Communications of the Association for Information Systems

Volume 26 Article 21

4-2010

Acceptance of Educational Technology: Field Studies of Asynchronous Participatory Examinations

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Abstract:

This research examines asynchronous participatory examinations, a new technology-mediated assessment strategy especially suitable for online courses. The participatory exam innovation utilizes information technology to support engaging students in the entire examination lifecycle, including creating and solving problems, and grading solutions. These learning processes enable students to not only gain new knowledge but also to strengthen their assessment skills. A five-semester field study in the U.S., supplemented by a small scale replication in Austria, investigated how participatory exams can facilitate higher-order learning and what explains students' acceptance of the innovation. An extended version of the Technology Acceptance Model (TAM), adapted to the educational context, predicts acceptance based on three key constructs: "perceived enjoyment," "perceived learning," and "recommendation for use." The study results support the premises that participants perceive learning from all stages of the cooperative exam process, and that the innovation acceptance is a function of both intrinsic motivations (e.g., enjoyment of the experience) and extrinsic motivations (e.g., perception that one has learned from the process).

Keywords: participatory examination; exam; assessment; Asynchronous Learning Networks; ALN; e-learning; distance learning; collaborative learning; constructivism; Technology Assessment Model; TAM; UTAUT; training

Volume 26, Article 21, pp. 451-476, April 2010

The manuscript was received 5/11/2009 and was with the authors 5 months for 1 revision.

Communications of the Association for Information Systems

I. INTRODUCTION AND MOTIVATION

How willing are students to embrace a new technology-supported approach that engages them in the entire examination lifecycle? Can information technology improve the assessment process, making it more enjoyable and increasing learning? The online participatory examination transforms the traditional instructor-dominated exam process into a cooperative learning experience. Students create, solve, and grade the exam questions, all in an asynchronous virtual learning environment in which they can see all questions, answers, and grading commentaries. While some students have trouble adjusting to the radical change in their traditional role, our research shows overall acceptance and recommendation of the participatory exam approach. It also supports a Technology Acceptance Model (TAM) adapted to the educational context for predicting acceptance of this new approach to assessment made possible by information technology.

This paper presents the results of a long-term series of case studies on transforming the traditional educational process. The main study took place within a U.S. university course in Information Systems, using the Asynchronous Learning Networks (ALN) technology as a pedagogical approach. ALN employs primarily "anytime-anywhere" computer-mediated communication (though some synchronous chat sessions may be incorporated) and emphasizes extensive student–student as well as instructor–student communication and collaboration. Participatory exams better fit the cooperative or collaborative learning model characterizing the ALN "virtual classroom" [Hiltz, 1994; Hiltz and Goldman, 2005] or "virtual continuous learning spaces" [Leidner and Jarvenpaa, 1995] than do traditional examination procedures. In order to explore generalizability of results, a small scale replication was conducted in two graduate courses at an Austrian university, using a different learning management system, different cultural context, and different subject matter. While we discuss this in terms of online courses, traditional face-to-face courses also can take advantage of online participatory exams.

This research builds on Leidner and Jarvenpaa's theoretical summary of "collaborativism" and relates to their vision of transforming education through the use of information technology (IT) to create virtual continuous learning spaces: "In the context of education, the vision to transform would involve using IT (1) to redraw the physical boundaries of the classroom, (2) to enable more teamwork, (3) to allow learning to be a continuous time-independent process, and (4) to enable multi-level, multi-speed knowledge creation." It also responds to their call for "research … needed on understanding the roles of instructors and students as well as the appropriate learning assessment strategies in virtual learning spaces." Further, the study embraces the challenge to move beyond simplistic comparisons of the outcomes of face-to-face versus online learning, to much more in-depth research into what makes online interaction more or less effective [Alavi and Leidner, 2001; Alavi et al., 2002; Arbaugh et al., 2009].

In this paper, our primary objectives are to describe students' perceptions of the educational value of the participatory exam process, and to build and test a general theoretical model of the determinants of its acceptance. This model also is expected to apply to the acceptance of other types of educational technologies and educational assessments (homework, semester projects, etc.). It combines the data for five semesters of field studies in the U.S. course on participatory exams, examines the data within a theoretical framework, and presents an overview of the full results. Thus besides building and testing our general model, we also summarize the reported learning advantages, e.g., how is the participatory exam better than or inferior to the traditional exam process, particularly for online courses? There is a need to reconsider assessment—particularly the examination process in online courses. The participatory exam emphasizes self-paced learning, "deep" learning, and collaborative learning. In this descriptive summary of participatory exam learning outcomes, we also compare the results of the small-scale replication of the research at the Austrian university.

Increasing the effectiveness of online learning is of special interest to information systems researchers. Learning together online in a "virtual classroom," instead of in a physical classroom, has become one of the most prevalent applications of IT; by Fall 2007 over 3.9 million university students in the U.S. were taking an online course [Allen and Seaman, 2008]. In addition, "e-training" courses are increasingly prevalent in the corporate sector. A great deal of investment in organizations is allocated to IT end-user training to enhance business productivity and competitiveness [Compeau and Higgins, 1995]. However, little attention has been paid to the quality of corporate e-training procedures and the assessment of learning outcomes. Currently, e-training is the trend for corporate IT training because of low cost, time and location flexibility. Though our study did not take place in a corporate e-training environment, many of the students who participated were being sponsored by their organizations, and the participatory exam approach appears suitable for the corporate as well as the university campus environment. This research provides a contrast to existing literature comparing a traditional classroom to a web-based virtual learning environment. The participatory exam aims to foster deep learning, which is focused and pertinent to the course topics [Turner et al., 2002]. (In educational theory, learners' approaches to learning can be classified as either surface level or deep level [Entwisle, 2000; Gordon and Debus, 2002]. A deep learner searches for knowledge and understanding, whereas a surface learner is concerned only with passing exams by memorizing facts.) The participatory exam process actually engages students in the entire exam lifecycle (see the detailed exam procedure in Section IV). The students in the participatory exam are given more power and control than in a traditional exam. Through the following research questions about participatory exams conducted in asynchronous learning networks, we attempt to identify key determinants for adopting this new educational technology.

RQ1: Do students enjoy their learning experience in the participatory exam?
RQ2: Do students perceive learning during the participatory exam?
RQ3: Do students learn from all phases or only some specific participatory exam processes (designing, reading, answering, and grading exam questions)?
RQ4: Do students accept the new technology-supported participatory exam? Would they recommend its continued use?
RQ5: What theoretical model best explains recommendation for continued use?

After reviewing related learning and exam research in Section II, Section III presents our research model based on an extension of the TAM/UTAUT models and research hypotheses. In Section IV we describe our participatory exam process framework. Section V relates our data analysis and research results, followed in Section VI by selected student comments from the questionnaires. In Section VII, we discuss limitations and some possible future research directions. Finally, the conclusions section summarizes and provides some observations.

II. LITERATURE REVIEW

Our participatory exam approach in asynchronous learning networks is grounded in pedagogical theory and collaborative learning, which we review in this section along with examination research. We then describe the uniqueness of the participatory exam approach in online courses. We close this section by briefly reviewing the Technology Acceptance Model and extended TAM models such as UTAUT, which form the basis of our research model.

Pedagogical Theories

Pedagogical theory describes two major approaches to learning: objectivist and constructivist [Piaget, 1928; Vygotsky, 1978]. Most traditional courses follow an instructor-centered objectivist approach, in which instructors transfer knowledge to students by presenting lectures and asking and answering questions. The objectivist approach holds that students learn passively by receiving and assimilating knowledge individually, independent from others [Bouton and Garth, 1983]. This is based on a one-way or instructor-centered model of knowledge transmission, in which each student studies individually. By contrast, constructivist learning is based on a model that treats the student as an active participant in individual (or group) learning activities. The student becomes actively involved in constructing knowledge by applying concepts to problems, and/or formulating ideas into words, and these ideas are built on through reactions and responses of others [Alavi, 1994; Bouton and Garth, 1983].

The constructivist approach is less content-oriented and more student-centered. Instructor and student roles change. A basic principle is that learning is conceived of as something a learner does, not something "done to" the learner [Johnson and Johnson, 1975]. As a result, the instructor becomes a facilitator, evaluating and refining the learning environment in order to promote student learning. The instructor aids the students via the creation of authentic (realistic) tasks and helps students integrate multiple perspectives through reflection. This emphasis on students' active learning and engagement with one another as well as the instructor has been observed to be more relevant and effective than traditional objectivist approaches for today's "net generation" [Oblinger and Oblinger, 2005]. Researchers across a range of disciplines have reported positive results for active, constructivist learning that supports higher-order learning through student involvement in analysis, synthesis, and evaluation [Williams and Chinn, 2009; Chernay, 2008]. However, when it is time for the midterm or final examination, most instructors who otherwise incorporate a constructivist approach still employ the traditional "objectivist" process of assessment. One reason may be that without the use of information technology to assist the process, it would be almost impossible to involve students in the phases of constructing questions and grading answers in a timely manner that preserves the anonymity of the question designers and graders.

Expertise and Higher-Order Learning

Activities in which students can categorize their knowledge and construct relationships between concepts are likely to promote expert-like thinking about a domain. In the workplace, surface learning does not improve professionals' job performance. Gaining expert-level knowledge is desired, as professionals deal with ever-changing tasks and problems. Participatory exams provide students this opportunity by asking them to create, rather than simply respond to, questions about a topic. To design appropriate problems for their peers, students must organize and synthesize their ideas and learn to recognize the important concepts in the domain. This results in "deep" learning, which involves seeing relationships and patterns among pieces of information, recognizing the logic behind the organization of material, and achieving a sense of understanding. "Surface" learning, in contrast, remains at the level of unrelated bits of knowledge mastered through memorizing and rote application of formulas [Entwistle, 2000; Hargreaves, 1997].

