A Review of Research on Technology-Mediated Learning: A Multiple Perspectives Approach

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Abstract

The use of technology in learning and education has witnessed exponential growth in recent years. This calls for newer conceptualizations and organizing frameworks for the research in this domain. This paper addresses this call by proposing the Multiple Perspectives Framework as a suitable conceptual model for organizing research in technology-mediated learning. Existing research in TML is reviewed and presented in line with the framework, with the aim of identifying key research issues in technology-based education.

Keywords: Technology-mediated Learning, Multiple Perspectives Framework

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Globally, the education sector is witnessing a fundamental transformation with newer applications of technology to improve not only student learning outcomes but also enhance the learning experience itself while reaching out to students at an unprecedented scale. With such rapid and disruptive changes to the education landscape, there is a need for a cohesive organizing framework that links the various research issues related to the application of technology in education, which is referred to as technology-mediated learning (TML) in this paper. Technology-Mediated Learning has been defined as an environment in which the learners' interactions with learning materials, peers, and/or instructors are mediated through advanced information technologies (Alavi & Leidner, 2001). TML research has used a variety of terms to describe the use of technology in education such as e-learning, blended learning, computer-based learning, computer-assisted learning and so on. Given the diversity of research in TML, this paper proposes the multiple perspectives framework (Linstone, 1999) as an organizing approach for the literature in this domain.

The multiple perspectives paradigm suggests that any socio-technical phenomenon must be viewed from not only the traditional problem-solving or technical approaches, but by simultaneously analyzing its Technical (T), Organizational (O) and Personal (P) aspects. The TOP framework has been applied to a wide range of contexts ranging from military strategy to environmental planning (Linstone, 1989) and terrorism (Linstone, 2003). This theory can be applied to the context of schools that use technology as a pedagogical tool and therefore, can be described as a socio-technical system. Based on the TOP framework, the literature on TML is categorized into its technical factors (i.e., review of research in educational technology), its

organizational factors (i.e., review of research on TML as applied to organizations) and its personal aspects (review of TML research related to students and teachers). The rest of the paper reviews research on TML related to each of the dimensions of the TOP framework. The TOP framework for TML is presented in Figure 1.

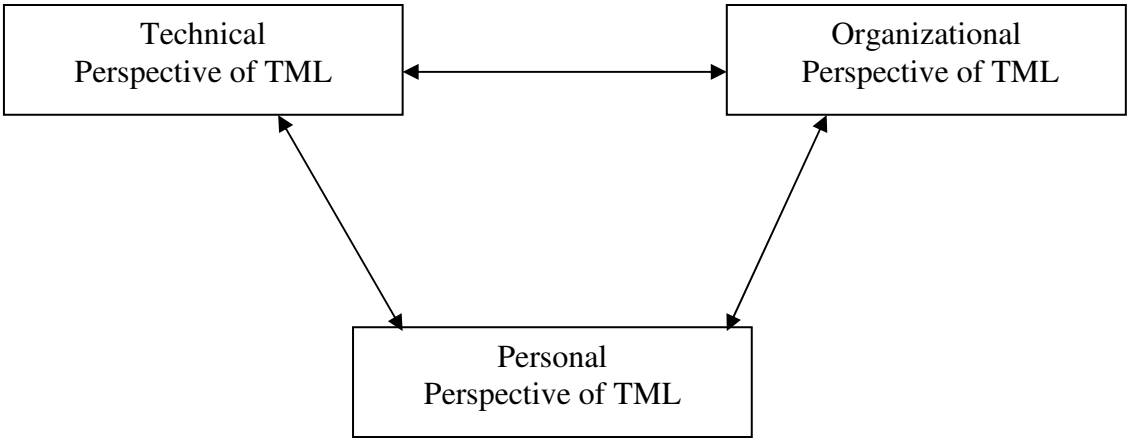

Figure 1: The TOP Framework for Technology-Mediated Learning (adapted from Linstone, 1989)

The Technical Perspective

Research in technology management as applicable to TML has spanned a broad range of research disciplines such as economics, psychology, sociology and strategic management to name a few. This section reviews research on the nature of access, adoption and diffusion of technology in education as well as users' experiences with the use of TML.

