The Role of Information Technology in Technology-Mediated Learning: A Review of the Past for the Future

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ABSTRACT

Technology-mediated learning refers to an environment in which the learner's interactions with learning materials, peers, and/or instructors are mediated through information technologies (Alavi and Leidner, 2001). The objective of this paper is to review current research on technology-mediated learning using a theoretical framework derived from the existing literature. The framework presents three dimensions (primary participant, instructional design, and information technology) that influence students' psychological learning processes, and eventually lead to different learning outcomes. The literature review reveals that certain relationships identified by this framework have received significant attention (e.g., the influence of a technology feature on learning outcomes), while others have been ignored (e.g., the influence of IT on psychological processes). Research questions that can help advance our understanding of technology-mediated learning are discussed.

Keywords: Technology-mediated learning, Information technology, Education.

1. INTRODUCTION

In the last decade, the development of technology-mediated learning has advanced dramatically due in part to the rising demand for postsecondary education. According to the Education Industry Association, education in the United States has become a US $1 trillion industry (Education Industry Association, 2006), and this is expected to grow due to an additional two million full-time students enrollments by 2010 (Datamonitor, 2004).

Concomitant with this growing demand for education, the pace of information technology advancement has continued unabated, resulting in (among other things) increasingly pervasive network connectivity from both business and home (Alavi, 2004). The education sector is facing substantial Internet-driven change (Beller and Or, 1998). Datamonitor (2004) reports that annual education-related ICT investments in the US are expected to reach over $9 billion by 2008.

Despite these heavy investments in education and technology, we have ignored key factors related to learning effectiveness such as individual student characteristics (Vician and Davis, 2002), and emphasized factors that do not necessarily lead to favorable learning outcomes (Ma et al., 2000). To achieve better learning outcomes from investments in IT within the educational environment, it is imperative for researchers to develop a more comprehensive understanding of the role of IT in the context of technology-mediated learning.

To better understand the benefits, costs and influencing factors associated with technology-mediated learning, numerous studies have been conducted across multiple disciplines (e.g., Alavi and Leidner, 2001; Piccoli et al., 2001). The development of this field is promising, yet there remains considerable ambiguity about what we know and what directions future research should take. The current study responds to this situation by pursuing the following objectives. First, an integrated framework of technology-mediated learning research derived from the existing literature is presented. Second, the information technology component and its individual and/or collective interactive effects with other factors are highlighted. Third, a review of existing research is provided and key factors related to technology-mediated learning are established, including technological, instructional, psychological and environmental factors. Our findings show that while some of the relationships between IT, primary participants and instructional designs have been thoroughly examined, others, such as those related to psychological learning processes, have been under-investigated or ignored. Future research directions are discussed.

2. THEORETICAL FRAMEWORK FOR TECHNOLOGY-MEDIATED LEARNING

While interest in technology-mediated learning has grown rapidly in recent years, a comprehensive theoretical framework on relevant constructs and their relationships has not yet emerged. Several papers have provided research models, and in this paper we focus exclusively on four that have been published in the information systems literature: Alavi and Leidner (2001), Piccoli et al. (2001), Benbunan-Fich and Hiltz (2003), and Sharda et al. (2004). These papers represent a reasonable cross section of model types and examine different lines of research. They each have a focus on one or several dimensions of technology-mediated learning. While none of these models represent the entire area, taken together they offer a relatively complete view of the technology-mediated learning research area. A brief summary of each of the four models is presented below, and then an integrated framework is developed.

Alavi and Leidner (2001)'s research commentary provided an excellent literature review and summary of the technology-mediated learning research field. They proposed a framework for technology-mediated learning research to illustrate potential research avenues in this area. This framework emphasized forming relationships among technology and relevant instructional, psychological, and environmental factors to enhance learning outcomes. However, this framework ignored participant factors such as student and instructor characteristics, which other researchers have found to be influential on course design, technology use, and ultimately on learning outcomes (Piccoli et al., 2001; Sharda et al., 2004).