By participating in the exam process, students revisit material in a variety of ways—through problem design, problem solving and assessment [Wu et al., 2008, 2009]. Viewing different perspectives increases depth of understanding. Students adapt their understandings to include these other points of view [Goldman–Segall, 1998]. New relationships between concepts are discovered and the students build a collaborative understanding of the problems. Participatory exams force students to think about others' perspectives on a problem as they assess solutions, and review the problems and solutions of the entire class. This process often takes place in the workplace, where collective efforts are used to obtain the best solutions. This may be one of the most mind-expanding parts of the process. Cognitive Flexibility Theory holds that a necessary condition for acquiring advanced knowledge is that it be used in a variety of contexts [Spiro, 1991]. Knowledge that is acquired in one context and then used in another is "useful knowledge" and develops "cognitively flexible" processing skills.

Bloom's Taxonomy of Educational Objectives [Bloom et al., 1956] categorizes the cognitive skills of various educational tasks. The skill levels, from lowest to highest, are knowledge, comprehension, application, analysis, synthesis, and evaluation. The higher levels of the taxonomy can be aligned to the concept of "deep" learning earlier described [Felder and Brent, 2004]. The participatory exam focuses on developing the higher order skills. Students create and solve problems that require synthesis and analysis of the course materials; they evaluate their peers' problem solving through peer assessment. The support or scaffolding provided for by the exam process helps develop mastery of these higher cognitive levels. This assessment process benefits problem solving, in particular, when dealing with challenging uncertain tasks in a dynamic environment.

Peer Evaluation

Self- and peer-evaluation contribute to learning in several ways. Students participating in assessment activities develop a metacognitive awareness of what constitutes excellent work [Frederickson and Collins, 1989]. This awareness is facilitated when students are given specific criteria by which their own work is evaluated [Shepard, 2000]. An analysis of sixty-two studies showed that self-, peer-, and co-assessment are effective tools for developing competencies required in professional organizations [Sluijsmans and Moerkerke, 1998]. Peer-assessment has been shown to be highly reliable [Cho and Schunn, 2003; Liu et al., 2002; Topping, 1998]. Therefore, the learning value is both for the student as an evaluator and as one whose work is assessed.

In previous studies, students have generally responded positively to peer- and self- assessment activities [Liu et al., 2001]. Students who participate in self-assessment may become more intrinsically motivated and more interested in getting feedback than in their grade [Klenowski, 1995]. Students reported benefiting from needing to defend their opinions about their work and from having access to their peers' work. They also reported that knowing that their peers would read their assignments motivated their learning [Cho and Schunn, 2005]. The unique feature of participatory exams is the assessment component which allows students to evaluate their peers' exam performance with critical feedback. Professionals are often evaluated and they are also involved in critiquing peers' work.

Collaborative Learning and Computer-Mediated Communication

The participatory exam transforms the traditional instructor-dominated exam process into a cooperative learning experience. Collaborative learning often results in higher learning compared with individual-oriented learning [Leidner and Jarvenpaa, 1995; Reinig, 1996], due to social interaction among students. On the one hand, this enhances knowledge sharing, helping students clarify confusing course materials as well as grasping understanding beyond the individual's perception [Harasim, 1996; Tu, 2000]. On the other hand, "the underlying assumption for educators is that collaborative learning holds the promise of active construction of knowledge, enhanced problem articulation, and benefits in exploring and sharing information and knowledge gained from peer-to-peer communication" [Haythornthwaite, 2006, p. 10].

Among the pedagogical advantages of collaborative learning online, besides its fundamental characteristic of helping students to actively construct knowledge, are that collaboration models activity in the workplace, enhances students' understanding and appreciation of diversity, and may give students a sense of belonging [Swan, 2006]. "Perhaps most importantly, collaboration allows distant students to interact socially and develop a feeling of community in online courses" [Swan, 2006, p. 3]. For information systems researchers, there is a need to further investigate students' psychomotor, cognitive, and affective skills in computer-supported collaborative learning environments [Sharda et al., 2004]. A number of ALN technologies (e.g., online discussion boards, visualization tools, multimedia) have been implemented to support the online educational content delivery. Our participatory exams engage the students in ALN systems to increase their learning and their enjoyment of the exam process. Our study examines what determinants impact acceptance of this specific process utilizing educational technology.

Exam Research

In most classrooms, assessment and instruction are viewed as separate activities with different purposes. The main purposes of an exam are to measure learning achievement, and to motivate and direct further learning [Ebel and Frisbie, 1986] and strengthen learning quality [Berglund and Daniels, 1997]. It is suggested that even just the process of taking an exam and discussing its scoring should be a rewarding learning experience in itself. The exam approach deployed strongly affects the way students learn and changing classic final exam methods could improve the quality of education [Berglund and Daniels, 1997]. Thus instructors and schools should deliberate carefully about exam formats and contents to better attain educational goals. Yet, little research on exams has been carried out, and most studies that have been done focus on computer programming courses.

Different courses utilize different exam approaches to influence the way students study and motivate them to thoroughly understand the subjects. A series of field studies [Berglund and Daniels, 1997], which share this objective with our study, were conducted in three computer science courses. For example, in a "Computer Architecture" course, the final examinations were supplemented by seminars in which final projects were presented, analyzed, and discussed. The regular written exam was still kept, but the main focus of the exam questions was to show understanding and ability to analyze and synthesize. Some positive results were reported, such as: students worked harder and more deeply understood the subjects. But this change also caused the negative result of an increased workload for both students and instructors. A three-year study combined conventional and online-programming exams in first-year programming courses [Woit and Mason, 1998]. Students were better motivated to learn practical skills in this combined online testing environment than the researchers expected. In contrast, our research uses a writing-intensive information systems course instead of a programming course. Our exam consisted of essay questions instead of computer programming questions. (We intend to experiment with other types of exam questions in future research, including programming questions.) Also, our exam contexts are opposite. Woit and Mason's study tried to avoid students communicating during the online exam period, while we encourage students to collaboratively share their work. They looked at operational and pedagogical aspects of online testing, while we measured the learning effects during the participatory exam processes.

Participatory Exam Activities

Many instructors have tried various pieces of the participatory exam technique on classroom problems (including non-exam problems), and aspects have been studied individually (disconnected from others) more rigorously. For example, some instructors have students generate questions (and sometimes answers), as a study tool or to foster class discussion [de Jesus et al., 2003; Dolinsky, 2001; Foos et al., 1994; Hargreaves, 1997; Merrill, 1994; Silva, 1995]. Others have students grade peers' projects, either sharing them online or after a class presentation [Hersam et al., 2004; Reynolds, 2004; Richards et al., 2004; Wiswall and Srogi, 1995]. This occurs at the college and secondary school level. The Networked Peer Assessment System (NetPeas), for example, facilitates peer assessment of (instructor-created) mathematics homework problems at the pre- or junior high school level [Liu et al., 2001]. Furthermore, inquiry-focused approaches (Polman 2000) and problem-based learning [Hmelo–Silver, 2004; Koschmann et al., 1996], in which students develop problems and investigation strategies, are often used in secondary school classrooms. No other line of research, however, has previously investigated the learning or educational technology acceptance aspects of involving students in the entire problem lifecycle. Other research on participatory exams has been carried out. Shen et al. [2005] extended participatory exams to "collaborative examinations" in which teams instead of individuals make up questions and grade solutions. Within this context they also examined students' learning style. However, no prior exam research focuses as deeply on technology acceptance for participatory exams using asynchronous learning networks as the current research. In the next subsection, we discuss the technology acceptance model theories which ground this research.

The Technology Acceptance Model and UTAUT

What factors lead to the acceptance of a technology-supported educational innovation? The Technology Acceptance Model (TAM) [Davis, 1989], the most widely used model in Information Systems [Lee et al., 2003b], predicts that Behavioral Intention to Use an information system in the future is a product of Perceived Usefulness and Perceived Ease of Use. It has seen many variations in its development and has been criticized for treating its constructs as "black boxes" with little effort going into understanding what actually makes a system useful [Benbasat and Barki, 2007]. A number of authors have extended TAM by proposing external variables as antecedents to better explain perceived usefulness and perceived ease of use [e.g., Gefen et al., 2003; Venkatesh, 2000].

The various TAM and related models of user acceptance were reviewed and combined into a single Unified Theory of Acceptance and Use of Technology (UTAUT) [Venkatesh et al., 2003]. We shall refer to some of these constructs when we present our model, and to others in our discussion in Section VII. Figure 1 shows the UTAUT model, from which we adapted several constructs in developing our theoretical model. The Venkatesh et al. [2003] paper not only presented the model that unifies various extensions of TAM, but also validated it using a variety of data sets.