Access, Adoption and Diffusion of Technology in Education

Access

This section covers research on access to technology in education. In a study on the extent of digital divide among children, Becker (2000) described children's differential access to computers in school and at home, and the environment that affects children's experience with computers. In this study, teachers who taught students from low-income families reported

weekly use of computers more often than those teaching high-income students. The results also suggested that low-income students use computers more often for repetitive practice, whereas high-income students use computers more often for more sophisticated, intellectually complex applications. In a subsequent study, Farrell (2003) argued that adoption of ICTs in education had reached the stage of early adoption. The author suggested that decision makers and teachers would be interested in knowing how this innovation will increase access to educational opportunities, what the costs will be, what will be the impact on the quality of the content and the learning experience.

In a study analyzing the determinants of Internet access, Chaudhuri, Flamm and Horrigan (2005) reported that demographic factors such as household income, gender, marital status, employment, education level, race and age had an effect on Internet access. The empirical analysis showed income and educational attainment to be the strongest predictors of Internet purchase. While demographic factors had a favorable impact on Internet access and purchase, government initiatives to support Internet access further increased access to the Internet.

Powell (2007) reported on a specific case of a camp set up to give students an experience in introductory computer skills, word processing, web authoring, web research, page design principles and programs. The study found that simply having a computer available to them did not completely open access for these students. Access was a dynamic process and depended on the students' use of everyday social and literary practices. In a longitudinal study of technology-mediated distance education, Ozdemir and Abrevaya (2007) examined factors facilitating the rapid adoption and utilization of technology-mediated distance education among higher education institutions. Their analysis showed that size, public/private status, and location significantly predicted actual adoption of technology-mediated distance education. Urban

locations negatively affected enrolment in the courses at the undergraduate but not at the graduate level. While the intent to adopt technology-mediated distance education was significantly correlated with its actual adoption, many schools which were not interested in technology-mediated distance education in 1997-1998 adopted it by 2000-2001. Late adopters were found to utilize certain technologies, such as synchronous Internet-based instruction and the use of CD-ROMs as frequently as early adopters.

In their study on the adoption of TML in the USA, Ozdemir, Altinkemer, and Barron (2008) conducted a university-level analysis of the adoption of TML programs. The findings of their study revealed that top-ranked universities used TML less than their lower ranked counterparts, possibly due to the difficulty involved in improving their already well-established degree offerings. The authors suggested that universities in sparsely populated states that rely on a commuting student body ought to consider the opportunities enabled by TML. This would allow their students to meet their educational objectives with less time spent on travelling, consequently increasing the value of the degrees offered by these universities.

Research on Diffusion of Technology

Diffusion is the process by which innovations spread among members of a social system (Rogers & Shoemaker, 1971). The diffusion process has four main elements: a) an innovation, b) communicated through certain channels, c) over time and d) among members of a social system (Rogers, 1995, p. 10). The diffusion of innovations framework dates back to the late 1800s in anthropology and later in sociology (Davied, Fisher, Arnold & Johnsen, 1999). Leigh and Atkinson (2001) pointed out that though the ‘‘digital’’ divide is being discussed in recent research, earlier, society was divided in terms of ownership of telephones and television sets.

Schement (2001) reported that information technologies that require a one-time purchase, such as the radio and the VCR, have steadily increasing diffusion curves.

Applying the concept of disruptive innovation to education, Christensen, Johnson and Horn (2008) predicted that computer-based education is likely to be adopted in two distinct phases. In the first phase the educational software will be proprietary and expensive to develop and relatively inflexible to students' learning styles and intelligence. In the second phase, student-centric technology is likely to be developed where students learn each subject in a manner that is consistent with their intelligence and learning style. According to this study, student-centric technology will therefore make it affordable and convenient for many more students to learn in ways suitable to them. The authors observed that school reforms so far have not addressed the root cause of students' inability to learn. In their view, school reformers need to work within the schools' existing structures and systems instead of attacking it directly in an attempt to fundamentally overhaul it. Indirect rather than direct approaches are better suited for innovation in schools. Emerging online user networks were identified by the authors to have tremendous potential to work within the existing school system in the USA to create a new, modular educational system.

