Volume 12, No. 4
July 2014
ISSN: 1545-679X

INFORMATION SYSTEMS EDUCATION JOURNAL

In this issue:

The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **EDSIG**, the Education Special Interest Group of AITP, the Association of Information Technology Professionals (Chicago, Illinois). Publishing frequency is six times per year. The first year of publication is 2003.

ISEDJ is published online (http://isedjorg) in connection with ISECON, the Information Systems Education Conference, which is also double-blind peer reviewed. Our sister publication, the Proceedings of ISECON (http://isecon.org) features all papers, panels, workshops, and presentations from the conference.

The journal acceptance review process involves a minimum of three double-blind peer reviews, where both the reviewer is not aware of the identities of the authors and the authors are not aware of the identities of the reviewers. The initial reviews happen before the conference. At that point papers are divided into award papers (top 15%), other journal papers (top 30%), unsettled papers, and non-journal papers. The unsettled papers are subjected to a second round of blind peer review to establish whether they will be accepted to the journal or not. Those papers that are deemed of sufficient quality are accepted for publication in the ISEDJ journal. Currently the target acceptance rate for the journal is about 45%.

Information Systems Education Journal is pleased to be listed in the 1st Edition of Cabell's Directory of Publishing Opportunities in Educational Technology and Library Science, in both the electronic and printed editions. Questions should be addressed to the editor at editor@isedj.org or the publisher at publisher@isedj.org.

INFORMATION SYSTEMS EDUCATION JOURNAL

Tool Choice for E-Learning: Task-Technology Fit through Media Synchronicity

Jun Sun
jsun@utpa.edu

Ying Wang
ywangz@utpa.edu

Department of Computer Information Systems & Quantitative Methods
University of Texas-Pan American
Edinburg, TX 78539, U.S.A.

Abstract

One major challenge in online education is how to select appropriate e-learning tools for different learning tasks. Based on the premise of Task-Technology Fit Theory, this study suggests that the effectiveness of student learning in online courses depends on the alignment between two. Furthermore, it conceptualizes the formation of such a fit through the lens of Media Synchronicity Theory: each type of learning task in the online environment requires a certain level of media synchronicity, and various e-learning tools enable different levels of media synchronicity. Their alignment forms along two dimensions of media synchronicity: the purpose dimension ranging from conveyance to convergence and the process dimension ranging from asynchronous to synchronous. The conceptualization leads to research hypotheses that posit the aligned relationships between learning tasks and e-learning tools in terms of purpose and process. The hypotheses were tested with the observations collected from an experiment, and the conjoint analysis results support that students do perceive and prefer the fit between learning tasks and e-learning tools along the two dimensions. The findings yield helpful insights on the best practices concerning the utilization of information technology for the enhancement of student learning outcomes in online course design.

Keywords: Online Course Design; E-learning Tool; Learning Task; Media Synchronicity; Conjoint Analysis.

1. INTRODUCTION

Today, computer-mediated communication technologies transform teaching and learning with their capacities to extend interactions over time and distance with the support of multiple media, such as text, graphic and voice (Garrison 2011). E-learning, a relatively new form of learning has been adopted by institutions at various levels, especially in higher education. In 2006, there were 3.5 million college students participating in on-line learning, and since then there has been a steady increase of more than 10 percent in on-line course enrollments per year in the United States, compared with an average of approximately two percent annual increase in overall enrollments (Allen & Seaman, 2007; Allen & Seaman, 2009; Allen & Seaman, 2003). Allen & Seaman (2009) found that that almost a quarter of all students in post-secondary education were taking purely online courses in 2008, and many more took some of their courses online. Therefore, e-learning is becoming a predominant form of education in the colleges and universities around the country.

Rogers (2000) described three levels of information technology adoption in learning. The first level is "personal productivity aids" based on the use of applications (e.g. word processing, spreadsheet) to perform the tasks more efficiently. This is the basic level of technology that has been adopted by most higher education institutions. The second level is "enrichment add-ins". At this level, CMC technologies such as email, video, websites and other multimedia tools, are added in to the traditional learning. However, course instructions remain the same with traditional lectures. At the third level, there is a "paradigm shift" (Massy & Zemsky, 1995) that requires instructors to redesign learning content and reconfigure teaching and learning tasks in order to take full advantage of new technology. Today, most higher education institutions have already reached the first and second level, and are striving for the third that leads to a fundamental change in the instructional paradigm (Rogers, 2000).

Unlike traditional pedagogy, educators need to rethink of instructional approaches to realize the potential of e-learning as an effective teaching method (Garrison, 2011; Rogers, 2000). Moreover, college students are different from children and teenagers: they are generally more self-motivated and capable of learning by themselves (Knowles, Holton, & Swanson, 2011). Thus, the education paradigm should shift from traditional lecturing to active learning in order to give students more control of how they learn (Smith, 2002). Instructors should rather facilitate student participation in learning tasks than just lecturing.