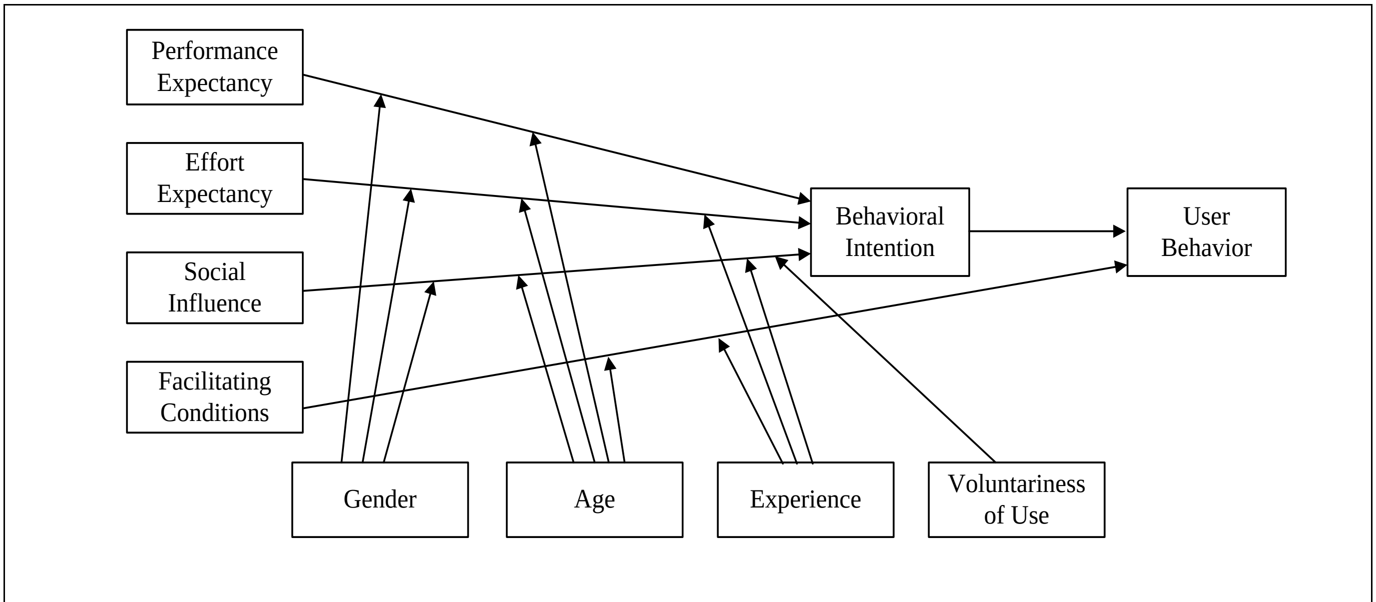

Figure 1: UTAUT's Research Model (Source: Venkatesh et al. 2003, p. 447).

This unified TAM model (UTAUT) identifies a variety of individual differences (i.e., gender, age, experience, social influence, etc.) that may affect acceptance of IT within an educational context. Recent TAM research has further incorporated individual characteristics and situational/contextual variables to understand initial and continuous acceptance and adoption of an IT. For instance, Bhattacherjee and Sanford [2006] examine how processes of external influence shape IT acceptance among potential users. National cultural values (i.e., masculinity/femininity, individualism/collectivism, power distance, and uncertainty avoidance) are also identified as an important set of individual difference moderators for accepting a new technology [Sánchez-Franco et al., 2009; Srite and Karahanna, 2006; Teo et al., 2009].

Some TAM studies have extended the TAM model to different domains, in particular involving different new technologies with different user populations. Both individual differences and system characteristics were found to have significant effects on perceived ease of use of digital libraries [Hong et al., 2001]. An empirical study [Chau and Hu, 2002] conducted with physicians also indicates that individual physicians' acceptance decision on telemedicine technology practically relies on the usefulness of the technology rather than the ease of use. In the mobile commerce context, task types (general tasks, gaming tasks, and transactional tasks) moderate wireless technology acceptance [Fang et al., 2005]. Higher education and corporate e-training sectors are an important and widespread domain utilizing information systems, so understanding what constructs impact educational technology acceptance is critical. Therefore, researchers have utilized TAM to evaluate educational technologies acceptance. They adapted TAM or UTAUT to examine effectiveness of a particular desktop technology [Hu et al., 2003], online technology [Bekkering and Hutchison, 2009; Saadé and Bahli, 2005], ALN platform [e.g., Ibdalla, 2007; Landry et al., 2006; Lee et al., 2003a; Marchewka et al., 2007; Sanchez-Franco, 2010; Stoel and Lee, 2003], or online learning communities [Liu et al., 2010]. Our research, in contrast, is built on adapting and extending the original TAM model and the

UTAUT extended framework not to a particular *technology*, but to a particular technology-supported learning *process* (i.e., participatory exam) in asynchronous learning networks.

III. RESEARCH MODEL AND HYPOTHESES

Research Model

The original TAM contains two main constructs, Perceived Usefulness[1] and Perceived Ease of Use, which impact Intention to Use, which in turn affects Usage Behavior. Perceived Ease of Use also directly influences Perceived Usefulness. Perceived Usefulness and Perceived Ease of Use respectively can be associated with Extrinsic Motivation causing one to act in order to achieve a goal, and Intrinsic Motivation causing one to act for the pleasure or satisfaction of doing so [Venkatesh, 2000].

TAM is not useful in telling us whether students would intend to or actually take a technology-enhanced participatory exam, because exams are mandatory and students have no choice but to take whatever exam is presented by the instructor. Instead, TAM can help us understand whether and why students embrace (or at least accept willingly) the new technology-enhanced participatory exam process. Thus, our dependent variable to measure acceptance of this process, rather than the usual Behavioral Intention to Use, is "recommendation for (future) use." Note that the student subjects in our studies had already participated once in the participatory exam process; they are answering questions about what they perceived about the process and about whether they would recommend that it be used in the future. Figure 2 presents a model based on UTAUT for student acceptance of online participatory exams.

In Figure 2, the dashed-line square highlights the acceptance model for educational information technologies. Three major constructs are identified: "perceived learning," "perceived enjoyment," and "recommendation for use." "Perceived learning" is a key variable in our model, because learning more from the participatory exam is its primary objective. It is an educationally-relevant adaptation of Perceived Usefulness in TAM and Performance Expectancy in UTAUT. "Perceived enjoyment" is an adaptation of the concepts of Perceived Ease of Use in TAM, or Intrinsic Motivation in TAM2 [Davis et al., 1992].

We include several antecedent variables in our model. In an educational setting, "performance outcome," which is defined as the degree to which an individual believes that using the system will help him or her to gain in performance, is equivalent to an exam grade. We postulate that a higher learning outcome will increase reported enjoyment (and lead to the perception that more was learned as well as a recommendation for the new exam process). Note that in terms of causal sequence, in our study students participated in the exam and grading, and then received their grade, before completing the post-exam questionnaire.

The independent variable, perception of "effort expectancy," which is defined as the degree of ease of use of the system in the UTAUT model, in our research represents perceived course difficulty. "Effort expectancy" covers task "complexity," which means the degree of difficulty to understand and use a technology [Thompson et al., 1991]. "Effort expectancy" is postulated to influence the intrinsic motivation or enjoyment of students as well as the grade received.

"Facilitating conditions," as defined and measured in prior TAM-related studies, generally measure aspects of use of an information system itself, rather than of a technology-supported process. For instance, the items used to measure this concept in the Venkatesh et al. [2003] UTAUT study included the provision of guidance in using the system, specialized instruction or training, or a person to provide help. It is essential to have explicit and well-designed instructions for the participatory exam process to successfully implement this new assessment strategy in asynchronous learning networks. Because of the nature of online learning, facilitating conditions [Thompson et al., 1991] are a key component for adopting this assessment technology in organizations. However, we are not studying the acceptance of an information system per se, but rather of a process that is supported by a computer-mediated communication system. Facilitating conditions would thus include aspects of use of the hardware, software, and the process itself. In our studies, the student subjects were already familiar with the communication system that served as the platform for the exam process, because they had been using it for weeks in their course. Thus, they already had experience and knowledge necessary to use the computer system itself. If the system "crashed" or slowed down during the process, this would be a negative facilitating condition. We did not expect this to happen, and thus did not form hypotheses or constructs with system reliability in mind, though we did remain vigilant to document if such events did occur during the exam process. In our research, "facilitating conditions" represent the clarity, perceived

[1] Constructs beginning with capital letters refer to the TAM or UTAUT models. Constructs in quotation marks refer to our research model.

quality, and fairness of the exam and grading procedures themselves. This encompassed in particular the perceived fairness of the assessment criteria and procedures, and instructor online facilitation.

Comparing our model to UTAUT, we did not incorporate equivalents of Social Influence, because this was a first use of a novel approach for the subjects and in the universities in which the studies occurred, and thus they are not likely to be influenced by the opinions of peers, family or friends. We also do not incorporate explicitly the mediators from UTAUT (e.g., Age, Gender, Experience, Voluntariness of Use) because most of them do not vary sufficiently in our studies. In all studies, taking the participatory exam was mandatory rather than voluntary. Almost all of the students in the master's level course were in their twenties. In our analysis, we do look at gender and experience with the ALN technologies, though they were not included in the initial model.