Information Systems Research

Researchers in information systems have explored issues related to the use of technology, specifically the causes and outcomes of technology use. In an early study, Davis (1989) defined perceived usefulness of technology as the degree to which a person believes that using a particular system would enhance his or her job performance. In contrast, perceived ease of use was defined by Davis (1989) as the degree to which a person believes that using a particular system would be free of effort. In an early two-wave study by Davis, Bagozzi, and Warshaw

(1989), MBA students who had an hour's introduction to a word processing program, were asked to fill out a questionnaire once after the introduction and again after 14 weeks. The study found usefulness to be more influential than ease of use in driving usage behavior, consistent with the earlier study by Davis (1989).

In an effort to study the impact of a specific technology (desktop video conferencing), Alavi, Wheeler and Valacich (1995) carried out a longitudinal field study to examine its efficacy in support of collaborative tele-learning (i.e., collaborative learning among non-proximate team members). The results showed that the three environments were equally effective in terms of student knowledge acquisition and learning outcome satisfaction. However, higher critical thinking skills were found in distant desktop video conferencing environments.

Findings of a study by Webster and Hackley (1997) supported the hypothesis that the quality and reliability of technology were positively linked to learning outcomes. Moreover, perceived richness of the medium was found to be higher for face-to-face learning than technology-mediated courses. Increased frequency of female participation in class discussion in the Internet-based class section was noted. Focusing on the size of the class, Arbaugh and Duray (2001) argued that increased class size would be negatively associated with learning and satisfaction in web-based MBA courses. Results of their study showed that perceived flexibility, class section size and prior courses taught were significantly associated with perceived learning. Variables related to the school, perceived usefulness and student course website usage were also significantly associated with perceived learning. Class size was most strongly associated with course satisfaction, followed by perceived flexibility, perceived usefulness, prior courses taught and the school-related variables.

In an effort to demonstrate the impact of handheld devices on student learning, Mandryk, Inkpen, Bilezikjian, Klemmer and Landay (2001) demonstrated that the combined use of multiple interconnected devices to form a larger, shared workspace was an effective collaboration technique. The approach of semantically partitioning information across handheld displays thus, took advantage of the rich face-to-face interactions and was found to help children synthesize information, creating a dynamic and engaging learning environment.

In a different context, Arbaugh and Duray (2002) compared differing delivery platforms of multiple business schools. The study involved a multi-site, multi-course web-based MBA program. As part of their study, two schools with online MBA courses were surveyed. Results showed that student use of the course site was moderately associated with perceived learning and course satisfaction. The findings of this study suggested that larger class sizes may be negatively associated with perceived learning and course satisfaction in online MBA courses. In addition, perceived flexibility of these courses and degree programs were significantly associated with perceived learning and satisfaction in the online format and lastly more experienced online students tended to be more satisfied with their web-based delivery medium.

Examining the role of course content, Arbaugh (2005a) used the structure-conduct-performance (SCP) paradigm to discuss course effects, which denotes the subject matter structure, course conduct and participant performance. The results of the study showed that while the subject matter was relevant, course conduct, technological, behavioral, and institutional factors also influenced online course effectiveness. Student use of the course site was a positive predictor of all three dependent variables (higher grades, higher student perceived learning and greater student satisfaction) while prior instructor experience with online courses was a positive predictor of perceived learning and perceived delivery medium satisfaction.

Subsequently, Roca, Chiu and Martinez (2006) examined the factors associated with the intention behind e-learning use. Results of their study found that confirmation of expectations with respect to using e-learning was a strong determinant of perceived usefulness, satisfaction, perceived ease of use and cognitive absorption. Perceived quality of information, service quality and system quality were found to have a strong impact on confirmation and satisfaction. Information quality was found to be the strongest predictor of confirmation as compared to service quality and system quality on satisfaction.

In their study on course design, Tung and Deng (2007) used dynamic and static emoticons as social cues in e-learning environments for computers to be able to convey social presence and increase children's motivation to learn.The program had two features for treatments: dynamic emoticons and static emoticons. The results showed that children in the dynamic emoticon condition perceived a higher degree of social presence and reported greater motivation than those in the static-emoticon condition. The feeling of social presence created by the computer can therefore mediate children's motivation.