Piccoli et al. (2001) clearly pointed out the human (participant) dimension in their research model, and provided variables for measuring several constructs. However, their model was focused exclusively on the web-based virtual learning environment, and ignored the role of learning processes that mediate the relationships between instructional design/technology dimensions and learning outcomes (Alavi and Leidner, 2001). Unlike Alavi and Leidner (2001), Piccoli et al. (2001) deemphasized information technology by including it as just another variable in the design dimension.

Benbunan-Fich and Hiltz's (2003) research framework separated technology from course design, and highlighted the mediating effect of learning processes (e.g., active participation and motivation) on the relationship between design, technology, and learning outcomes. Unlike the other frameworks, this one proposed that the technology-mediated learning environment must be student-centric rather than teacher-centric, and thus treated the instructor's skill and effort as a component of course design. This is not a convincing argument – e.g., we believe it would be more convincing to classify instructor characteristics according to the primary participant dimension, rather than as a variable that can be designed into a course. Another weakness of this model is that learning outcomes were measured exclusively by students' perceptions, which is highly subjective and only captures one aspect of what may be a multidimensional construct.

Inconsistent measurement of learning outcomes is a common weakness. Some studies measured learning effectiveness, while others measured the students' perceptions of learning. This leads to difficulties in comparing and triangulating results across multiple studies, and thus to building a cohesive understanding. To address this, Sharda et al. (2004) classified learning outcomes into three groups. Cognitive learning outcomes include knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom, 1956); affective learning outcomes are associated with emotion, feelings, relationships and the ability to deal with situations (Sharda et al., 2004); and psychomotor learning outcomes refer to movement characteristics and capabilities such as efficiency and effectiveness (Simpson, 1966, Sharda et al., 2004).

These four frameworks have provided considerable value to the technology-mediated learning field. Together they have framed a large body of empirical research. However, these models have a common drawback in that each of them takes a limited view of the technology-mediated learning phenomenon, leading to the exclusion of recent "authentic" research falling outside one or more of these frameworks. Appendix 1 provides a comparative summary.

Building on and integrating the seminal works by Alavi and Leidner (2001), Piccoli et al. (2001), Benbunan-Fich and Hiltz (2003), and Sharda et al. (2004), we propose an input-process-output framework as the basis for our literature review (Figure 1). This framework is broad enough to facilitate categorization of the previous research, and at the same time is detailed enough to suggest specific areas of study. It contains three main dimensions as inputs: primary participant (students and instructor), instructional design (ways of instruction), and information technology (the collection of technology tools used during learning). These determinants individually and collectively influence students' learning processes, which eventually affects learning outcomes (output).

2.1 Primary Participant Dimension

Student and instructor are the two primary participants in any learning environment (Piccoli et al., 2001). Student factors