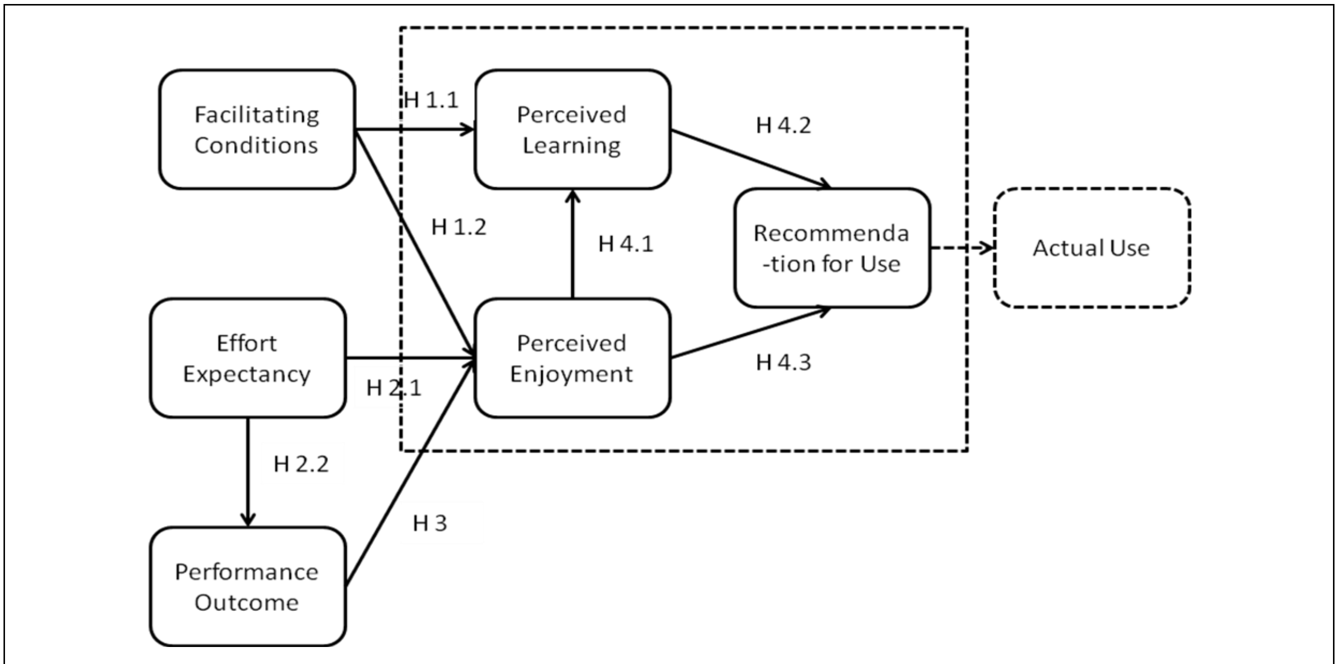

Figure 2: Participatory Examination Research Model and Hypotheses

A major purpose of the participatory exam process is to make preparing for and taking an exam more engaging for the students and thus to lead them to learn more from the exam process. The hypotheses listed below are derived from the theoretical research model in Figure 2 and discussed in the prior literature review.

H1: Facilitating Conditions

The independent variable, "facilitating conditions" (i.e., grading procedure, perceived quality and fairness in this research), reflects the importance of faith in the fairness of the peer evaluation that the participatory exam system facilitates. As detailed in Section IV, procedures and heuristics need to be specified in detail for grading so that students perceive that the process is fair, objective, and replicable. If they do not accept the grading procedures, then they are likely to reject the entire participatory exam process. Both for research methodological reasons and for students' peace of mind, it is crucial to control the grading process quality.

Performance outcome (e.g., exam grades) is the students' primary concern [Guskey, 1996]; thus explicit grading criteria and perceived fairness will determine whether students perceive that they learn from and enjoy the whole participatory exam process. Therefore, we hypothesize:

> Hypothesis 1.1: Students who perceive higher quality of facilitating conditions will report higher perceived learning from participatory exams.

In the initial test of UTAUT by Venkatesh et al [2003, p. 468], Facilitating Conditions were found to have a small but significant effect on use only when mediated by age and experience (with the effects present only for older workers and those with more experience). However, our adaptation of "facilitating conditions" goes to the heart of the entire participatory exam procedure. If students do not believe that the procedures used during the exam and grading are reasonable and fair, this negative judgment will lead them to reject the process as one from which they can benefit through improved learning as compared to traditional exam processes. From critiques of student evaluations of faculty teaching comes indirect evidence of such a "halo" effect of attitudes toward teaching process variables on ratings of course outcomes such as learning. Faculty reports and correlational analyses suggest that results of student evaluations seem to be related to demanding relatively little work from students and giving relatively high grades [e.g., Ryan et al., 1980; Titus, 2008].

> Hypothesis 1.2: Students who perceive higher quality of facilitating conditions will report higher enjoyment from participatory exams.

In a pilot study, it was noted that some students raised objections to being graded by their peers from the outset of the participatory exam process and that these students tended to be resistant and negative throughout the process. Even though procedures such as instructor review of the grading and appeals of grading to the instructor were incorporated into the process (see Section IV), it is the student perception of fairness that is a necessary facilitating condition, no matter that the instructors believe that they have created fair procedures. Throughout the studies, our qualitative observations suggested that students who felt that a strong role for peer grading was not fair, were so worried about their grade that they did not enjoy the process. Thus we hypothesize that reported enjoyment will be negatively related to perception of lacking the necessary conditions for a valid exam, namely, the perceived fairness of the grading process.

H2: Effort Expectancy

In the UTAUT theoretical model, effort expectancy is shown as influencing both performance outcome and perceived enjoyment. Thus, we hypothesize similar impacts for the participatory exam context.

> Hypothesis 2.1: Students who perceive higher effort expectancy will perceive less enjoyment from participatory exams.

Note that ideally, perceived effort expectancy (in the participatory exam context, e.g., course difficulty) would have been measured before the exam procedure, instead of afterwards. Because effort expectancy was measured at the same time as perceived enjoyment, we are actually predicting association rather than causation. Because so many students are primarily focused on their grades rather than on learning as their objective for both an examination process and the course as a whole, it is likely that "difficult" courses (e.g., those in which more effort is required or in which it is harder to earn a top grade) are also seen as less enjoyable in most or all ways.

> Hypothesis 2.2: Effort expectancy will be related to performance outcomes from participatory exams.

Effort expectancy is measured in this context by how easy or difficult the course is perceived to be. Performance outcome in this study is the grade actually received on the exam. It is logical that students who believe that the course is easier would expect better performance outcomes than those who perceive higher course difficulty.

H3: Performance Outcome

Performance outcome (e.g., grades) is regarded as a standard way for instructors to communicate and assess the adequacy of students' performance at a specific time [Bloom et al., 1981]. Grades often are used by schools to evaluate a program's effectiveness [Frisbie and Waltman, 1992]. High grades represent the achievement of students—the positive recognition of their success, and, furthermore, are viewed as rewards and incentives to learn [Feldmesser, 1971]. Low grades are usually blamed as a negative and meaningless sign in motivating further learning [Selby and Murphy, 1992]. As Guskey [1996, p. 5] states, "Teachers don't need grades or reporting to teach well. Furthermore, students don't need them to learn." Therefore, performance outcomes do not directly impact students' learning but the perception of students' enjoyment, which is widely recognized as a factor of intrinsic motivation [Venkatesh, 2000]. We thus hypothesize:

> Hypothesis 3: Students who attain higher performance outcomes will report higher enjoyment from participatory exams.

H4: Perceived Learning and Enjoyment

The intervening variable "enjoyment" substitutes for Perceived Ease of Use in TAM and UTAUT to reflect the concept of intrinsic motivation. Two types of intrinsic motivation—perceived enjoyment and computer playfulness—are strong indictors for perceived ease of use [Venkatesh, 2000]. One ALN study finds that perceived enjoyment is part of perceived motivation that significantly impacts student learning [Wu and Hiltz, 2004]. In our research, the construct combines aspects of enjoyment, flexibility, and motivation to succeed (see Section V). Perceived enjoyment causes a deep cognitive absorption and engagement, which impacts behavioral intentions to use a specific technology [Agarwal and Karahanna, 2000]. In the educational context, Perceived Usefulness is equivalent to the perception by students of their learning, since Perceived Usefulness is regarded as the belief that IT use will improve one's performance. Future research also could measure actual learning, but perception more closely corresponds to expectation. Psychological theories [Lepper et al., 1973) explain that intrinsically motivated activities are interesting and enjoyable. In our research, the more enjoyment the students perceive from the technology-enhanced exam process, the more engagement (learning involvement and effort) in working on the exam components is likely to occur, and thus the more the student will learn. So we predict:

> Hypothesis 4.1: Students who perceive higher perception of enjoyment will report higher learning from participatory exams.

Do students recommend the participatory exam for continued use? In this adapted and extended TAM model, the dependent variable "recommendation for use" substitutes for Intention to Use as the measure of acceptance, since students in a course do not have any choice over whether or not to use it. (In our theoretical model, the recommendation for use can be also extended to "actual use," which we intend to investigate for future research.) Venkatesh et al. [2003] found that the strongest predictor of the dependent variable (Behavioral Intent) in the UTAUT model was Performance Expectancy. Thus, in this adaptation of the theory we predict:

> Hypothesis 4.2: Students who perceive higher learning will be more likely to recommend the participatory exam for future use.

Intrinsic motivations such as Perceived Ease of Use in TAM have been found to predict technology acceptance, though the effects are generally not as strong as those for Perceived Usefulness. The parallel construct to Perceived Ease of Use in our model, as pointed out above, is "perceived enjoyment." Therefore, we hypothesize:

> Hypothesis 4.3: Students who perceive higher enjoyment will be more likely to recommend the participatory exam for future use.

A major purpose of the participatory exam process is to make preparing for and taking an exam more engaging for the students. The hypotheses test our research model, which the following procedures implement.

IV. PARTICIPATORY EXAM PROCEDURES

This section briefly describes the innovative participatory exam procedures used in this study. This will enable researchers to understand our conceptual approach and results, and practitioners who teach online or otherwise utilize ALN to replicate the procedure if they so desire.