Given the long history of the TAM, Schepers and Wetzels (2007) carried out a quantitative meta-analysis of previous research on the TAM to understand the role of subjective norms. The results of their research indicated a significant influence of subjective norm on perceived usefulness and behavioral intention to use. The study concluded that there was evidence for a stronger dependence of an individual on utility than on lower complexity while adopting new technologies.

The Organizational Perspective

In this section research on the application of TML specifically in education and organizations in general, is reviewed. First an overview of TML in India at the school level is

presented, followed by the initiatives in TML in India, and finally the use of TML in organizations is discussed.

TML in India: School Policy

In an early effort, the National Institute of Open Schooling (NIOS) was set up in 1979 by the Central Board of Secondary Education (CBSE). The NIOS provides learning opportunities through open and distance learning through its Open Basic Education (OBE) program, Secondary Education Course, Senior Secondary Education Course, Vocational Education Courses/Programs and Life Enrichment Programs. The NIOS operates through a network of 5 departments, 11 regional centers and 3367 accredited institutions (study centers) in India and abroad. It has about 1.5 million students currently enrolled at the Secondary and Senior Secondary levels making it the largest open schooling system in the world[1].

In addition, the power of technology has been leveraged successfully by the launch of India's satellite for educational delivery, EDUSAT in 2004, which is aimed at expanding the reach of distance education in India. Indian education is also emerging as a promising destination for other applications of educational technology, specifically in the areas of computer-based learning, teaching, online tutoring, testing and evaluation as a complement to traditional face-to-face teaching methods in order to enrich the learning experience of students across India.

The Indian education system is one of the largest in the world with the number of student enrolments increasing significantly at all levels: the upper secondary and tertiary levels have registered increases of 46% and 51% respectively (UNESCO Report, 2005). An increasing number of children have enrolled at all levels of schooling, particularly at the secondary education level (9th standard to 12th standard for ages 15-18 years) where the gross enrolment

[1] http://www.nios.ac.in, accessed on July 19th, 2013.

ratio stood at 36% in 2002 (Wu, Kaul, & Sankar, 2005). However, education in India faces several challenges, mainly the lack of qualified teachers, contributing to a low teacher-student ratio in India, which stands at 1:42[2], compared to 1:15 for developed countries (UNICEF Annual Report, 2007).Policy makers in education have developed several avenues to bridge the student-teacher gap in Indian higher education, particularly by implementing countrywide programs such as the Sarva Shiksha Abhiyan (SSA). As part of the SSA, computer-aided learning was introduced in over 20,000 schools to improve learning outcomes for students.

Government Initiatives in TML in India

The Ministry of Human Resource Development, Government of India launched the ICT at School Program in December 2004, to provide opportunities to secondary stage students to develop ICT skills and also for ICT aided learning. This scheme aims to bridge the digital divide amongst students of various socio-economic and geographical backgrounds. As part of the program, SMART schools are to be set up in Kendriya Vidyalayas and Navodaya Vidyalayas to act as 'Technology Demonstrators' and to teach ICT skills among students of other schools[3].

At the state level, technology-enabled learning has been successfully implemented in several states in India. According to Bhattacharya and Sharma (2007), in Kerala, which has the highest literacy rate in India, one constituency, Vadakkekara is poised to be the first fully integrated e-learning constituency in the state. All schools, including lower primary, upper primary, high school and higher secondary schools in the Government and aided sectors, in the constituency would be brought under the project which is being implemented with the

[2] http://.unicef.org//education_1551.htm, accessed on July 19th 2013.
[3]http://.nic.in//_school.asp accessed on May 25th 2010.

cooperation of the IT@school project and Keltron. A 50-CD library is proposed to be set up in all upper primary and lower primary schools as part of this project.

According to a study by Pal, Lakshmanan, and Toyama (2007) computer-aided projects are active in over 20,000 public primary schools in India. These projects include a computer center with three to five machines set up per primary school of about 200-400 students with an approximate 1:50 machine-to-child ratio. The authors concluded from their study that computers were viewed as shared resources and as a public good which should be located in schools rather than at homes.

Based on an ethnographic study on the use of computers in public schools in India, Arora (2007) suggested that merely providing access to ICT in schools was not sufficient, it was more important to use technology to create learning spaces in the classroom. The author called for access to culturally appropriate educational software to maintain the regional language and culture within schools. Strong partnerships between non-profits, the private sector and the government were suggested by Arora (2007) to create meaningful and engaging ICT-enabled content for children.