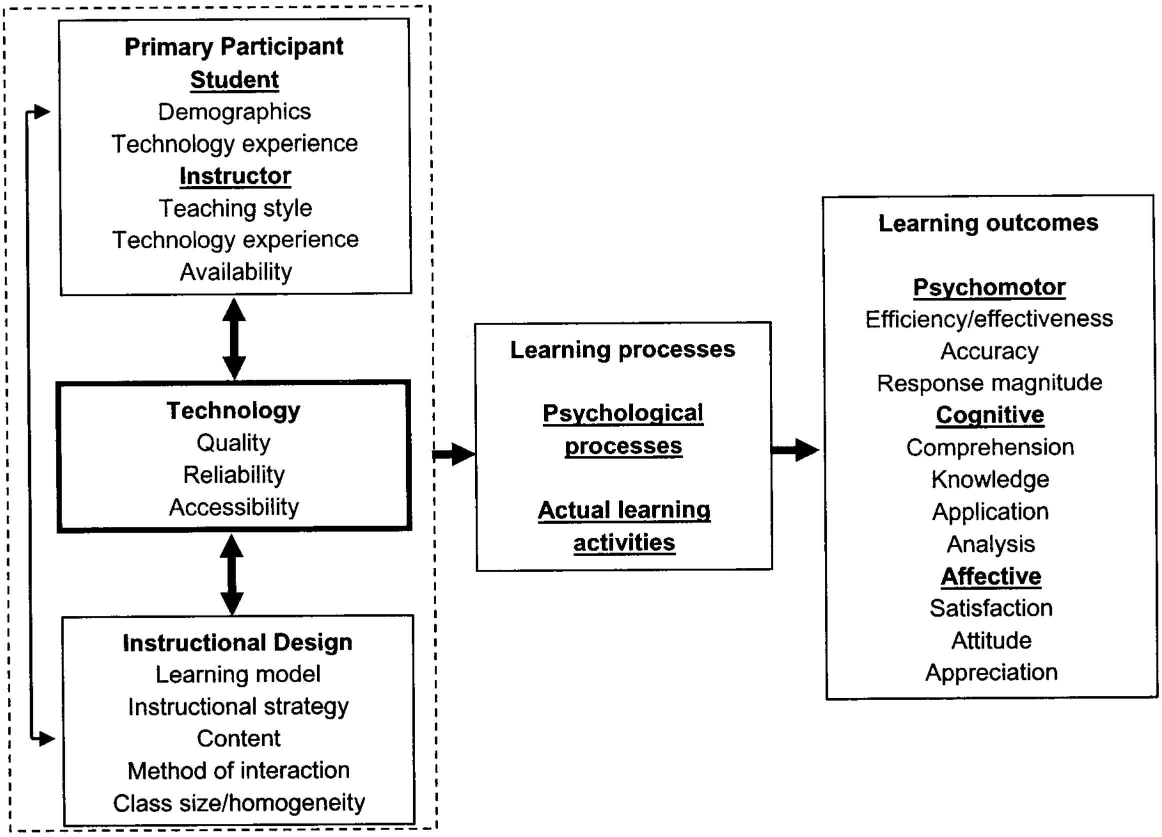

Figure 1: A theoretical framework for technology-mediated learning

include demographics (e.g., age and gender), language, and communication skills (Piccoli et al., 2001). Students' technology experience and computer anxiety are also commonly investigated (e.g., Arbaugh and Duray, 2002; Lee, et al., 2001).

It may be tempting to conclude that the instructor is less important (or even dispensable) in technology-mediated learning environments. However, research has shown that technology-mediated teaching may demand even more effort from instructors than traditional teaching approaches, because students perceive the class as being "in session" whenever they sign in, and so feel free to ask questions or solicit feedback anytime and from anywhere (e.g., Marks et al., 2005). Instructor characteristics such as availability and engagement, level of technology experience, self-efficacy, and skill have been investigated in considerable depth (e.g., Piccoli et al., 2001; Benbunan-Fich and Hiltz, 2003; Webster and Hackley, 1997; Hantula, 1998) .

2.2 Instructional Design Dimension

The instructional design dimension includes learning model, instructional strategy, learning content, method of interaction, class size / homogeneity (Piccoli et al., 2001, Benbunan-Fich and Hiltz, 2003, Hardaway and Scamell, 2005). Among these factors, IS researchers have been mostly drawn to investigate learning models and instructional strategies.

A learning model is the foundation of the learning process and influences the overall instructional design of a learning environment (Piccoli et al., 2001). Five learning models have been identified by Leidner and Jarvenpaa (1995): objectivism, constructivism, collaborativism, cognitive information processing, and socioculturalism, each with different basic premises, goals, major assumptions and implications. Objectivism is considered to be the traditional model of learning. Its primary competing model is constructivism, which has a number of derivations including collaborativism and cognitive information processing. The socioculturalism model lies somewhere in the middle of the objectivist-constructivist continuum. Leidner and Jarvenpaa (1995) argued that it is important for researchers to explicitly take into account the role of the learning model when they conduct any studies related to technology-mediated learning.