The major source of data is a participatory exam field study conducted for five semesters in a graduate Information Systems core course at a U.S. public research university, featuring intensive writing and reading assignments. Students from both blended (face-to-face plus online) and distance learning sections participated in weekly asynchronous (anytime, anywhere) online discussions throughout the course, as well as during the exam. The main communication platform on which we conducted these studies was WebBoard™. However, the participatory exam process could be conducted on most, if not all educational ALN platforms (e.g., Moodle, WebCT™). Our small scale replication during December 2008 with two graduate courses in Communications and Media at the Austrian university used the Blackboard™ system.

During the participatory exam period, the instructor plays the role of exam procedure controller and students perform major activities including composing, answering and grading exam questions. The interaction among students and instructor occurs continuously. Figure 3 shows the two major processes in the participatory exam: the instructor's control process and the students' learning process.

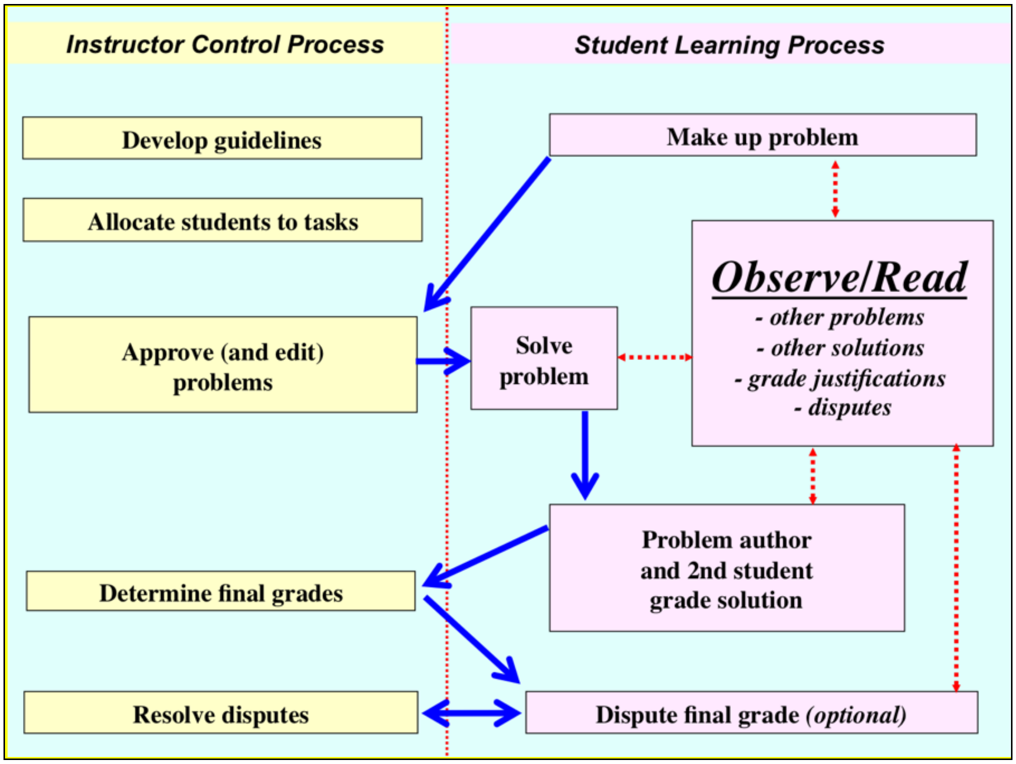

Figure 3: Participatory Exam Process Framework.

The participatory exam embodies the following systematic procedure. Students can read everything peers post online, which is an important learning component. All entries use short-term or “targeted threading,” which groups the description, solution, and grade for each problem. Entries are anonymous among the students; instructors know student identities. Confidentiality is an important factor for people who are new to the peer feedback process [McGourty et al., 1998]. In the U.S. the following specific procedures were used; in Austria we extended the number of days for each phase by one or two because all students had English as a second or third language.

- Each student had four days to design two problems for their peers based on the course materials, using guidelines provided by the instructor. Students posted the problem descriptions online. Questions require essay-length answers (up to 1500 words) that synthesize several course topics.
- The instructor approved each problem description, editing it if necessary.
- Each question was allocated (by the instructor, or in the future by software) to a different student who answered it.
- Each student had five days to post his or her two solutions online. Students could use any reference materials. They were required to submit their answers through the Turnitin service (www.turnitin.com) to reduce the ability to plagiarize.
- Students had three days to grade the solutions to the problems they authored, using guidelines provided by the instructor. Students were required to use rubrics to assess along several different criteria. They had to provide a written justification of at least two sentences for each evaluation criterion. Justifications, a detailed written critique—positive or negative—are a vital aspect of learning how to assess. Most existing peer-assessment systems do not insist on justification of evaluation.
- Students were allocated additional solutions to evaluate, providing each solution with a second opinion using the same guidelines. (This step was not incorporated in Austria.)

- The instructor assigned a final grade to each solution, using the student evaluations as input. If the two student grades were close enough (e.g., within 10 out of 100 points), to conserve time the instructor sometimes chose to accept the higher grade without re-evaluating a solution.

- Students optionally could dispute their grade, in which case they were required to re-grade their own solution using the same evaluation guidelines. This provides another opportunity for learning. Disputes are an especially important feature. They help ensure the fairness of the approach, especially when instructors do not have time to carefully review each answer and evaluation. If a student believes the peer (or instructor) evaluations were incorrect, a dispute will ensure that the instructor focuses adequate attention to this specific problem.

- The instructor determined the final grade for disputed solutions.

A variation is the "collaborative" exam [Shen et al., 2008] which follows the basic procedures described above, but uses small groups of two to four students working together in the question creation and answer grading phases. This collaborative variation was used at the Austrian university.

V. RESEARCH METHOD AND DATA ANALYSIS RESULTS

Methods and Measures

The data for this study were collected from post-exam online surveys. The specific items used to measure each construct are shown in Tables 1–3 and 5 with frequency distributions of results. As in the original TAM studies, only one item was used to measure the dependent variable, "recommendation for future use." Three newly devised items were used to measure "perceived enjoyment," and seven for "perceived learning," the variable of most interest to us. Of those items, the first three shown in Table 5 were new to this research, while the last four are adapted from items often used to measure teaching effectiveness in student evaluations of faculty [Centra, 1982; Hiltz, 1994]. The three items used to measure "facilitating conditions" regarding faith in the grading process were all new, as were the one item for "effort expectancy" and three items for "performance outcome."

In addition to the structured questions, the questionnaires closed with two open-ended questions about what aspects of the exam process the students liked best and least. We analyze this qualitative data in the next section. Finally, the observations we offer and conclusions we draw are also informed by participant observation. All three authors were involved in the design and monitoring of the participatory exam process in two or more classes.

Research Sample and Overall Results

We conducted five post-exam surveys in distance learning and blended (face-to-face supplemented by online) course sections in a graduate level Information Systems course at the U.S. university. While the exam was mandatory, participation in the survey was optional. Among the 240 voluntary participants, 61.1 percent are male and 38.9 percent are female. 40.8 percent have English as their native language, and the rest (59.2 percent) of the participants speak English as a second language. The majority (61.7 percent) had no prior online learning experience, 14.6 percent had taken one prior online course, 17.9 percent had two to four online courses, and only 5.8 percent had taken five or more online courses previously. (Note: All detailed historical data comparisons have been reported [Wu et al., 2008].)

The second author had the opportunity to replicate our study in two small graduate seminars that she taught in the Communications and Media Studies department at an Austrian university. All students had some prior experience with the Blackboard system that was used in hybrid mode for teaching the courses, and to support the exam process. Responses from the seventeen different students who voluntarily completed the survey in January 2009 are compared to the results for the U.S. sections. There are too few Austrian students to validly conduct statistical tests of significance, but the comparative distribution of responses can indicate the extent to which the results were similar or different. Tables 1 to 3 present the major results, which relate to our first four research questions. Note that the overall results in both contexts are quite similar and positive. For example, in terms of reporting that they enjoyed the participatory exam process, 59.5 percent of the U.S. students and 58.8 percent of the Austrian students agreed or strongly agreed. For several items, the Austrian results were even more positive. For example, 60.4 percent of the U.S. students and 82.4 percent of the Austrian students reported that they learned from making up questions; and for our dependent variable, 60.8 percent of the U.S. students versus 76.5 percent of the Austrian students strongly agreed or agreed that they would recommend using the participatory exam procedure in the future. On the other hand, the Austrian students did not report learning as much from the grading and reading of other responses phases, so there is some possible cultural variation.

Research question 5, concerning the best theoretical model explaining recommendation for continued use, follows both from overwhelming support in the literature for our model's origins, plus the positive evidence presented next for its modifications to best reflect our context of ALN participatory exams.