In a randomized experimental study on the effectiveness of computer-assisted learning program in schools in India, Banerjee, Cole, Duflo and Linden (2007) found increased math scores by 0.36 standard deviations in the first year of the program and by 0.54 standard deviations in the second year thus, revealing the positive effects of the use of computers in schools in India. In their study on the role of mass media in providing education in India, Arulchelvan and Viswanathan (2008) discussed how radio and TV broadcasts have been used as a medium of education in India. The authors illustrated the use of ICT in education in India with successful projects such as the Radio Farm Forum Project (started in 1956), Delhi School TV

Project (started in 1961), Satellite Instructional Television Experiment (started in 1975-76), University Grants Commission (UGC) Countrywide Classroom (started in 1984), Education and Research Network (started in 1986), Lutsaan Radio Project (started in 1990), Training and Development Channel (started in 1995), Gyan Darshan (started in 2000), Gyan Vani (started in 2001), and the use of Educational Web Portals.

Some of the key challenges to technology-enabled learning in India are the language of communication, access to affordable and faster broadband connectivity, interactive e-learning content, compliance with curriculum requirements of higher education, cost of access and usage of content, students' acceptance of the self-paced learning mode, parents' acceptability of e-contents for their wards at a cost, and piracy[4]. From a policy perspective, some of the main challenges to the use of ICT in schools in India are with respect to access to technology, participation and equity of education and quality of education (Veeramacheneni, Vogel, & Ekanayake, 2008). Given the low technology penetration in India, estimated to be less than 10% (Jayanti & Jose, 2008)[5] a fully online e-learning model is not feasible. Thus a blended or hybrid model would be better suited for Indian education.

In their study on educational gaming, Kam, Agarwal, Kumar, Lal, Mathur, Tewari and Canny (2008) proposed the receptive-practice-activation approach as a foundation for designing educational games for children. Their study concluded that the learning goals in their e-learning games were clearer to learners when they maintained a distinction between fun and education in game designs. The Ministry of Human Resource Development (MHRD), Government of India (2009) developed a National Policy on ICT in school education wherein ICT was defined as all

[4]http://.thehindu.com/sci-tech/technology/article34183.ece, accessed on July 19th 2013.

[5] http://www.financialexpress.com/news/Investing-in-elearning-proves-to-be-lucrative/314400/0, accessed on July 19th 2013.

digital devices, tools, content and resources, which can be deployed for realizing the goals of teaching-learning as well as management of the educational system. The objective of the policy was a three-stage implementation of ICT at the school level, namely a) ICT literacy and competency enhancement, b) ICT enabled teaching-learning, and c) introduction of ICT related elective subjects at senior secondary level.

In a related study, Light (2009) used a case study approach to examine the impact of an ICT tool called the Intel Teach Essentials Course in six schools in India, Chile and Turkey. The impact of the course for teachers was with respect to a change in their knowledge, beliefs and attitudes, teachers' greater understanding of student-centered practices and an improvement in teachers' ICT knowledge and skills. With respect to students, the ICT course influenced the students' engagement with the course content, and resulted in collaborative relationships among teachers, students and parents. Shifts in pedagogical paradigms were suggested not only with respect to the teachers, but also at the educational system level.

As part of the 11th Five Year Plan about 128,000 schools are proposed to have Internet connectivity. Also as part of the plan, nearly USD 1.02 billion has been sanctioned to provide Information and Communication Technology (ICT) infrastructure to schools consisting of a networked computer lab with at least ten computers, a server, a printer connected on Local Area Network and broadband Internet connectivity of 2Mbps. Technology classrooms with audio visual equipment, CD-based content and computer training for teachers have also been proposed as part of this Plan, which indicates the emphasis placed on ICT in education in India[6].

The 11th Plan envisages the setting up of ICT infrastructure at 128,000 government and government-aided secondary and senior secondary schools. Of these, about 80,000 schools are

[6]http://planningcommission.gov.in/plans/planrel/fiveyr/welcome.html, accessed on July 19th 2013.

proposed to be connected on the Internet through terrestrial/wireless broadband mode and 28,000 schools will be provided Internet connectivity through Very Small Aperture Terminals (VSATs). Every school is proposed to have a technology classroom with audio-visual equipment so as to enhance learning. A dedicated program for content creation as per the curriculum is also proposed.