Instructional strategy refers to methods used for presenting, sequencing, and synthesizing the learning content (Reigeluth et al., 1994, Alavi and Leidner, 2001). It will affect how the format of content information is selected, the ordering of different topics, and the ways in which relationships are established among these topics (Reigeluth et al., 1994). For example, learner control is one type of instructional strategy in which learners make the decisions regarding the instructional path, flow or events (Piccoli et al., 2001). Other instructional strategies include the use of group projects versus individual projects (Marks et al., 2005).

In conclusion, technology-mediated learning may be suitable for a wide range of topics, but its effectiveness will depend on the course design, e.g., learning model, instructional strategy, and technologies used (Piccoli et al., 2001).

2.3 Information Technology

For the purpose of this study, information technology broadly refers to computing, communication, data management technologies, and their convergence (Alavi and Leidner, 2001). Technology quality, reliability and accessibility are important determinants of learning effectiveness and learner satisfaction (e.g., Webster and Hackley, 1997; Arbaugh and Duray, 2002; Marks et al., 2005). Some technologies are best suited to support specific theoretical learning models (Leidner and Jarvenpaa, 1995), while others provide general support for different learning models (Piccoli et al., 2001). For example, group support system (GSS) may be better aligned with the constructivist learning model than the traditional model. On the other hand, e-mail and the Internet present examples of technologies that provide general support for learning activities. Nowadays, the Internet often plays a central role in the development of technology-mediated learning programs by providing scalable connectivity to bridge geographic distance, with the Web browser acting as a ubiquitous user interface for various distributed learning software applications.

There have been contradictory views on whether information technology should be treated as part of the instructional design dimension (e.g., Piccoli et al., 2001) or not (e.g., Alavi and Leidner, 2001; Benbunan-Fich and Hiltz, 2003). The framework presented here builds on Alavi and Leidner's classification which separates IT from the instructional design dimension. This approach provides more opportunity to question and explore possible interactions between technology and the other dimensions, including the instructional design dimension. Although technology itself does not produce desired learning outcomes, it facilitates intentional changes in teaching and learning processes and so operates as an enabler (Leidner and Jarvenpaa, 1995). The combined effect of interactions between the technology, primary participant and instructional design dimensions impacts the students' learning processes, and subsequently their learning outcomes (as illustrated in figure 1 by the set of two-way arrows).

2.4 Learning Processes

Learning processes include both psychological processes (Alavi and Leidner, 2001) and actual learning activities (Benbunan-Fich and Hiltz, 2003). Psychological processes refer to the individual learner's cognitive and information processing activities, motivations, interests, and cognitive structures (e.g., memory) (Alavi and Leidner, 2001). Actual learning activities include learners' active or passive participations and interactions (Benbunan-Fich and Hiltz, 2003). This important mediator has been largely ignored in the technology-mediated learning literature, perhaps due to the complexity and difficulties in measuring psychological learning processes. Some studies have examined the direct effects of technology features on learning outcomes (e.g., Alavi et al., 2002; Abraham, 2002; Arbaugh and Duray, 2002), but very few have touched on motivation, interest, learner's cognition or cognitive structures (Benbunan-Fich and Hiltz, 2003; Stafford, 2005).

2.5 Learning Outcomes

A central purpose of learning is to acquire knowledge and increase the capability to take effective action. However, knowledge and capability can not be directly measured: only the action and performance resulting from learning can be observed and measured (Alavi and Leidner, 2001). According to Sharda et al. (2004), learning outcomes can be classified into three groups: psychomotor outcomes, cognitive outcomes, and affective outcomes. Psychomotor outcomes include efficiency, accuracy, and response magnitude. Cognitive outcomes include comprehension, knowledge, application, and analysis. Affective outcomes include students' perception of satisfaction, attitude, and appreciation for the learning experience (Sharda et al., 2004).