In today's higher education, most of the courses are still "teacher-centered": instructors give lectures, assign homework exercises and give tests. Learning in such traditional classroom settings largely relies on how instructors effectively communicate their knowledge to the student by improving the clarity of messages (Jonassen & Land, 2000). However, using the same instructional design in e-learning environment, such as reading and memorizing information online and then taking on-screen exams, will cause three significant problems (Privateer, 1999): 1) many contemporary ways of learning that are far more valuable and effective than traditional ways of learning are excluded; 2) important student needs that are related to their abilities to cope with the tasks in their future careers are mostly disregarded; and 3) colleges and universities fail to make necessary changes to adapt to the changes in the environment and narrow the gap between academia and industry.

Therefore, successful use of technology in online courses requires a shift from "teaching" to "learning", that is: instructional approach should switch from "teacher-centered" learning to "learner-centered" learning (Rogers, 2000). The students of new generation are learning in different ways from their predecessors, and in particular, college students who take online courses desire more active learning based on the learner-centered approach than those who take in-classroom courses (Anson, 1999; McCormick, 1999; Rogers, 2000). This study tries to address the issue of how to promote the effectiveness of online education with appropriate use of information technology.

2. LITERATURE REVIEW

A report from the Columbia University found that students who participated in online courses had lower success rates than those in face-to-face courses: on average, online course completion rates were eight percent lower than traditional course completion rates (Xu & Jaggars, 2011). The top reason for dropping online courses is the lack of time due to personal issues such as family, health, jobs and child care (Xu & Jaggars, 2011). However, Mason (2006) found that students often use the lack of time as a convenient excuse for not engaging in learning. On the other hand, the root of the problem may be in the fact that many online courses lack the means to motivate students and allow them to learn effectively.

The goal of the higher education is to prepare students for their future career in the real world. Rather than traditional lecturing, learner-centered courses engage students in hand-on experiences, problem solving, collaborating with classmates and instructors, and even contributing course content (Bale & Dudney, 2000; Cooper & Henschke, 2005). The advances in information technology great facilitate such active learning. Students can easily establish online learning communities to share experience and knowledge with each other for team problem solving, collaborative essay writing, discussions, group projects, and so on (Bonk, Wisher & Lee, 1998). Through the participation in these learning tasks, students can develop their own skills to handle real-world problems that often require compromising and improvising to accommodate tradeoffs and limitations (Simonson et al., 2000).

Since 1990s, the American Psychological Association (APA) has advocated the learner-centered approach that emphasizes the reflective and collaborative aspects of learning and the active role that students can play in such efforts. APA announced a set of 14 Learner-Centered Psychological Principles that address four dimensions of factors: cognitive and metacognitive factors, motivational and affective factors, developmental and social factors, and individual difference (APA, 1997). The learner-centered approach in online environment needs to encourage students to actively participate in learning tasks, promote in-depth discussions, develop deep and comprehensive understanding of teaching materials, and connect learning to work experiences and requirements (Davies & Graff, 2005; Karayan & Crowe, 1997; Smith & Hardaker, 2000).

The ultimate success of online courses, therefore, largely relies on the establishment of learner-centered and collaborative learning environment. The emergence of electronic learning (e-learning) tools, such as Discussion Board, Wiki, and Blog, provide much needed technical support for this active learning approach (Dron, 2003; Glogoff, 2005; Parker & Chao, 2007; Tosh & Werdmuller, 2004; Weller, Pegler & Mason, 2005). For example, Discussion Board provides students a platform to exchange ideas with and give feedbacks to each other on a certain topic. An instructor plays the role of moderator by outlining the theme and guiding the discussion.

Because e-learning tools have great potential to support active learning, there is a need for the discussion of best practices concerning their use in online course development. Prior research has established some understanding of the roles that various e-learning tools play in online education. For instance, Hrastinski (2008) found that asynchronous e-learning tools are more appropriate for achieving content-related objectives that often require students to spend time digesting course materials, whereas synchronous e-learning tools are better suited for team-based learning such as group task planning and execution in which real-time responses help students focus on their endeavor.

However, few researchers have examined student preferences toward different e-learning tools for different learning tasks. The main obstacle is the lack of appropriate theoretical frameworks for such empirical studies. The lack of theories and observations lead to the absence of guideline that educators can follow to incorporate e-learning tools in the development of online courses. At the current stage, many instructors may select the e-learning tools that they are familiar with. If students do not like to use a given tool for a certain task, they may get frustrated and complain to each other. This distracts their attentions and compromises the effectiveness of online learning.

3. RESEARCH MODEL AND HYPOTHESES

The primary objective of this study is to develop and test a research model to answer the question of how to select appropriate e-learning tools for different learning tasks. An appropriate theoretical foundation is the Task-Technology Fit model that suggests the alignment between task characteristics and technology characteristics leads to enhancement of task performance and technology utilization (Goodhue & Thompson, 1995). However, the model does not elaborate on how the alignment is established; rather, it assesses the perceived fit with users' subjective responses in empirical studies.