TML in Organizations

This stream of research focuses on the use of TML in corporate training, the characteristics of the training programs using TML and its related outcomes. Different types of organizations, such as healthcare (Pratt, Pellowe, Shelley, Adams, Loveday, King & Jones, 2005) and their experiences with the use of TML have been covered in this stream of research. In one study, Harun (2002) described the use of e-learning in a healthcare organization using a tele-health initiative. This initiative focused on providing just-in-time continuing medical education (CME), formal distance education (online electronic courses with award of certificates by accredited academic institutions or agencies), modular distance learning (packaged learning modules to maintain competencies and excel at relevant knowledge and skills) and personalized continuing medical education focusing on knowledge, information and skill sets for healthcare professionals tailored to their areas of expertise, interest and need.

From a manager's perspective, Pratt (2002) suggested creating a blended learning environment for staff by understanding what the staff want to learn, taking an inventory of current training practices, learning about potential learning tools and providing staff with some learning options. Teaching them how to use new learning tools, giving them an incentive for learning, making learning easy, convenient and making learning a fun experience are some strategies for blended learning suggested for managers by Pratt (2002).

Offering a consultant's viewpoint, Driscoll (2003) described the use of blended learning in an organization, where blended learning refers to the following four different concepts: a) to combine or mix modes of web-based technology (for example, live virtual classroom, self-paced instruction, collaborative learning, streaming video, audio and text) to accomplish an educational goal, b) to combine various pedagogical approaches (for example, constructivism, behaviorism, cognitivism) to produce an optimal learning outcome with or without instructional technology, c) to combine any form of instructional technology (for example, videotape, CD-ROM, web-based training, film) with face-to-face instructor-led training and, d) to mix or combine instructional technology with actual job tasks in order to create a harmonious effect of learning and work.

In their review of e-learning in organizations, Derouin, Fritzsche, and Salas *et al.* (2005) suggested that e-learning as an instructional strategy was likely to be adopted by more organizations in the future. The viability, effectiveness and potential to return tangible benefits to organizations would depend to a great extent on how it is designed, delivered and evaluated in organizations.

In highlighting the usefulness of blended delivery for competency-based training in organizations, Holton Coco, Lowe and Dutsch (2006) suggested that the optimum blended learning strategy is dependent on the characteristics of the adult learners as specified by this theory. Self-directedness and computer (or technology) self-efficacy were found to be important when using technology-based learning, such that adults with lower levels of self-directedness and technology self-efficacy would require more external support and program control of instruction.

In their study on corporate e-learning in Indian organizations, Mital and Luthra (2006) investigated the effectiveness of corporate e-learning among employees of public and private

banks in India. Results of this research found no age correlation between attitudes towards e-learning or towards its adoption and effectiveness. The authors suggested that identifying actual e-learning needs of employees rather than an organizationally driven approach would improve attitudes towards e-learning, its adoption and effectiveness for employees.

In a related study, Bellinger (2007) suggested the following best practice recommendations for e-learning use in businesses: a) manage change as e-learning shifts from being a departmental concern to an enterprise-wide activity, b) understand that e-learning will change dramatically but will be the norm within five years, c) be knowledgeable about the 'software-as-service model', d) flexibility and agility, e) risk management and, f) embrace change.

The Personal Perspective

Research on Student-related Factors related to TML

This section reviews the research related to student characteristics, their experience and outcomes with respect to TML. In an early study, Webster and Hackley (1997) found that higher number of student locations was negatively associated with learning outcomes in technology-based courses. The link between comfort of students with images on the screen and learning outcomes, as well as the attitudes of classmates and student learning outcomes was supported in this study.

Subsequently, Arbaugh (1999) tested technological predictors of student satisfaction in Internet-based MBA courses. Perceived advantage, quality and student use of course site as well as daily web usage at work and home accounted for 84% of the variance in perceived satisfaction with the courses. In the study on student engagement, Arbaugh (2000a) demonstrated the role of student engagement in online courses, where it was proposed that students with past experience

of Internet- based courses and their use were likely to be more satisfied with an online learning experience. In this study, the interaction-related variables were significantly associated with learning, namely, the instructor's emphasis on interaction, ease of interaction and classroom dynamics. The results suggested that instructors play a significant role in enhancing learning in Internet-based courses through their efforts to generate and facilitate interaction.