Table 1: Participatory Exam Perceived Enjoyment

Items		SA	A	N	D	SD	#
I enjoyed the flexibility in organizing my resources.	U.S.	26.2%	48.9%	16.7%	3.6%	4.6%	221
	Austria	41.2%	29.4%	29.4%	0	0	17
I was motivated to do my best work.	U.S.	23.5%	42.9%	28.2%	3.4%	2.0%	238
	Austria	23.5%	35.3%	29.4%	11.8%	0	17
I enjoyed the examination process.	U.S.	17.2%	42.3%	22.6%	10.5%	7.4%	239
	Austria	29.4%	29.4%	29.4%	11.8%	0	17

SA = Strongly Agree; A = Agree; N = Neutral; D = Disagree; SD = Strongly Disagree;
# = Number of Responses

Table 2: Perceived Learning from Participatory Exam

Items		SA	A	N	D	SD	#
I learned from making up questions.	U.S.	17.9%	42.5%	21.3%	13.8%	4.5%	240
	Austria	70.6%	11.8%	11.8%	5.8%	0	17
I learned from grading other students' answers.	U.S.	17.7%	48.1%	19.4%	9.3%	5.5%	237
	Austria	5.9%	47.1%	35.3%	11.7%	0	17
I learned from reading other people's questions, answers, and grading.	U.S.	15.8%	45.0%	22.1%	11.3%	5.8%	240
	Austria	0	41.2%	52.9%	5.9%	0	17
The exam was successful in enabling me to demonstrate what I learned in class.	U.S.	13.6%	50.2%	22.6%	10.9%	2.7%	221
	Austria	11.8%	52.9%	29.4%	5.9%	0	17
My skill in critical thinking was increased.	U.S.	22.6%	46.0%	27.6%	1.7%	2.1%	239
	Austria	11.8%	58.8%	23.5%	5.9%	0	17
My ability to integrate facts and develop generalizations improved.	U.S.	21.8%	49.2%	25.6%	2.1%	1.3%	238
	Austria	5.9%	47.1%	47.0%	0	0	17
I was stimulated to do additional reading.	U.S.	25.5%	39.7%	22.6%	7.9%	4.3%	239
	Austria	23.5%	47.1%	17.6%	11.8%	0	17
I learned to value other points of view.	U.S.	17.6%	51.9%	27.6%	1.3%	1.6%	239
	Austria	17.7%	29.4%	52.9%	0	0	17

Table 3: Recommendation for Future Use

Item		SR	R	N	O	SO	#
Would you recommend in the future that this exam process be used?	U.S.	20.7%	40.1%	24.5%	8.9%	5.8%	237
	Austria	11.8%	64.7%	23.5%	0	0	17

SR=Strongly Recommend; R=Recommend; N=Neutral; O=Oppose; SO=Strongly Oppose;
#=Number of Responses

The data in Tables 1 to 3 enable us to answer our research questions affirmatively:

RQ1: Most students enjoyed and were motivated by the process.

For example, roughly 60 percent of both the U.S. and Austrian students agreed or strongly agreed with the statement “I enjoyed the examination process” (Table 1).

RQ2 and RQ3: Students tended to perceive that they learned from all phases of the process, including making up questions, reading other students' answers and grading answers. For example, 60 percent of the U.S. students and 82 percent of the Austrian students agreed or strongly agreed that they learned from making up questions. (There is an exception to this generalization for the items on learning from reading other students' answers, for which the Austrians tended to be “neutral.”)

RQ4: A majority (60 percent–70 percent) recommend its future use to replace traditional exams.

On the other hand, there is substantial variance in the responses. For example, in different semesters between 10 percent and 23 percent of the U.S. students did not recommend future use. This variance allows the testing of our predictive model, which was conducted using the U.S. data only.

Data, Reliability and Validity Assessment

PLS-Graph 3.0 software [Chin and Frye, 1994] was utilized to assess internal consistency (reliability) and discriminant validity of the constructs in the research model (Figure 2). This was calculated using composite reliability and the square root of average variance extracted (AVE).

First, to assess reliability, composite reliability was computed. All composite reliabilities (see Table 4) exceed the minimum 0.70 and all AVE values exceed the suggested 0.50 based upon Fornell and Larcker (1981)'s recommended criterion (see Table 1). In order to keep as many construct items as possible, the factor item loading threshold is 0.60 in this research.

Second, discriminant validity assessment was evaluated. Table 4 (leading diagonal) shows the square root of AVEs for all constructs (> 0.71), which are all larger than the inter-construct correlations. The AVE test result is consistent with what Gefen and Straub [2005, p. 94] stated: “the AVE test is equivalent to saying that the correlation of the construct with its measurement items should be larger than its correlation with the other constructs,” although no guidelines are given for “how much larger the AVE should be than these correlations.” This indicates that all research constructs exhibit appropriate discriminant reliability and validity [Chin, 1998; Fornell and Larcker, 1981]. Hence, the instruments sufficiently support validity testing of our proposed research model.

Table 4: Inter-construct Correlations (U.S. Data)

Construct	Mean	S.D.	Inter-Construct Correlations					
			FC	EE	PO	L	E	R
FC	3.41	0.80	***0.81***					
EE	4.05	0.94	0.06	***1.00***				
PO	80.46	17.66	0.15	–0.09	***0.85***			
L	3.72	0.71	0.19	–0.08	0.17	***0.73***		
E	3.74	0.79	0.47	–0.13	0.27	0.73	***0.74***	
R	3.60	1.10	0.31	–-0.15	0.28	0.60	0.69	***1.00***

Construct Legend: FC: Facilitating Conditions; EE: Effort Expectancy; PO: Performance Outcome; L: Perceived Learning; E: Perceived Enjoyment; R: Recommendation for Use
S. D.: Standard Deviation
Diagonal elements (in bold and italics) present the square root of AVE for that construct. For adequate discriminant validity, diagonal elements should be greater than corresponding off-diagonal elements.

Building and Testing a General Theoretical Model

To test interactions and the entire theoretical model, a multivariate analysis is necessary. We conducted a Partial Least Squares (PLS) analysis (using only the U.S. data), which has been used widely in the Information Systems research field [Lee et al., 2003b; and see, e.g., Barclay et al., 1995; Chin, 1988; Compeau and Higgins, 1995; Saadé and Bahli, 2005]. While PLS is often assumed to impose minimal demands on sample size, Marcoulides and Saunders [2006] cautions that PLS modeling should be more carefully used, particularly in selecting an appropriate sample size. In our case, our sample size is 240, which is much larger than the marginal sample size.

Table 5: PLS Confirmatory Factor Analysis Results

Scale Items	Mean	S. D.	Item Loading	Standard Error
(1) Facilitating Conditions (FC) CR = 0.85, AVE=0.66				
FC1: I felt the grading process was fair.	3.13	1.15	0.91	0.018
FC2: I think the grading criteria given by the professor are explicit enough.	3.88	0.95	0.62	0.074
FC3: Using Ph. D. students as the second graders improved the grading fairness.	3.25	1.04	0.87	0.028
(2) Effort Expectancy (EE) CR = 1.00, AVE=1.00				
EE1: How easy/difficult do you find this course is?	4.05	0.94	1.00	0.000
(3) Perceived Learning (L) CR = 0.89 , AVE=0.53				
L1: I learned from making up questions.	3.55	1.08	0.67	0.067
L2: I learned from grading other students' answers.	3.63	1.06	0.67	0.058
L3: I learned from reading other people's answers.	3.54	1.07	0.68	0.067
L4: My skill in critical thinking was increased.	3.85	0.88	0.83	0.032
L5: My ability to integrate facts and develop generalizations improved.	3.88	0.83	0.78	0.059
L6: I was stimulated to do additional learning.	3.74	1.08	0.75	0.047
L7: I learned to value other points of view.	3.82	0.81	0.72	0.058
(4) Perceived Enjoyment (E) CR= 0.77, AVE = 0.54				
E1: I enjoyed the flexibility in organizing my resources.	3.88	1.00	0.60	0.076
E2: I was motivated to do my best work.	3.82	0.92	0.74	0.059
E3: I enjoyed the examination process.	3.51	1.13	0.84	0.026
(5) Performance Outcome (PO) CR = 0.88, AVE = 0.72				
PO1: What grade did you receive from the student who wrote the question?	81.22	16.43	0.81	0.077
PO2: What grade did you get from the second grader?	79.22	17.61	0.89	0.042
PO3: What final grade did you get from the instructor?	81.66	21.15	0.83	0.061
(6) Recommendation For Use (R) CR = 1.00, AVE=1.00				
R1: Would you recommend in the future that this exam process be used?	3.60	1.10	1.00	0.000

CR: Composite Reliability; AVE: Average Variance Extracted; S.D.: Standard Deviation
Construct Scale: Performance Outcome (PO) is from 1-100; Effort Expectancy (EE) scale: Difficult: 5:4:3:2:1: Easy; the rest of constructs [Facilitating Conditions (FC), Perceived Enjoyment (E), Perceived Learning (L), Recommendation for Use (R)]: Strongly Agree: 5:4:3:2:1: Strongly Disagree

Hypotheses Testing

According to Chin's recommendation (1998), bootstrapping with 1000 re-samples was performed on our proposed research model (Figure 2) to test the significance of path coefficients using t-tests. Our research model accounted for substantial variance in learning (R square = 0.56) and recommendation for future use (R square = 0.49), and modest variance in perceived enjoyment (R square = 0.28). In the PLS analysis results (see Figure 4, solid lines mean significant results, dashed line means non-significant result), we found the majority of the hypotheses were supported, as follows (see Table 6).