In the context of the alignment between e-learning tools and learning tasks, the conceptualization of fit needs to be based on the understanding of the roles that e-learning tools play in student learning tasks. The emerging e-learning tools promote the participation of students in active learning by allowing them to interact with instructors and collaborate with each other. In this sense, the e-learning tools are that electronic media that facilitate and support such computer-mediated communications. Thus, the characteristics of e-learning tools can be examined with an established theory on electronic media.

One theory that focuses on the characteristics of electronic media is the Media Synchronicity Theory (Dennis, Fuller & Valacich, 2008; Dennis & Kinney, 1998). It characterizes electronic media with the concept of media synchronicity according to their transmission capabilities and processing capabilities (Dennis et al., 2008). Similarly, computer-mediated communications are usually classified into two types: synchronous versus asynchronous (Turoff, 1989). Distributing at different levels of synchronicity, therefore, the characteristics of e-learning tools as electronic media and the characteristics of learning tasks as computer-mediated communications are comparable.

In addition to the process that can be either synchronous or asynchronous, researchers suggest that computer-mediated communications vary in their purposes (Thurlow, Lengel & Tomic, 2004). There are generally two communication purposes for which electronic media are used for: conveyance that refers to "the discussion of preprocessed information about each individual's interpretation of a situation, not the raw information itself" and convergence that refers to "the transmission of a diversity of new information— as much new, relevant information as needed—to enable the receiver to create and revise a mental model of the situation" (Dennis et al., 2008; Dennis & Kinney, 1998). Media of relatively low level of synchronicity generally support communications for conveyance purposes, but media of relatively high level of synchronicity generally support communications for convergence purposes (Dennis et al., 2008).

The degrees of alignment between e-learning tools and learning tasks vary along these dimensions. When a tool and a task match with each other along both dimensions, there is a task-technology fit. On the other hand, if they mismatch with each other along either dimension, there is a lack of fit. An alignment between a tool and a task leads to the enhancement of technology usage and learning outcome, but a misalignment discourages students from participation and weakens their performance.

Therefore, the characteristics of e-learning tools and the characteristics of learning tasks are comparable along the process and purpose dimensions. The research model shown in Figure 1 depicts that the fit between learning tasks and e-learning tools is established through media synchronicity. In specific, a learning task requires a certain level of synchronicity in terms of the process and purpose of computer-mediated communications, which leads to user preference of an e-learning tool that enables such a level of synchronicity. That is, students would like to use a tool for a task if they perceive a fit between two along both the process and purpose dimensions.

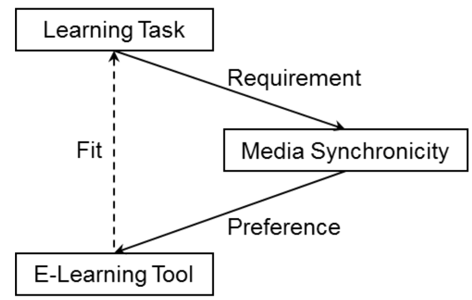

Figure 1. Research model

To validate the proposition that students do prefer the alignment between learning tasks and e-learning tools along the two dimensions of media synchronicity, it is necessary to develop relevant hypotheses that can be tested with empirical observations. In the research hypotheses, both process and purpose dimensions are treated as dichotomous variables that take two values: 0 indicates the relatively low level of synchronicity and 1 indicates the relatively high level of synchronicity. For the purpose variable, convergence implies a higher level of media synchronicity than conveyance, and thus the former is coded as 1 and latter is coded as 0. On the other hand, synchronous process suggests a higher level of media synchronicity than asynchronous process, and in the same way, the former is coded as 1 and latter is coded as 0.

In each hypothesis, the independent variables concern the characteristics of a certain type of learning tasks in terms of the purpose and process required in computer mediated communications, and the dependent variables concern the preferred characteristics of e-learning tools in terms of the purpose and process supported by the media. In other words, the characteristics of a learning task influence student preference toward e-learning tools along the two dimensions. A learning task is expected to have a positive (or a negative) effect on a variable if it requires a relatively high (or low) level of synchronicity along that dimension. For example, if a task requires asynchronous computer-mediated communication, its effect on the process variable of user preference toward e-learning tools is likely to be negative. The discussions lead to the following four hypotheses:

H1: A learning task of asynchronous process for conveyance purpose has negative effects on both the process and purpose variables of e-learning tool preference.

H2: A learning tasks of synchronous process for conveyance purpose has a positive effect on the process variable but a negative effect on the purpose variable of e-learning tool preference.

H3: A learning tasks of asynchronous process for convergence purpose has a negative effect on the process variable but a positive effect on the purpose variable of e-learning tool preference.

H4: A learning task of asynchronous process for convergence purpose has positive effects on both process and purpose variables of e-learning tool preference.