In a study focusing on differences among MBA courses, Arbaugh and Rau (2004) hypothesized that perceived learning and delivery medium satisfaction of students with online MBA courses differed by course discipline (specialization). The study found behavioral effects to be most significantly related to perceived learning, while course specialization-related and course structural effects were more significantly associated with satisfaction with the Internet as an educational delivery medium.

In distinguishing between knowledge actively constructed by the student versus that received from the instructor, Benbunan-Fich and Arbaugh (2006) hypothesized that students engaged in knowledge construction through web-based courses would achieve better learning outcomes than students in web-based courses where knowledge is directly transferred from the instructor. The results of their experimental study demonstrated that students in knowledge construction courses reported lower learning perception than students in knowledge transfer courses. Ong and Lai (2006) studied gender differences in perceptions of computer self-efficacy, perceived usefulness, perceived ease of use, and behavioral intention to use. The authors also studied how women and men differ in their decision-making processes regarding acceptance and usage of e-learning. Results showed that men's ratings of perceptions with respect to computer self-efficacy, perceived usefulness, perceived ease of use and behavioral intention to use e-learning were all higher than women's ratings. In another study, Berenson, Boyles and Weaver

(2008) studied the impact of Emotional Intelligence (EI) and personality to determine the extent to which these factors predicted grade point average in online courses. The findings indicated that EI was the primary predictor of academic success in online courses, and was strongly associated with higher grades among online students.

Research on Student-related Outcomes

Previous research has focused on a variety of student-related outcomes, such as knowledge construction, cooperation and problem solving (Alavi, 1994). In examining outcomes of learning for the student, the Malcolm Baldrige National Quality Award (2008) emphasized that schools need to measure student outcomes such as enrolment, preferences, loyalty, positive referrals, test results, complaints, perceived value of the course, level of knowledge, level of activity and mastery over key functions, persistence, graduation and course completion. In their review of learning outcomes, Soh and Subramanian (2008) observed that perceptual evaluations of learning (for example, the experience of the medium) outcomes were more frequently employed than objective results of performance (for example, exam scores) in previous research.

Role of Teachers in TML

This stream of research covers the role of teachers in using TML in education. In one study, Arbaugh and Duray (2001) suggested that higher levels of prior instructor experience were significantly associated with student learning and course satisfaction. Second, the study emphasized the importance of experience, which suggested that business schools needed to do more to accelerate the experience curve for online instructors. In another study, Arbaugh and Hwang (2006) explored the nature of teaching presence in online MBA courses, hypothesizing that course design and organization, facilitating discourse, and direct instruction are empirically distinct dimensions of teaching presence. Results showed that these three components were

indeed separate but highly correlated with each other implying that online learning is a demanding environment where the instructor has to fulfill all three roles of teaching presence well, while facilitating discourse and finally meet students' knowledge needs through direct instruction.

Proserpio and Gioia (2007) recommended that in response to changing learning styles of the virtual generation, teachers should evolve beyond sage on the stage model, and the facilitator figure to become a guide for teaching ways to search for and recombine information and knowledge. From a teacher's perspective, Deghaidy and Nouby (2008) suggested a blended e-learning approach required new pedagogic skills so that the learner gains the most from the course. The findings of the study suggested that pre-service teachers in the experimental group had higher achievement levels in their post overall course test, comprehensive scores and attitudes towards e-learning environments compared to those of the control group. Table 1 presents an overview of the review of research presented above.

Table 1

Review of Research on Technology-Mediated Learning based on the Multiple Perspectives Framework

TOP Dimension	Related TML Research	Key References
The Technical Perspective	Access, and adoption of technology	Becker (2000), Farrell (2003), Chaudhuri, Flamm & Horrigan (2005), Powell (2007), Ozdemir & Abrevaya (2007), Ozdemir, Altinkemer & Barron (2008)
	Diffusion of technology	Rogers (1995), Davied, Fisher, Arnold & Johnsen (1999), Leigh &Atkinson (2001), Schement (2001), Christensen, Johnson & Horn (2008)

Table 1 (contd.)

