marquis' Conditioning and Learning*. New York: Appleton-Century-Crofts, 1961.
[42] B. S. Bloom, J. T. Hastings, and G. F. Madaus, *Handbook on the Formative and Summative Evaluation of Student Learning*. New York: McGraw-Hill, 1971.
[43] J. Biggs, "A reflective institution: Assuring and enhancing the quality of teaching and learning," *Higher Edu.*, vol. 41, no. 3, pp. 221–238, 2001.
[44] G. Tenenbaum, "The effect of quality of instruction on higher and lower mental processes and one the prediction of summative achievement," *J. Edu. Res.*, vol. 80, no. 2, pp. 105–114, 1986.
[45] D. Leidner and S. Jarvenpaa, "The information age confronts education: Case studies on electronic classrooms," *Inform. Syst. Res.*, vol. 4, no. 1, pp. 24–54, 1993.
[46] G. Paré and J. J. Elam, "Using case study research to build theories of IT implementation," in *Information Systems and Qualitative Research*, A. S. Lee, J. Liebenau, and J. I. DeGross, Eds. London: Chapman & Hall, 1997, pp. 542–568.
[47] A. R. Dennis, "Information processing in group decision making: You can lead a group to information, but you can't make it think," *MIS Quart.*, vol. 20, no. 4, pp. 433–458, 1996.
[48] S. M. Miranda and C. S. Saunders, "The social construction of meaning: An alternative perspective on information sharing," *Inform. Syst. Res.*, vol. 14, no. 1, pp. 87–106, 2003.
[49] P. E. Shrout and J. L. Fleiss, "Intraclass correlations: Uses in assessing rater reliability," *Psychol. Bull.*, vol. 86, no. 2, pp. 420–428, 1979.
[50] K. O. McGraw and S. P. Wong, "Forming inferences about some intraclass correlation coefficients," *Psychol. Methods*, vol. 1, no. 1, pp. 30–46, 1996.
[51] L. R. James, R. G. Demaree, and G. Wolf, "Estimating within-group interrater reliability with and without response bias," *J. Appl. Psych.*, vol. 69, no. 1, pp. 85–98, 1984.
[52] J. A. Arter and J. McTighe, *Scoring Rubrics in the Classroom: Using Performance Criteria for Assessing and Improving Student Performance*. Thousand Oaks, CA: Corwin Press, 2000.
[53] B. Huot, "Relibility, validity, and holistic scoring: What we know and what we need to know," *College Composition Commun.*, vol. 41, no. 2, pp. 201–213, 1990.
[54] B. M. Moskal and J. A. Leydens, "Scoring rubric development: Validity and reliability," *Practical Assessment, Res. Evaluation* vol. 7, no. 10, 2000 [Online]. Available: http://pareonline.net/getvn.asp?v=7&n=10
[55] S. P. Klein, B. M. Stecher, R. J. Shavelson, D. McCaffrey, T. Ormseth, R. M. Bell, K. Comfort, and A. R. Othman, "Analytic versus holistic scoring of science performance tasks," *Appl. Meas. Edu.*, vol. 11, no. 2, pp. 121–137, 1998.
[56] R. Agarwal and V. Venkatesh, "Assessing a firm's web presence: A heuristic evaluation procedure for the measurement of usability," *Inform. Syst. Res.*, vol. 13, no. 2, pp. 168–186, 2002.
[57] J. C. Nunally, *Psychometric Theory*. New York: McGraw Hill, 1978.
[58] N. J. Venkatraman and H. Grant, "Construct measurement in organizational strategy research: A critique and proposal," *Acad. Manag. Rev.*, vol. 11, no. 1, pp. 71–87, 1986.
[59] J. Hawkins, "Technology and the organization of schooling," *Commun. ACM*, vol. 36, no. 5, pp. 30–35, 1993.

Helen S. Du is a Ph.D. candidate at the City University of Hong Kong, Department of Information Systems. Her main research focus lies in the areas of human-computer interaction and collaborative knowledge management. With a strong interest in IT-supported learning, she is also involved in research projects exploring and promoting the pedagogical use of weblogs and wikis. She has published in journals such as *Decision Support Systems* and *International Journal of Human-Computer Studies*.

Christian Wagner is a Professor of Information Systems at the City University of Hong Kong. He is an avid user of technology for instructional uses. He has used blogs and wikis in the classroom since 2002 and has authored and coauthored several articles on the subject. Overall, he has authored or coauthored over 60 articles. His current research examines wiki use as a medium for corporate knowledge sharing to harness the collective knowledge of employees. He also leads a project on the use of wireless PDAs to facilitate interactive learning.