This framework presents the major concepts relevant for investigation into technology-mediated learning. While the role of information technology in technology-mediated learning has been investigated in the IS literature, Alavi and Leidner (2001) suggest that IS researchers should move beyond specifying simple cause-effect relationships between observable technology features (e.g., presence of a GSS) and learning outcomes, and instead look into relationships between technology and other constructs. In other words, we should answer the question about how information technology enhances learning processes as well as outcomes, as it interacts with the primary participant and instructional design dimensions (Alavi and Leidner 2001).

3. THE ROLE OF INFORMATION TECHNOLOGY

While technology-mediated learning involves multi-disciplinary research, studies conducted in the educational psychology and pedagogy fields are not included in this review because they generally do not examine information technology explicitly, or relationships between IT and primary participant or instructional design dimensions. Only studies investigating relationships involving technology are discussed here. That is, we focus on four groups of relationships that immediately involve IT: (1) between IT and the primary participant dimension; (2) between IT and the instructional design dimension; (3) between IT and learning processes; and (4) between IT and learning outcomes, mediated by learning processes (illustrated with thick lines in Figure 1).

We focused on papers published after Alavi and Leidner's 2001 research commentary, and examined the extent to which they responded to Alavi and Leidner's research direction. A search of the literature revealed 30 relevant articles published over the past six years in 23 leading education-related outlets. The breadth of outlets implies an emerging yet dispersed research effort that is still at an early stage of development. Dimensions discussed across these 30 papers are shown in Appendix 2.

3.1 IT and the Primary Participant Dimension

Students. The existing literature has examined relationships between individual student characteristics and learning outcomes. No connections have been established between student age, gender, GPA (grade point average) and choice of web-based or traditional course (Parnell and Carraher, 2003). However, computer anxiety and communication apprehension may be negatively related to usage and learning outcomes (Vician and Davis, 2002; Fuller et al. 2006). In particular, prior studies have shown that technology experience is a strong predictor of students' perceptions of technology usage (e.g., Thompson et al., 1994; Atkinson and Kydd, 1997), and that more experienced students visit course web sites more frequently and for longer periods (Lee, et al., 2001). Recent studies have presented mixed findings on the relationship between student technology experience and course satisfaction. For example, one study confirmed that more experienced on-line students are more satisfied with their course delivery medium (Arbaugh and Duray, 2002), while another study reported no differences in perceived learning and satisfaction (Marks et al., 2005).

Instructors. The importance of the instructor in technology-mediated learning environments has been examined in numerous studies (Coppola et al., 2002; Easton, 2003; Martins and Kellermanns, 2004). Instructors' level of technology experience and self-efficacy, in terms of having the ability to control the technology and having a positive attitude toward it, affect students' learning outcomes (Piccoli et al., 2001). Outcomes can be improved when professors support the growth of online learning communities by making themselves available online to interact with students (Benbunan-Fich and Hiltz, 2003) and encourage student involvement in electronic discussions (McFadzean and McKenzie, 2001; Marks et al., 2005). Such instructor-initiated activities are highly valued by students (Frey et al., 2003).

3.2 IT and the Instructional Design Dimension

Information technology can be integrated into course designs in two different but overlapping ways: (1) as a mechanism for transmitting learning content; or (2) as a mechanism for supporting communication between instructor and students, or among students (Benbunan-Fich, 2002). As a content-transmission tool, technology can complement or replace the traditional role of printed materials and provide richer and more dynamic information display, animation, and computer-based tutorials (Seal and Przasnyski, 2003). PowerPoint, audio, video and multimedia are very common tools used in today's classroom (Marks et al., 2005; Gemino et al. 2005).