TOP Dimension	Related TML Research	Key References
The Technical Perspective	Information Systems Research	Davis (1989), Davis, Bagozzi & Warshaw (1989), Alavi, Wheeler & Valacich (1995), Arbaugh & Duray (2001), Mandryk, Inkpen, Bilezikjian, Klemmer & Landay (2001), Arbaugh & Duray (2002), Arbaugh (2005a), Roca, Chiu & Martinez (2006), Tung & Deng (2007), Schepers &Wetzels (2007)
The Organizational Perspective	TML in India	NIOS, EDUSAT, UNESCO Report (2005), Wu, Kaul & Sankar (2005), UNICEF Annual Report (2007)
	Government Initiatives in TML in India	Bhattacharya & Sharma (2007), Pal, Lakshmanan & Toyama (2007), Arora (2007), Banerjee, Cole, Duflo & Linden (2007), Arulchelvan & Viswanathan (2008), Veeramacheneni, Vogel & Ekanayake (2008), Jayanti & Jose (2008), Kam, Agarwal, Kumar, Lal, Mathur, Tewari & Canny (2008)
	TML in Organizations	Harun (2002), Pratt (2002), Driscoll (2003), Derouin, Fritzsche & Salas et al (2005), Holton Coco, Lowe & Dutsch (2006), Mital & Luthra (2006), Bellinger (2007)
The Personal Perspective	Research on Student-related factors	Webster & Hackley (1997), Arbaugh (1999), Arbaugh (2000a), Arbaugh & Rau (2004), Benbunan-Fich & Arbaugh (2006), Ong & Lai (2006), Berenson, Boyles & Weaver (2008)
	Research on Student-related Outcomes	Alavi (1994), Malcolm Baldrige National Quality Award (2008), Soh & Subramanian (2008)
	Role of Teachers in TML	Arbaugh & Duray (2001), Arbaugh & Hwang (2006), Proserpio & Gioia (2007), Deghaidy & Nouby (2008)

Observations from the Literature

Previous research has examined student outcomes using both objective measures (such as grades, marks, etc.) as well as subjective measures (such as surveys and interviews) spanning a broad range of behavioral factors such as learning, conceptual mastery, enhancement in knowledge and so on. While these measures have been well established in the literature, there is a need to leverage other data sources in education to derive better insights into enhancing outcomes for education. This is beginning to gain some attention in the industry with the emerging trend of Big Data in education[7].

Research on learning enablers has focused primarily on the teacher as a key learning enabler for students using TML. Thus the focus has been largely on learning in the classroom context. Other learning enablers, namely, parents and peers and their use of TML have been examined to a relatively lesser extent. With more recent models of learning such as the 'flip the classroom' model[8], there is a need to explore more novel teaching and learning strategies using technology over and above traditional classroom learning and teaching using TML.

Policy research on the use of ICTs in education has used objective measures of performance of programs in ICT-enabled education, and focused on the macro-level issues of technology use, particularly with a focus at the school level, with inputs from school administrators, policy makers and other stakeholders in education. Key issues of investigation in policy research include a study of factors exploring access, adoption and diffusion of ICTs in education, as well as the nature and extent of the digital divide in education, among others.

[7] http://www.qas.com/data-quality-news/education_cios_can_glean_insights_from_working_with_more_data_9612.htm, accessed on July 19th 2013.
[8] http://en.wikipedia.org/wiki/Flip_teaching#cite_note-11

Discussion

This paper offers a framework to organize the literature in technology-mediated learning, based on its technical, organizational and personal dimensions. We review research in TML relevant to each of these dimensions. The Technical perspective (T) covers research on access, adoption and diffusion of technology in education and studies on TML from the information systems domain. The Organizational perspective (O) of TML presents an overview of TML in India from a school policy perspective, initiatives from the government to improve access to TML in India, and the application of TML in organizations. The Personal perspective (P) provides an overview of research related to student characteristics, their experience and outcomes with respect to the use of TML in the classroom. The role of teachers as key enablers of learning using TML is also covered in the Personal Perspective. Based on the review in each of the TOP dimensions, we offer insights for further research for the use of ICTs in education.

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