Based on the hypothesized relationships, Table 1 gives the likely task-technology fit between common e-learning tools and typical learning tasks. Blog stands for "Web Log" and it allows each student to *share* their thoughts, experiences and ideas with others through a personal space, and thus it is probably preferred for a learning task that requires the communications of asynchronous process for conveyance purpose. Discussion Board allows students to *explore* a certain topic by posting comments and responses without the necessity to reach an agreement. Thus, it is probably preferred for a learning task that requires the communications of synchronous process for conveyance purpose. Wiki stands for "what I know is" and it allows students to *compile* an essay on a certain topic in turn. Thus, it is probably preferred for a learning task that requires the communications of asynchronous process for convergence purpose. Web conference applications (e.g. Wimba®) allow multiple users to *coordinate* teamwork (e.g. presentation) on a real-time basis. Thus, it is probably preferred for a learning task that requires the communications of synchronous process for convergence purpose.

	Process	
Purpose	Asynchronous	Synchronous
Conveyance	Sharing: Blog	Exploring: Discussion Board
Convergence	Compiling: Wiki	Coordinating: Web Conference

Table 1. Task-Technology Fit Examples

To test the research hypotheses, observations need to be gathered from a laboratory experiment that simulates different learning tasks to students and asks for their preferences toward different e-learning tools. If e-learning tool preferences are consistent with what are expected from the requirement of task characteristics, there is supporting evidence of the research hypotheses. The next section discusses the methodology.

4. METHODOLOGY

Target Population

The purpose of this study is to find out how to choose different e-learning tools for different learning tasks for the design and development of online courses in higher education. The selection of target population needs to be based on who are the true stakeholders in the use of such tools. Unlike traditional teaching tools (e.g. PowerPoint), the emerging new e-learning tools aim to facilitate student participation and active learning. Students are the actual user of the e-learning tools, rather than instructors who are supposed to play the role of facilitators and moderators (Bonk & Kim, 2004; Maor, 2003).

In designing and developing an online course, therefore, an instructors need to select an e-learning tool that is the most appropriate for a learning task to enhance student learning experiences. The leaner-centered approach gives students the final say for e-learning tool choice: if an instructor selects an inappropriate e-learning tool for a learning task, students may complain and ask for the change. The target population of this study, therefore, comprises college students who are the potential users of e-learning tools.

Experiment Design

Testing the aforementioned research hypotheses requires an experiment in which participants are exposed to different learning task treatments. Because the tasks vary along two dimensions and each dimension has two levels, there will be altogether four treatments from a 2x2 factorial design. One factor is process that has asynchronous and synchronous levels, and the other factor is purpose that has conveyance and convergence levels. Table 2 gives the factorial design.

	Process	Purpose
Task 1 (H1)	Asynchronous	Conveyance
Task 2 (H2)	Synchronous	Conveyance
Task 3 (H3)	Asynchronous	Convergence
Task 4 (H4)	Synchronous	Convergence

Table 2. Factorial Design

At the beginning of the experiment, participants watched a demonstration of different e-learning tools, including a Blog article, a Wiki entry, a Discussion Board thread and a video of how to use Wimba. Then they indicated their preferences among the e-learning tools by ranking them for each of learning tasks. To find out user background information, they also answered a few questions regarding their gender, the access to computer and Internet, online course experience, Blackboard usage and computer anxiety. The total process took about 15-20 minutes.

Analyses

The main analytical technique applied is conjoint analysis. Conjoint analysis is a statistical technique often used in market research to find out people's preferences towards different features of a product or service (Green & Srinivasan, 1978). Though not many IT researchers have applied conjoint analysis in their studies, there have been some cross-disciplinary studies such as electronic commerce that employ the technique (e.g. Schaupp & Bélanger, 2005).

Compared with typical survey studies, conjoint analysis does not require the collection of perceptional and attitudinal responses from participants but rather their multi-attributed preferences towards different options in form of rankings or choices (Srinivasan, 1988). The technique is appropriate for this study as it is less subjective but more direct-to-the-point to examine user choice of e-learning tools for different learning tasks.

There are three steps of conducting conjoint analysis: 1) orthogonal design that generates different options based on the combinations of several attributes; 2) preference elicitation that collects the preferences of participants towards the options; and 3) data analysis that analyzes the user preferences in accordance to the orthogonal design (Green & Srinivasan, 1990). In this study, there are two attributes of e-learning tools, process and purpose, and each has two levels. Thus, e-learning tools can be categorized based on the combinations: Blog that facilitates asynchronous process for conveyance purpose; Discussion Board that facilitates synchronous process for conveyance purpose; Wiki that facilitates asynchronous process for convergence purpose; and Wimba that facilitates synchronous process for convergence purpose.

Most of the studies that conduct conjoint analysis are exploratory in nature in that they want to find out how important each attribute is to subjects. This study applies the technique in a confirmatory manner to test research hypotheses. In addition to different technological options, the participants of this study are exposed to different tasks. The characteristics of tasks and technologies vary along the same dimensions, and it is expected that user preferences of e-learning tools be consistent with the configuration of learning tasks. Thus, multiple rounds of conjoint analysis are to be conducted to test the hypothesized fits between e-learning tools and learning tasks.