Communication technologies can facilitate interactions between learners (Hay, Hodgkinson, Peltier and Drago, 2004), extend instructor availability beyond class times and office hours, and support administrative activities such as distribution of learning materials (Benbunan-Fich, 2002). E-mails containing lecture notes and assignments may be used extensively by both instructors and students and are perceived to increase productivity (Zhao et al., 2003). Although interaction between students is important in predicting course effectiveness (Hay, Hodgkinson, Peltier and Drago, 2004), the instructor-student interaction is even more important and has twice the influence of student-student interaction (Marks et al., 2005). Technology-mediated interactions can foster effective learning by enabling students to evaluate the course progress and their instructional needs, and thus complement a high degree of learner control (Piccoli et al., 2001). To enhance learning outcomes, the course designer also needs to design appropriate structure and guidance for students to manage the group processes (Oliver and Omari, 2001), provide instructional infrastructure to support learning activities (Sharda et al., 2004), make communication policies to govern the conversation, and provide technological facilities and algorithms to facilitate communication (Leung and Li, 2004).

As discussed earlier, different learning models require different approaches to IT design and use (Leidner and Jarvenpaa, 1995). Along the same lines, Benbunan-Fich (2002) provided a three-dimensional conceptual model by integrating learning models (objectivist vs. constructivist), time (synchronous vs. asynchronous), and place (proximate vs. dispersed). Each of the eight resulting "cubes" represents a unique learning context, and thus demands different educational applications of IT. For example, in the traditional classroom (objectivist, synchronous, proximate) presentation technologies and computerized tutorials can mediate traditional lectures to increase the efficiency of knowledge transmission. In a mediated classroom (e.g., constructivist, asynchronous, dispersed) relevant IT applications may range from e-mail to collaborative/team-based software to asynchronous learning networks. Thus, technology-mediated learning may be designed into most learning environments, albeit in quite different ways.

3.3 IT and Learning Processes

Learning processes include the learner's psychological processes such as cognitive information processing activities, motivation, interest, and cognitive structures (memory) (Alavi and Leidner, 2001), as well as actual learning activities such as active or passive participation and interaction (Benbunan-Fich and Hiltz, 2003). Technology can influence learning processes by facilitating cognitive information processing activities such as search, scanning, transformation, or comparison of information (Alavi and Leidner, 2001). However, five years after Alavi and Leidner called for greater depth of research on students' psychological learning process, related studies are still in short supply.

Among the limited number of studies, one tentative finding is that higher learner motivation leads to greater perceived learning (Benbunan-Fich and Hiltz, 2003). Stafford (2005) identified three dimensions of Internet usage motivations: content, process and social motivation. For example, online course content was highly sought after by students with content motivation; those with process motivation diverged into searching versus browsing in support of their learning; and students with strong social motivation show their need for social contact with others.

In terms of social motivation, prior research has shown that technology can influence learning processes through interaction between individuals and within groups. According to adaptive structuration theory (DeSanctis and Poole, 1994), individuals and groups actively appropriate technology to their own purposes instead of passively receiving it. Therefore, technologies in use rely heavily upon participants' social practices that evolve over time (a continuous process referred to as adaptive structuration).

Due to the importance of adaptive structuration, empirical studies need to focus on process variables, e.g. learner's actual learning activities.

3.4 IT and Learning Outcomes

Numerous studies have compared learning outcomes between traditional and online courses, controlling for design factors such as content, sequence and instructors (Hay, Peltier and Drago, 2004; Chou and Liu, 2005; Bryant et al., 2003; Abraham, 2002), as well as hybrid courses (e.g., Benbunan-Fich and Hiltz, 2003). However, mixed findings are often reported and there is no clear conclusion as to which type of courses will lead to better learning outcomes.

Another stream of research has compared specific technologies such as interactive video (Zhang et al. 2006) and GSS (Alavi et al. 2002) and their impacts on learning outcomes. Alavi et al. (2002) employed a quasi-experimental field study to compare learning effectiveness between two types of information technologies, and found that the learning outcomes for students using simple e-mail and listserv capabilities were better than those of students using a more sophisticated GSS. In a post-hoc analysis the authors found that students using e-mail focused more on the learning task, whereas students using the GSS focused more on technology sense-making. This is a clear example of the mediating effect of learners' actual learning activities on learning outcomes. In another study conducted in a problem-based learning environment, researchers found that learners using GSS initiate more ideas, have fewer questions, and provide better feedback than those in non-GSS supported environments (Kwok et al., 2002). These positive learning outcomes may be due to a match between the technology (e.g., GSS) and instructional design dimension (e.g., collaborative learning model), rather than because of technology alone (as Kwok et al. concluded).