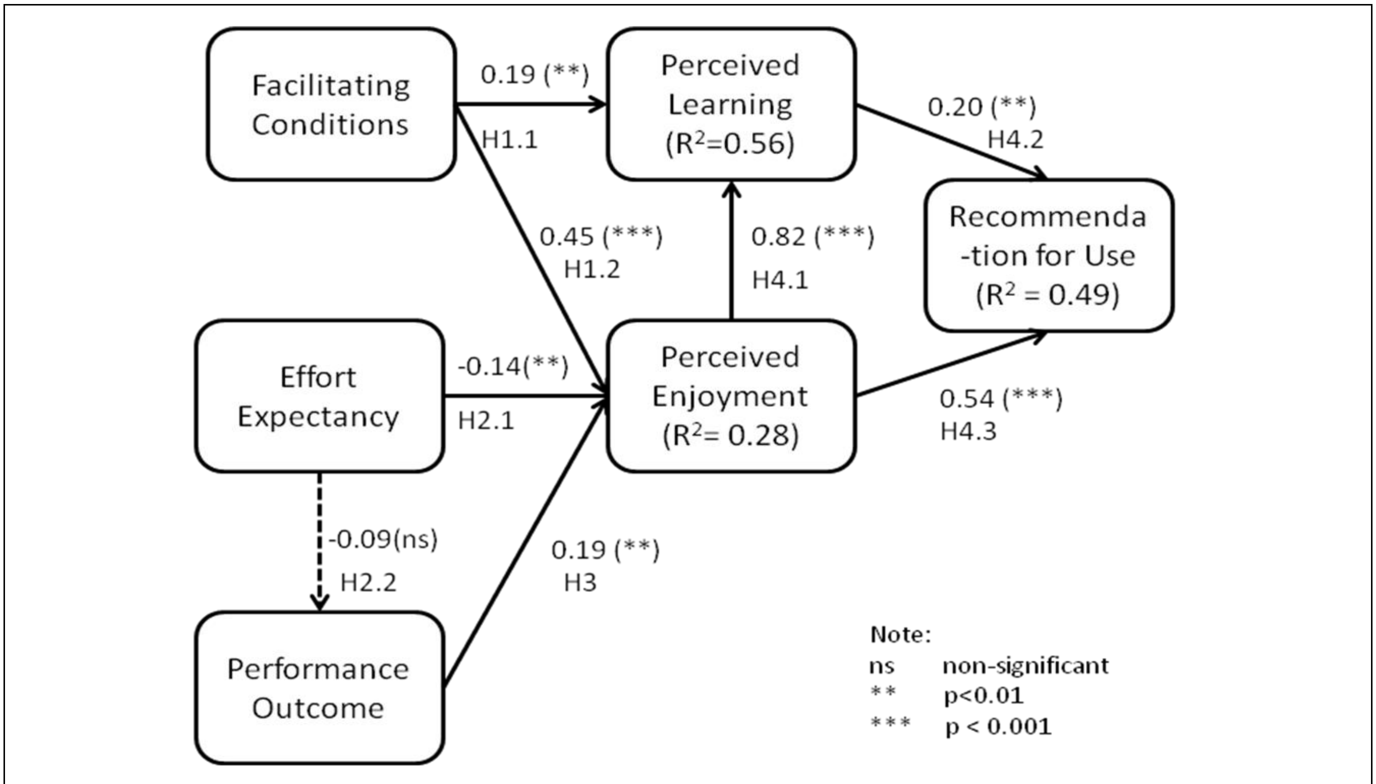

Figure 4: Results of Hypotheses Testing

Table 6: Hypotheses Results from PLS Analysis

Hypotheses	β Value	Significant P-value	Supported (Yes/No)
H1: Facilitating Conditions			
H 1.1	0.19	<0.01	Yes
H 1.2	0.45	<0.001	Yes
H2: Effort Expectancy			
H 2.1	–0.14	<0.01	Yes
H 2.2	–0.09	ns	No
H3: Performance Outcome			
H 3	0.19	<0.01	Yes
H4: Perceived Learning and Enjoyment			
H 4.1	0.82	<0.001	Yes
H 4.2	0.20	<0.01	Yes
H 4.3	0.54	<0.001	Yes

As is evident from Figure 4, the majority of hypothesized casual relationships among the research constructs are supported at a very significant level of confidence. “Facilitating conditions” is strongly associated with both “perceived learning” (Perceived Usefulness in the original TAM model; H1.1) and “perceived enjoyment” (Perceived Ease of Use in the original TAM model; H1.2). This indicates that for educational technology acceptance and adoption, it is important to have clear and explicit participant instructions (in our case, we used long explicit exam grading criteria). In addition, when we ran another correlation analysis with the Austrian group, we found the same positive relationship between “facilitating conditions” and “perceived learning.” Therefore, regarding educational technology adoption and acceptance, facilitating conditions significantly impacts student learning, which is the main goal of education.

Not surprisingly, “effort expectancy” was found to be negatively associated with “perceived enjoyment” (H2.1 is supported). More generally, “effort expectancy” could represent certain levels of participant frustration with the new technology, which has a negative impact on Perceived Ease of Use. The only insignificant path in our research model is from “effort expectancy” to “performance outcome” (H2.2, $\beta = -0.09$). Perhaps for students who have good self-motivation, “effort expectancy” is not a significant determinant to predict their learning outcomes. However, “performance outcome” is a good predictor of whether or not students enjoyed the learning process (H3 is supported with $\beta = 0.09$ and $p < 0.01$). In our extended TAM model, H4.1 ($\beta = 0.82$, $p < 0.001$), H4.2 ($\beta = 0.20$, $p < 0.01$) and H4.3 ($\beta = 0.54$, $p < 0.001$) are strongly supported. This implies that “perceived enjoyment,” “perceived learning,” and “recommendation for use” can be three valid and reliable determinants for general educational information technology acceptance, since this research validates these three constructs.

VI. QUALITATIVE INSIGHTS FROM OPEN-ENDED QUESTIONS

We collected some valuable student opinions from the open-ended questions on the best and least liked features of the process that help explain the results. Two major controversial concerns are grading fairness and procedure control. These seem to indicate that facilitation conditions must be set up correctly to increase intention for adoption. Students greatly worried about the qualification of peer graders, some of whom were regarded as “difficult graders.” Some students were also afraid of being negatively evaluated by peers giving low grades, so they preferred that the professor do all grading. Possibly this is because of competition among the students. These concerns and motivations are expressed in the following comments from U.S. students:

- “In the online exam, one of the drawbacks is the grading of the learners is not uniform and it varies significantly.”
- “Different people and communities were different in labeling something “great,” ”good,” or “OK.” Hence the students’ grades may have this bias. A way of leveling this gap should be found.”
- “When learners are asked to grade each other, the attitude is to improve one’s own chances by aborting another’s chance. In this attempt, the majority of the students give less marks to their peers. This will not be the case if the instructor himself grades the answers….”

Concerns from Austrian students also focused on peer grading:

- “I think the process of grading should remain with the professor. Creating exam questions is a good and effective thing, but the grading made me feel uncomfortable and I did not enjoy it at all.”
- “The grading wasn't fair in my opinion. Some people didn't really care about mistakes, missing issues or something like that and gave the subject who answered full credit. The graders just didn't want to give bad marks. But on the other hand if you compare a maybe better answer that was strictly graded with only 22 points just because some little thing wasn't mentioned, it isn't fair if you see it in relation! Furthermore some people just wrote one sentence in their grading like: ‘Very good thoughts, so I'll give you full credit.’”

On the other hand, several comments indicated that many students felt that the peer grading procedures were not only “fair” but also beneficial to learning. For example, an Austrian student said:

- “For me it was perfect the way it has been conducted. I think it's good that the instructor does the final grading and not the students. Therefore I have a better feeling that the grading is fair.”

And a U.S. student noted:

- “The questions I asked were answered in a totally different manner than I expected, but they were good answers.”

This provides evidence that in at least some cases, the grading process itself (i.e., facilitating conditions) contributed to the "deeper" learning and broader perspectives that we hoped would emerge from the participatory exam process.

In answering the open-ended question about *best liked features* of the process, the students expressed liking the participatory exam in many ways. They reported they did enjoy having time and location flexibility for allocating their resources to create and integrate exam answers. Anonymity features were favored, under which students enjoyed sharing and learning new knowledge by reading and criticizing peers' work. Overall, by participating in the participatory exam, the students got to understand their peers better, and thus the technology and pedagogical procedures of our participatory exam seem to offer a desirable communication channel for the students' collaborative learning.

Best liked features from U.S. students:

- "I liked the fact the learners build questions for other learners to work on. This gives the perspective of a learner who may not be an expert and as experienced as the instructor."
- "The best was that I wrote my point of view and gathered others' views on a particular subject. It made me do some research on the topic and think on a broader perspective. Moreover, we didn't feel the pressure of giving a final exam as we all feel in the classroom."
- "I think this exam was a better way to measure the learners' knowledge than in class exam. It was an excellent way to review and integrate all class materials together."
- "I like the anonymous environment, you didn't have a clue to who wrote the questions and who was the second grader. I believe this brings fairness to the exam because no one can show favor to his/her friend. I believe that having the professor assign questions for us to answer and grade is a way of fairness as well."
- "The best thing about this exam was collaboration with people. Mostly we got to know the class through their questions, answers, queries, disagreements put on the WebBoard. It was fun, understanding each one of the class members even without ever meeting with them."

Best liked features from Austrian students:

- "The best part was to answer the questions from fellow classmates instead of instructor."
- "First, the flexibility of online examination is greater than a traditional exam. We can arrange our exam process within the deadline that professor assigned use…. It is interesting and exciting to try it out…. With a member that you don't know, you have to improve your expression and to work much harder to make sure that others get your idea and accept your point of view. In a word, it's of great fun!"
- "The student's integration in building questions as well as answering, grading, and reviewing processes represents the most innovative and motivating aspect to me."
- "Although it was very stressful to write two pretty long answers on not very easy questions in this exam, I really have to say that I preferred it to an usual exam … because you didn't have to learn in advance, but you had time to go into your assigned topic very deeply—deeper than you would have done it by learning for a usual exam! This is more effective in my opinion."
- "I enjoyed it very much to create my own questions and to be confronted with the other point of view (from a teacher's view). Furthermore I could formulate questions to topics I'm really good at and where I have a lot of understanding and information."
- "I liked to be in different roles (teacher, student, grader), this shows you different points of view and helps to understand other students, teachers…."