The tool used for conjoint analysis in this study is SPSS. It provides the module for generating the orthogonal design file, spread sheet for compiling data file of user preferences, and conjoint syntax for analyzing data. The output comprises the estimate of each attribute and its standard error, relative importance scores of attributes, as well as the correlation between the predicted and actual user preferences.

Sample Size

According to Johnson and Orme (2003), the minimal sample size for choice-based conjoint analysis can be calculated with formula [1]. The ratings-based conjoint analysis that is this study conducts generally requires smaller sample size as it is a more efficient way to learn about preferences than choice-based conjoint analysis (Orme, 2006). Generally speaking, larger sample size enhances the reliability of standard error estimates.

$$n = 500*c/(t*a) \qquad [1]$$

Where:
n = the number of respondents;
c = the largest number of levels for any one attribute;
t = the number of tasks;
a = the number of alternatives per task.

In this study, there are two levels for each of the computer-mediated communication attributes, process and purpose. There are altogether four learning tasks, and for each there are four e-learning tools that subjects can choose. Thus, *c*, *t* and *a* are equal to 2, 4 and 4 respectively. Formula [2] gives the calculation of sample size.

$$n = 500*c/(t*a) = 500*2/(4*4) = 62.5 \qquad [2]$$

The actual sample size used in this study will be a little bit larger than what is required to accommodate possible non-responses. The number of participants in this study, therefore, is in the range between 65 and 75. On one hand, if the sample size is too small, the study may lack the sufficient statistical power to detect significant relationships; on the other hand, if the sample size is too large, the analysis may be so powerful that it picks up errors and nuisances that are not practically significant at all (Kerlinger, 1986).

5. RESULTS

The participants of this study were solicited on a voluntary basis from three undergraduate classes in a southwest university. There were altogether 72 participants, and two of them did not give the rankings of all options, but just checked the ones that they preferred. Thus, there are 70 usable responses, and the response rate is 97%. Among the participants, 59.72% are males and 40.28% are females.

Researchers found that gender difference may be salient in information systems user behavior related to e-learning (Ong et al., 2006). If gender difference is salient in this study, it means that it might be necessary to customize the e-learning tool choice for males and females separately. Table 3 gives user profiles for the overall sample as well as for each gender. Almost all students had the access to computers and Internet, and few had computer anxiety as the average score is close to 1, the smallest value of the range between 1 and 5. Over 70% of the students had taken online courses before and close to 90% had used Blackboard in online and hybrid courses. The average frequency of using Blackboard is about 6 times a week. Close to 90% of the students have part-time or full-time work experiences.

	Overall	Female	Male
Having PC	97%	100%	95%
Internet Access	94%	100%	91%
Used Blackboard	87%	86%	88%
Online courses	73%	68%	76%
Work experiences	89%	86%	91%
Blackboard/week	6.24	5.54	6.71
Computer Anxiety	1.31	1.30	1.32

Table 3: User Profiles and Gender Differences

Across genders, there were some differences in the profiles: females in the sample had slightly higher rate of computer and Internet access but slightly lower rate of blackboard usage and online course taking than males. The differences were relatively small, indicating that the gender differences are not likely to play a significant role in the use of e-learning tools.

Table 4 gives the parameter estimates of the conjoint analysis for each learning task. Task 1 yielded significantly negative influence on both Process and Purpose variables of e-learning tool preference. This provides full support for Hypothesis One (H1). Task 2's effect on Process was positive and marginally significant and its effect on Purpose was negative but not significant. The directions of effects were consistent with what are hypothesized but the strengths of effects were not as strong as expected. Thus, this result provides partial support for Hypothesis Two (H2). In contrast, Task 3's effect on Purpose was positive and marginally significant and its effect on Process was negative but not significant. Similar to the previous case, the result provides partial support for Hypothesis Three (H3). Finally, Task 4 had significantly positive impact on both Process and Purpose variables, which provides full support for Hypothesis Four (H4).

H	Process	Purpose	RI	*r*
1	$-1.04(.34)^{**}$	$-1.39(.34)^{**}$	.44/.56	$.98^{**}$
2	$1.27(.87)^{*}$	-.57(.87)	.63/.37	$.85^{*}$
3	-.36(1.03)	$1.36(1.03)^{*}$	.25/.75	$.81^{*}$
4	$1.36(.33)^{**}$	$1.17(.33)^{**}$	.53/.47	$.98^{**}$

Table 4: Parameter Estimates

Note: Standard errors given in parentheses beside slope estimates. RI: Relative Importance; *r*: correlation between observed and estimated preferences. *: p-value<0.1; **: p-value<0.01.