A third stream of research considers general technology features such as flexibility, convenience and availability and their impacts on affective learning outcome (e.g., satisfaction). For example, perceived flexibility of technologies used for content delivery has been positively associated with perceived learning and satisfaction (e.g., Arbaugh and Duray, 2002; Marks et al., 2005). Perceived convenience of access leads to better perceptions of learning effectiveness (Benbunan-Fich and Hiltz, 2003).

In conclusion, the foregoing review supports the argument that information technology plays an important role in diverse learning environments. More specifically, it supports our theoretical framework which states that IT affects student's learning outcomes by interacting with the other two dimensions, i.e., the people who are involved, and the design of the course. Together, these dimensions influence the student's psychological processes and actual learning activities.

4. DISCUSSION AND FUTURE RESEARCH

We are still in the early stages of investigating technology-mediated learning, and much work remains to be done. The literature to date has surfaced and framed many issues and challenges associated with technology-mediated learning environments. Below we discuss relevant issues and, more importantly, give suggestions for future research.

Use of Research Subjects. External validity of studies that use students as research subjects may be limited. Student subjects are more homogeneous than the general population in several ways that may be very important to learning outcomes (e.g., in terms of age and cognition). Thus we must be careful when attempting to extend these research findings to organizational settings.

The social nature of learning. The literature has clearly demonstrated a link between information technology and the instructional design. Technologies provide enhanced capabilities for the execution of instructional strategies, and more effective and efficient delivery of content. At a higher level, technologies also enable the implementation of different learning models such as collaborativism (Leidner and Jarvenpaa, 1995). Collaborative learning, especially computer supported collaborative learning, has drawn a substantial amount of research attention (Williams and Roberts, 2002). It redefines the role of learner as more active in his/her own learning, and the role of instructor as a facilitator and resource guide who considers not only the cognitive but also the social nature of learning (Borthick et al., 2003).

IT infrastructure. More research should focus on how to build an appropriate IT infrastructure to support and facilitate the interaction between instructor and students, and between students and their peers. Although the importance of student-student and student-instructor interactions has been reinforced in many papers (e.g., Hay, Hodgkinson, Peltier and Drago, 2004; Marks et al., 2005), several researchers have argued that the role of information technology should not be limited to that of mere enabler of increased communication and interaction by providing "just another channel". Instead, IT should be used to provide more structure and guidance to manage group activities (Oliver and Omari, 2001), plan and support group practices (McFadzean and McKenzie, 2001), and establish communication policies to govern the conversation among 'agents' (Leung and Li, 2004). Since it can be difficult for a human collaborator to track multiple teams working in different time zones with members located in different places, there is growing interest in developing intelligent systems that support this facilitation process, such as computerized coaches (Constantino-Gonzalez and Suthers, 2003). Other developments include collaborative learning systems and immersive presence technologies, which integrate technologies and human-computer interface principles (Sharda et al., 2004).

Learning Models. Although objectivist, constructivist and collaborative models of learning have been well represented in the existing research, the other two learning models (i.e., cognitive information processing and socioculturalism) have not been investigated (Leidner and Jarvenpaa, 1995). Thus, future research should address the question: Can information technology support cognitive information processing and socioculturalist learning models? An ideal learning environment should respond to learners' needs and provide customized solutions for diverse learner communities, hence personalized learning environments (e.g., Xu et al. 2005) could also be a fruitful direction for future research. Furthermore, there is a need to investigate mechanisms for transforming conventional study materials to forms more appropriate for new learning models (McMurray and Dunlop, 1999).