VII. LIMITATIONS AND POSSIBLE FUTURE RESEARCH

The U.S. study that provided sufficient data to build and test the research model was limited to a single graduate course at a single university. The course was appropriate for integrative essay-type questions. Moreover, all instructors involved were enthusiastic volunteers. How would the participatory exam process need to be modified for different types of courses? Would the findings be different for courses in which more memorization is required? Would this procedure work as well if it became "routine" and/or were actually required of instructors, some of whom believed that the traditional exam process was better? How would the procedures themselves need to be changed to fit different course management systems, and would this affect the outcomes? Will students from non-Western cultures have very different reactions? These questions of generalizability of results can only be answered if the study is replicated for a wider variety of courses and contexts.

Our replication in Austria does indicate that the results are at least somewhat generalizable to different courses and cultural contexts. However, the total number of students for these courses was very small and not sufficient to test the theoretical model in a different cultural context. There was also an indication that the collaborative learning paradigm, especially as extended to the exam process, may not be compatible with the higher-education culture of some nations. One of the courses initially had six Chinese exchange students in it, who were in Austria for only one semester. Three of the six did not turn in questions and dropped the course during the final exam. Would they have dropped if the final exam process had been traditional? Their e-mail messages indicated that the decision to drop was due to conflicting academic demands, but one cannot help but think that the decision to drop that course instead of another one may be because the procedure was so "foreign" to them. Interesting enough, we found that students for whom English is not the first language reported higher "perceived learning" from a correlation analysis performed with the large U.S. data set ($p < 0.01$). These results indicate that culture differences exist and may warrant further investigation.

Other limitations are that the five-semester U.S. study did not have a "control" group and learning was measured only by student self-report. However, a follow-up study by another researcher [Shen et al., 2008] did compare course sections using traditional exams to sections using one of two forms of participatory exam, individual participation in creating and grading exam questions, and "collaborative" participation, in which small groups of students work together in creating and editing questions and in grading answers. Control sections used questions selected from those used designed by students in matching sections of the course, but were assigned and graded solely by the instructor. Those results show that the collaborative examination significantly enhanced interaction and promoted higher order learning, as compared to traditional exams. In particular, small group activities in the online learning process significantly increased interactions among students, which enhanced their sense of an online learning community. Thus, it is important to realize that participatory exams can involve different "forms" of participation, and that some forms may be more effective than others. Much more extensive field experimentation will be necessary to explore these issues further.

Further refinement of adaptations of constructs from the Unified Theory of Acceptance and Use of Technology Model (UTAUT) should be explored in future research. As the participatory exam is used in more courses, students will have a chance to "experience" it in successive semesters. This could in turn provide "social influence" to other students, encouraging them to buy into this examination approach [Hu et al., 2003; Lee et al., 2003a]. Will this added experience and social influence affect how students approach studying and learning, and their attitude toward education and training? Would students thus have overall greater acceptance and adoption of the participatory exam over time?

Finally, the UTAUT construct Facilitating Conditions or the belief that organizational and technological infrastructures support the new exam, leads us to ask whether an improved infrastructure would improve exam effectiveness (User Behavior). Accordingly, future research should focus on improving the software environment to reduce administrative overhead and streamline process flow. Preliminary examples include providing better scaffolds or tools for assessment (e.g., templates for correctly and completely inputting the various grading criteria), linking students and instructors directly to pending items in the exam for their attention, and automatically e-mailing students who are late in posting items.

This research has considered only acceptance and adoption by students. If the innovation is to spread, then faculty acceptance is crucial. In particular, even if participatory exam processes have superior learning outcomes, faculty will resist the innovation if they feel that it is more work. Although this study was limited to student perspectives, the follow-up field experiment by Shen et al. [2008] also included a total of eight post-exam interviews with five faculty members. (One faculty member participated in the study in all three semesters and was interviewed three times. Another faculty member participated in the study in two semesters and was interviewed twice.) Faculty members were asked in the interview whether they felt it was a lot of work in:

- Adapting the online exam to the existing course structure.
- Grading the online exam compared with the traditional exam.

Three out of five professors reported that it was not a lot of work to adapt the online exam to their courses. Three out of the five faculty members also reported it was more work for them to grade the online exam compared with a traditional exam, because they had had to grade not only the answers, as in a traditional exam, but also the questions and the grading. Particularly in examining faculty acceptance, it would be important to conduct longitudinal studies that focus on "users' adaptation, learning and motivation behaviors around a system" [Benbasat and Barki, 2007, p. 215]. One of the two faculty members who participated in the exam more than once initially reported the exam was more work, but then the following semester the total amount of time probably evened out or was less than the traditional exam. Much more extensive field experiments would be necessary to resolve key issues of the relative amount of faculty time needed and how it changes with experience, and to document instructor's strategies and software features for their support in conducting this new type of examination process in the most efficient and effective way possible. For example, over time faculty may learn to better judge when to trust grades assigned by the first and second graders that are close in agreement without needing to spend time reviewing them.
UTAUT also gives us guidance for investigating acceptance by instructors and trainers, which would be very useful. Would they expect their students to perform better (learn more)? Would the expected effort involved in switching to and conducting participatory exams dissuade them from use, and could this be counteracted by improved streamlining within supportive software? As other instructors become advocates, would the social influence of their peers convince an instructor to utilize participatory exam technologies [Hu et al., 2003]? Because use presumably would not be mandatory for instructors, will intention to use translate into actual use [Turner et al., 2009]? Convincing instructors may be strategically more important to the widespread adoption of participatory exams than getting students to recommend them.

A (task) training construct was included in an extended TAM model [Venkatesh, 2000], determining that the more enjoyable the training, the more users will perceive that the system is easy to use, which in turn increases intention to use. It seems logical that training students in the process of creating questions and grading solutions would ease their concerns and make the entire process more enjoyable. This then highlights the opportunity to develop online training tools that will guide students through these activities and thereby help them learn more effectively, which is our overall goal. Similarly instructors could be trained in how to administer participatory exams, which could increase their acceptance [Hu et al., 2003].

VIII. SUMMARY AND CONCLUSIONS

Little prior research has been undertaken to test technology acceptance constructs in evaluating pedagogical techniques for higher-order thinking, and subsequent usage intentions. Student acceptance of the asynchronous participatory exam innovation comes both from perceiving that one has learned from the process and from intrinsic motivation such as enjoyment of the experience afforded by its process and structure. The participatory exam design incorporates learning opportunities in every stage, which relies on the peer interaction facilitated by the online environment. The engagement and ownership that students feel in the exam activities add to their learning and enjoyment, as does the peer-supportive spirit inherent in the process. This research thus contributes a successful, new technology-supported peer examination process, an application of the TAM to an educational technology, and a set of validated research instruments for this domain.

The participatory exam uses computer-mediated communication to support a process in which students participate actively in all phases of the exam process: making up exam questions, answering them, and providing grading and critique for answers to the questions they designed. Post-exam surveys in two countries showed that students reported that they enjoyed this process, and that they felt that they learned from it, not just overall, but from all three phases. Most of the hypotheses derived from an adaptation of the TAM/UTAUT theoretical models to this context are supported. In particular, qualitative comments from students as well as quantitative results show that the issue of perceived fairness of the peer grading process is important to perceived outcomes. Furthermore, for the quantitative test of the model, the relationship between facilitating conditions, perceived learning and perceived enjoyment was very positive and significant. Further research would be necessary to explore the role of other facilitating conditions besides a perceived fair grading procedure.

Overall, our results support the premise that information technology can indeed be used to transform education, not just to automate the "old" ways of doing things in the face-to-face environment [Leidner and Jarvenpaa, 1995]. They illustrate that processes can be developed that involve much more collaborative and cooperative learning activities. These processes change the roles of students, making these and instructor roles somewhat more interchangeable. Our online participatory exams require instructors as "virtual professors" to take more in-depth cognitive roles (e.g., deal with students' disputes) and managerial roles (e.g., require more attention to students monitoring and structured learning procedures) [Coppola et al., 2002].

We have found that TAM, UTAUT and related models of technology acceptance are useful tools that can be adapted for analyzing and understanding acceptance of educational technologies. They help us better understand the success of the asynchronous participatory exam, and why students accept it and recommend its continued use. They provide a framework for analyzing the approach and technology to determine means for improvement. This research, therefore, challenges instructors and organizations to adopt a new paradigm for effective peer assessment enabled through educational technology.

ACKNOWLEDGEMENTS

We thank Dr. Wynne Chin for his PLS-Graph Version 3.00 software that was used for the statistical analysis in this paper. This research was partially supported by the Alfred P. Sloan Foundation, the Fulbright Scholar Program, the U.S. National Science Foundation (under grants DUE-0434581, DUE-0736961 and DUE-0434998) and the Institute for Museum and Library Services (under grant LG-02-04-0002). We are grateful to our reviewers and the journal editors for their excellent suggestions for revisions of an earlier version. The opinions in this paper are solely those of the authors.

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Communications of the Association for Information Systems

ISSN: 1529-3181