SPSS also gives the importance scores of the attributes. In this study, there are two variables and the score indicates the percentage of total variation explained by each variable. Thus, the importance scores reflect the actual task requirement on synchronicity along the two dimensions. For Task 1, users believed that the purpose that e-learning tools support was a little bit more important than the process they facilitate (approximately 5:4). Task 1 asked students to write down and share their ideas, thoughts and experiences with others. The communication process involved was very basic (i.e. writing), and the purpose of sharing was also quite simple. For Task 4, users regarded the process that e-learning tools facilitated a little bit more important than the purpose they supported (approximately 7:6). Task 4 asked students to work on a group project deliverable. The communication process involved real-time interactions and the purpose was to reach a consensus. Both tasks imposed equivalent levels of requirement on Process and Purpose, leading to similar importance scores.

For Task 2, users emphasized the communication process that e-learning tools facilitated then the purpose that they supported (approximately 5:3). Task 2 asked students to explore a research topic with others. It required intensive communication process in form of discussions but participants do not need to negotiate and compromise to reach agreements. For Task 3, on the other hand, users emphasized the purpose that e-learning tools supported much then the communication process that they facilitated (approximately 3:1). Task 3 asked students to develop a systematic study on a subject in a team. It required participants to work on individual basis but obtain a final product that was acceptable to all. Both tasks had unbalanced requirements on Process and Purpose, leading to different importance scores.

Finally, SPSS gave the correlation coefficients between predicted and actual preferences. The coefficient was highly significant for Tasks 1 and 4, but marginally significant for Tasks 2 and 3. For both Process and Purpose variables, Task 1 had low values and Task 4 had high values, resulting in clearly low and high requirements on media synchronicity. In comparison, the requirements of Tasks 2 and 3 were mixed as they had low value for one variable but high value for the other. This also explained why both variables were highly significant for Tasks 1 and 4, but only one variable was marginally significant and the other was insignificant for Tasks 2 and 3.

6. CONCLUSION AND IMPLICATIONS

This study examines an important issue in online course design and implementation: how to choose different e-learning tools for different learning tasks. With the emergence of numerous e-learning tools, instructors face the challenge of aligning technology and task in online course development, especially when they do not know which tools the students would like to use for a certain type of learning tasks. As an effort, this study develops a research model of task-technology fit through media synchronicity based on the premises of both Task-Technology Fit Theory and Media Synchronicity Theory. To test the research hypotheses derived from the model, this study conducted a conjoint analysis using student rankings of various e-learning tool options for different learning tasks, and the results provide fully supporting evidence for two hypotheses and partially supporting evidence for the other two.

This study yields some important theoretical and practical implications. Theoretically speaking, it integrates the Task-Technology Fit Theory and Media Synchrony Theory into the research model of task-technology fit through media synchronicity. Previous studies of task-technology fit typically assess the perceived fit between information technologies and tasks without addressing the intermediary of the alignment. This study posits that media synchronicity mediates the relationship between task and technology. That is, a learning task imposes certain requirement on the synchronicity level of the computer-mediated communication, which leads to user preference of an e-learning tool that facilitates the communication with needed media synchronicity capabilities. In addition, this study identifies the process and purpose dimensions of media synchronicity and uses both to categorize e-learning tools as well as learning tasks.

The inclusion of media synchronicity as the intermediary of task-technology fit allows the use of conjoint analysis to study fit. Prior research on task-technology fit focuses on user perception of fit. This perceptional fit is indirect and subjective. Rather, this study examines the fit based on student rankings of different e-learning tools for different learning tasks. Through multiple rounds of conjoint analyses, task-technology fit can be assessed in a more direct and objective manner. The methodology employed in this study, therefore, point out a new direction of studying task-technology fit.

For practitioners, the findings of this study provide a guideline for making good choice of e-learning tools for different learning tasks in the development of online courses. Different e-learning tools facilitate and support computer-mediated communications involved in active learning in different ways. Thus, the choice of appropriate e-learning tools for a variety of learning tasks will enhance the learning experiences of students significantly compared with traditional in-classroom lecturing. On the other hand, inappropriate e-learning tool choices may either limit student participation or distract student attention.

For example, if a learning task is designed to let student practice coordination and negotiation in teamwork but the learning tool selected support conveyance purpose, the students are not likely to reach an agreement using this tool. Student participation is limited in this sense as the tool does not promote coordination and negotiation. On the other hand, if a learning task emphasizes independent thinking, it only requires asynchronous communication. The use of an e-learning tool that facilitates synchronous communication may distract student attention. Therefore it is not necessary that that the higher synchronicity the better: the choice of e-learning tools needs to match the requirements of learning tasks.

Despite the contributions, this study has several limitations. First of all, this study includes Blog, Wiki, Discussion Board, and Wimba as the e-learning tools. There are many other e-learning tools in addition to them that instructors use for online and hybrid courses. The four tools are included because they can be categorized into the four quadrants along the process and purpose dimensions. The objective of this study is to test the research model of task-technology fit through media synchronicity, and the inclusion of typical e-learning tools that are distinct from each other enhance the statistical power for testing the research hypotheses. Nevertheless, the exclusion of other e-learning tools weakens the generalizability of the findings.