Learning Processes. The processes by which technology influences learners' cognitive and information processing activities, motivations, interests and cognitive structures remain poorly understood. In particular, we need to develop a better understanding of how learning processes are facilitated by information technologies, current and emerging. Research to date has only looked at individual motivational factors, leaving much room for further investigation. Future research might investigate how technology features and course design affects learners' cognitive structures, and subsequently their learning behaviors. In this endeavor IS researchers have an opportunity to cooperate with researchers in other fields, and this engagement should open up many additional avenues of future research.

5. CONCLUSION

This paper provides an integrated framework that explicates relationships among technology, primary participant and instructional design dimensions, psychological learning processes, and learning outcomes. While our literature review offers a significant response to Alavi and Leidner's fascinating research commentary that appeared five years ago, it also reveals that knowledge on this topic remains limited and underdeveloped. Research questions that hold potential to advance our understanding of technology-mediated learning are provided. Specifically, our analysis highlights five areas of research opportunity in the technology mediated learning domain: (1) using different (non-student) research subjects; (2) exploring the social nature of learning; (3) examining IT infrastructure and its various roles; (4) investigating the applicability and efficacy of new learning models (e.g., cognitive information processing, socioculturalist); (5) explicating learning processes and how they are facilitated by IT.

Continuous improvement in IT and IT-related innovation are making technology-mediated learning an increasingly viable alternative to traditional face-to-face learning approaches. This is not simply a means of reducing the cost of education; technology can be more than an "add-on" to existing learning processes (Hodgson and Watland, 2004). New technologies and learning theories may together serve as a catalyst for a fundamental rethinking of what learning can be and should be (Fisher and Scharff, 1998). The underlying assumptions of traditional learning have to be challenged, and the educational institutions should provide more institutional support to the instructional innovation. Both the instructor and student need to be involved in the planning and designing processes of this new learning environment to ensure positive learning outcomes. By considering all the factors and issues, technology-mediated learning can be very successful and highly beneficial.

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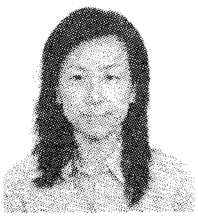

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Appendix 1: Comparasion of Four Existing Frameworks

Articles	Primary Participant Dimension		Instructional Design Dimension	Technology Dimension	Learning Processes	Learning Outcomes
	Student	Instructor				
Alavi and Leidner (2001)			X	X	X	X
Piccoli et al. (2001)	X	X	X			X
Benbunan-Fich and Hiltz (2003)	X		X	X	X	X
Sharda et al. (2004)	X	X	X	X		X

APPENDIX 2: List of Papers Reviewed

Articles	IT and Primary Participant Dimension	IT and Instructional Design Dimension	IT and Learning Processes	IT and Learning Outcomes
Abraham, 2002		X		X
Alavi et al., 2002				X
Arbaugh and Duray, 2002	X			X
Benbunan-Fich, 2002		X		
Benbunan-Fich and Hiltz, 2003	X		X	X
Bryant et al., 2003				X
Chou and Liu, 2005				X
Coppola et al., 2002	X			
Easton, 2003	X			
Frey et al., 2003	X			
Fuller et al., 2006	X			
Gemino et al., 2005		X		X
Hardaway and Scamell, 2005		X		
Hay, Hodgkinson et al., 2004		X		X
Hay, Peltier et al., 2004				X
Kwok et al., 2002				X
Lee et al., 2001	X			
Leung and Li, 2004		X		
Marks et al., 2005	X			X
Martins and Kellermanns, 2004	X			
McFadzean and McKenzie, 2001	X			
Oliver and Omari, 2001		X		
Parnell and Carraher, 2003	X			
Seal and Przasnyski, 2003		X		
Sharda et al., 2004	X	X		X
Stafford, 2005			X	
Vician and Davis, 2002	X			
Xu et al., 2005	X			
Zhang et al., 2006				X
Zhao et al., 2003		X		
Total	**14**	**10**	**2**	**13**

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