Another limitation of this study is related to binary coding of the process and purpose variables. Currently, the process variable has two levels: synchronous versus asynchronous. Few electronic media facilitate completely synchronous or asynchronous communications. For instance, this study categorizes Wiki as a media that facilitate asynchronous communications. Yet it is arguable that compared with Blog, Wiki is more synchronous as participants can take turns working on the same piece of work. In the same way, it may be too simplistic to categorize e-learning tools that support communications for either conveyance or convergence purposes respectively. Thus, many e-learning tools vary in degrees of both the process and purpose dimensions and they cannot be easily divided into just a few groups.

In future studies, more e-learning tools need to be included and their attributed need to be characterized with a more refined scale. For instance, the Process variable may have four levels: mostly asynchronous, somewhat asynchronous, somewhat synchronous, and mostly synchronous. In the same way, the Purpose variable may have four levels from mostly conveyance to mostly convergence. This will enrich the research hypotheses proposed in this study and make them more realistic. In addition, the results will provide practitioners such as instructors and IT administrators more guidance on how to choose among the numerous options of e-learning tools for different learning tasks.

7. ACKNOWLEDGEMENT

This study was partially supported by Academic Partnerships with a research grant awarded to the first author.

8. REFERENCES

Allen, E., and Seaman, J. (2007). *Online nation: Five years of growth in online learning*. Sloan Consortium. Retrieved on October 15 2012 from http://sloanconsortium.org/publications/survey/pdf/online_nation.pdf.

Allen, I., and Seaman, J. (2009). *Staying the course: Online education in the United States, 2008*. Sloan Consortium. Retrieved on December 2, 2012 from http://sloanconsortium.org/publications/survey/staying_course.

Allen, I. E., and Seaman, J. (2003). *Sizing the Opportunity: The Quality and Extent of Online Education in the United States, 2002 and 2003*. Sloan Consortium. Retrieved on November 18, 2012 from http://sloanconsortium.org/publications/survey/sizing_the_opportunity2003.

Anson, C. M. (1999). Distant voices: Teaching and writing in a culture of technology. *College English, 61* (3), 261-280.

APA (1997). *Learner-centered psychological principles: A framework for school reform & redesign*. Washington, DC: American Psychological Association. Retrieved on May 2, 2013 from http://www.cdl.org/resource-library/articles/learner_centered.php.

Bale, J. M., and Dudney, D. (2000). Teaching generation X: Do andragogical learning principles apply to undergraduate finance education. *Financial Practice and Education, 10*, 216-227.

Bonk, C. J., and Kim, K. A. (1998). Extending sociocultural theory to adult learning. In M. C. Smith and T. Pourchot (eds.) *Adult learning and development: Perspectives from educational psychology* (pp. 67-88), Mahwah, NJ: Lawrence Erlbaum Associates.

Bonk, C. J., Wisher, R. A., and Lee, J. Y. (2004). Moderating learner-centered e-learning: Problems and solutions, benefits and implications. In T. S. Roberts (ed.) *Online collaborative learning: Theory and practice* (pp. 54-85). Hershey, PA: Information Science Publishing.

Cooper, M., and Henschke, I. (2005). Additional thinking about andragogy: The international foundation for its research, theory and practice linkage in adult education and human resource development an update. In the *Proceedings of the Commission on International Adult Education (CIAE) Pre-Conference of the American Association for Adult and Continuing Education (MACE)*. St. Louis, MO: University of Missouri 2005.

Davies, J., and Graff, M. (2005). Performance in e-learning: online participation and student grades. *British Journal of Educational Technology, 36* (4), 657-663.

Dennis, A. R., Fuller, R. M., and Valacich, J. S. (2008). Media, tasks, and communication processes: A theory of media synchronicity. *MIS Quarterly, 32* (3), 575-600.

Dennis, A. R., and Kinney, S. T. (1998). Testing media richness theory in the new media: The effects of cues, feedback, and task equivocality. *Information Systems Research, 9* (3), 256-274.

Dron, J. (2003). The blog and the borg: A collective approach to e-learning. In A. Rossett (ed.) the *Proceedings of E-learn 2003: World Conference on E-Learning in Corporate, Government, Healthcare and Higher Education* (Nov. 2003, Phoenix), pp. 440-443.

Garrison, D. R. (2011). *E-Learning in the 21st Century: A Framework for Research and Practice, (2 ed.)*. New York, NY: Routledge.

Glogoff, S. (2005). Instructional blogging: Promoting interactivity, student-centered learning, and peer input. *Journal of Online Education, 1*(5). Retrieved on May 1, 2013 from http://www.innovateonline.info/pdf/vol1_issue5/Instructional_Blogging-__Promoting_Interactivity,_Student-Centered_Learning,_and_Peer_Input.pdf.

Goodhue, D. L., and Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly, 19* (2), 213-236.

Green, P. E., and Srinivasan, V. (1978). Conjoint analysis in consumer research: issues and outlook. *Journal of consumer research, 5* (2), 103-123.

Green, P. E., and Srinivasan, V. (1990). Conjoint analysis in marketing: new developments with implications for research and practice. *Journal of Marketing, 54* (4), 3-19.

Hrastinski, S. (2008). Asynchronous and synchronous e-learning, *Educause Quarterly, 31* (4), 51-55.

Johnson, R., and Orme, B. (2003). *Getting the Most from CBC*. Sawtooth Software Research Paper Series. Retrieved on May 7, 2013 from http://www.sawtoothsoftware.com/download/techpap/cbcmost.pdf.

Jonassen, D. H., and Land, S. (2000). *Theoretical foundations of learning environments, (1st ed.).* Mahwah, NJ: Lawrence Erlbaum Associates.

Karayan, S. S., and Crowe, J. A. (1997). Student perceptions of electronic discussion groups, *THE Journal, 24* (9), 69-71.

Kerlinger, F. N. (1986). *Foundations of behavioral research, (3rd ed.)*. New York, NY: Holt, Rinehart and Winston.

Knowles, M. S., Holton, E. F., and Swanson, R. A. (2011). *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development (7th Ed.)* Burlington, MA: Butterworth-Heinemann.

Maor, D. (2003). The teacher's role in developing interaction and reflection in an online learning community. *Educational Media International, 40* (1-2), 127-138.

Mason, R. (2006). Learning technologies for adult continuing education. *Studies in Continuing Education, 28* (2), 121-133.

Massy, W. F., and Zemsky, R. (1995). Using information technology to enhance academic productivity. In the *Proceedings of the Wingspread Enhancing Academic Productivity Conference* (June 1995). Retrieved on August 15, 2013 from http://net.educause.edu/ir/library/html/nli0004.html.

McCormick, S. (1999). The case for visual media in learning. *Syllabus Magazine, 13* (1), 55-57.

Ong, C. S., and Lai, J. Y. (2006). Gender differences in perceptions and relationships among dominants of e-learning acceptance. *Computers in Human Behavior, 22* (5), 816-829.

Orme, B. K. (2006). *Getting Started with Conjoint Analysis (2nd ed.)*. Madison, WI: Research Publishers.

Parker, K. R., and Chao, J. T. (2007). Wiki as a teaching tool. *Interdisciplinary Journal of Knowledge and Learning Objects, 3* (1), 57-72.

Privateer, P. M. (1999). Academic technology and the future of higher education: Strategic paths taken and not taken. *Journal of Higher Education, 70* (1), 60-79.

Rogers, D. L. (2000). A paradigm shift: Technology integration for higher education in the new millennium. *AACE Journal, 1* (13), 19-33.

Schaupp, L. C., and Bélanger, F. (2005). A conjoint analysis of online consumer satisfaction. *Journal of Electronic Commerce Research, 6* (2), 95-111.

Simonson, M. R., Smaldino, S., Albright, M., and Zvacek, S. (2000*). Teaching and Learning at a Distance (4th ed.)*. Upper Saddle River, NJ: Merrill/Prentice Hall.

Smith, D., and Hardaker, G. (2000). E-learning innovation through the implementation of an internet supported learning environment. *Educational Technology & Society 3* (3), 422-432.

Smith, M. K. (2002). Malcolm Knowles, informal adult education, self-direction and andragogy. *The Encyclopedia of Informal Education*. Infed. Retrieved on June 1, 2013 from www.infed.org/thinkers/et-knowl.htm.

Srinivasan, V. (1988). A conjunctive-compensatory approach to the self-explication of multiattributed preferences. *Decision Sciences, 19* (2), 295-305.

Thurlow, C., Lengel, L., and Tomic, P. A. (2004). *Computer Mediated Communication: Social Interaction and the Internet*. Thousand Oaks, CA: Sage.

Tosh, D., and Werdmuller, B. (2004*). ePortfolios and Weblogs: One Vision for ePortfolio Development*. Retrieved on May 1, 2012 from http://www.morrisville.org/classrooms_curriculum/hive_portal/documents/ePortfolio_Weblog.pdf.

Turoff, M. (1989). The anatomy of a computer application innovation: Computer mediated communications (CMC). *Technological Forecasting and Social Change, 36* (2), 107-122.

Weller, M., Pegler, C., and Mason, R. (2005). Use of innovative technologies on an e-learning course. *The Internet and Higher Education, 8* (1), 61-71.

Xu, D., and Jaggars, S. S. (2011). *Online and Hybrid Course Enrollment and Performance in Washington State Community and Technical Colleges*. Community College Research Center Working Paper No. 31, Teachers College, Columbia University.

Editor's Note:

This paper was selected for inclusion in the journal as a ISECON 2013 Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2013.