Int. J. Human-Computer Studies (2002) **56,** 475–494
doi:10.1006/ijhc.1004
Available online at http://www.idealibrary.com.on IDEAL®

Learner outcomes in an asynchronous distance education environment

Alan D. Carswell
Graduate School, University of Maryland, University College, 3501 University Blvd E, Adelphi, MD 20783, USA. email: acarswell@umuc.edu

Viswanath Venkatesh
Robert H. Smith School of Business, University of Maryland, College Park, MD 20742, USA. email: vvenkate@rhsmith.umd.edu

(Received 6 March 2001 and accepted in revised form 5 April 2002)

This research investigated student outcomes in a web-based distance learning environment characterized by asynchronous electronic communications between student and teacher. We employed two dominant theories—the theory of planned behavior and innovation diffusion theory—to study student reactions to web-based distance education. We hypothesized that student perceptions of the technology are positively related to learning outcomes and intentions to further use the technology, and are negatively related to using alternative, synchronous media in the learning experience. Quantitative and qualitative data were gathered from 540 students via a web-based survey. Partial support was found for the hypotheses. Theoretical and practical implications for human–computer interaction, distance education and user acceptance are discussed.

KEYWORDS: asychronous distance education; distance learning; innovation diffusion theory; theory of planned berhavior.

1. Introduction

Asynchronous distance education is an alternative model of learning where student and teacher are not located in the same classroom at the same time. Faster and more economical computing power, high-speed communications networks, and the standardized, interoperable software and communications technologies manifested by the World Wide web provide ways to link diverse locations to produce powerful virtual learning environments. In recent years, there has been an explosion of educational institutions offering their courses and even entire degree programs asynchonously via the web. Peterson's, the College Guide, listed 93 institutions offering on-line education in 1993, with the number increasing to almost 800 by 1997 (Gubernick & Ebeling, 1997). Another source cites a 10-fold growth, from 3% to over 30% of colleges and

universities offering some form of distance learning between 1990 and 1995 (Tucker, 1995). The business world has also joined in the rush to offer web-based asynchronous distance education to their employees. There are many anecdotal examples of organizations taking advantage of advances in information technology to train employees via distance learning (see Ganzel, 1998; Lohman, 1998; Roberts, 1998). Organizations are particularly attracted by efficiencies such as reduced downtime and lower travel expenses. Breaking the same time/same place mold provides flexibility in learning to accommodate the needs arising from geographical dispersion and conflicting schedules. Information technology suppliers have rushed products to market that facilitate such distance education (Schaaf, 1997; Edwards, 1998; Whiting, 1999). New information technologies provide solutions to meet the infrastructure challenges posed by distance education.

Although asynchronous distance education has increased in use, most research to date on technology-mediated distance learning has been in a synchronous environment (Alavi, 1994; Alavi, Wheeler & Valacich, 1995; Webster & Hackley, 1997) or an environment with mixed synchronous and asynchronous features (Alavi, Yoo & Vogel, 1997), where students have the opportunity to interact with their classmates and the instructor in real time in person or via videoconferencing facilities. Such research has sought to assess the effectiveness of distance learning outcomes by comparing outcomes in such an environment with outcomes in an equivalent face-to-face class (Alavi, 1994; Storck & Sproull, 1995; Webster & Hackley, 1997; Spooner, Jordan, Algozzine & Spooner, 1999). Most of this research has found little or no difference in outcomes that are attributable to differences between face-to-face and distance environments (see Russell, 1998). This ''no significant difference'' literature has concluded that there may be unexplored factors or interactions affecting educational outcomes (Hiltz, 1994; Webster & Hackley, 1997; Spooner *et al.*, 1999). There have been limited scientific investigations of asynchronous distance education environments (Wegner, Holloway & Garton, 1999; Kyounghee Lim, 2001). Most research into web-based asynchronous education has been atheoretical, anecdotal or descriptive in nature, consisting of discussions of instructor and student experiences and ''how-to'' guides. Quantitative information often consists of surveys of student satisfaction, using unvalidated instruments. In this research, we scientifically examine a completely asynchronous learning environment where the students were separated in time as well as place from their classmates and their instructor, thus contributing to the embryonic literature on asynchronous distance education.

As web-based asynchronous distance education becomes more widespread, understanding the important determinants of effectiveness is critical. Because the interactions between student, instructor and content are mediated by technology (Hillman, Willis & Gunawardena, 1994), it is particularly important for human–computer interaction (HCI) researchers and practitioners to understand the various determinants leading to effectiveness of this powerful new avenue of learning. Understanding the determinants will allow us to design systems that are more effective at meeting educational goals. The purpose of this research is to study the success of a web-based asynchronous learning environment, employing two well-established theories, namely the theory of planned behavior (Ajzen, 1985, 1991) and innovation diffusion theory (Rogers, 1995). We also investigate a range of success measures—i.e. acceptance outcomes (involvement,

engagement and use of alternate media), learning outcomes and future intention to use asynchronous distance education technologies.

2. Background

2.1. ASYNCHRONOUS DISTANCE EDUCATION

Although no single definition for the term distance education exists, there are key characteristics of distance education that researchers and practitioners agree on: (1) separation of instructor and learner; (2) use of media and (3) two-way communication between instructor and learner (Mood, 1995). In a distance learning situation, the student and teacher are separated in space. There is no requirement of a fixed place for the student and teacher to meet, which increases flexibility in scheduling educational activities. Spatial separation may or may not be accompanied by temporal separation, which leads to the distinction between *synchronous* and a*synchronous* distance education. Synchronous distance education consists of real-time interaction between student and teacher, although they are in different places—e.g. a telephone call between instructor and student that extends the classroom walls. However, the teaching/learning metaphor is still the classroom. Technological tools such as videoconferencing, teleconferencing and Internet chat rooms facilitate synchronous distance education. Asynchronous distance education dismisses the metaphor of the classroom by designing an educational environment without real-time interaction between student and teacher. Instead, there may be a delay of hours or days between a question or comment and a response to it from the instructor or another student. To overcome the limitations introduced by distance, asynchronous distance education uses a medium that facilitates communication between instructor and learner. This can be as conventional as postal mail in a correspondence course, which was how most distance learning was done in the past (Mood, 1995). With the advent of advanced information technologies (e.g. Internet, email and World Wide web), new ways and patterns of communicating have opened up.

2.2. USER REACTIONS TO TECHNOLOGY

When taking a course in a web-based asynchronous environment, a student is exposed to a novel set of technologies, and/or new implementations of those technologies. A web-based asynchronous learning environment is an implementation of an information system, thus allowing us to judge its success by drawing from relevant prior research on information system success. System success is a multifaceted construct (DeLone & McLean, 1992), consisting of quality measures, user attitudes, performance and user behaviors. Because systems first have to be used for other measures to be meaningful, a number of theoretical approaches have focused on the factors that lead to user acceptance of the technology. In keeping with this broad view of system success, the current research studies multiple, broad dependent variables. Specifically, we examine three sets of dependent variables: (1) acceptance outcomes—involvement, engagement and use of alternate media to communicate with the teacher and/or other students, (2) learning outcomes—expected grade and (3) future outcomes—intention to learn via asynchronous distance education in the future. Consistent with prior research, we

employ user reactions to the technology as predictors of system success. The theoretical approaches used in this research predict the acceptance of a technology based on the user's perceptions of the technology's beneficial qualities. Empirical research using these theories has typically studied intent or usage. Given the enormous investments of schools in order to offer distance education, it is logical that student outcomes and the factors influencing these outcomes, and whether or not students would want to continue taking courses via distance education would be of interest to educational institutions.

3. Theory development

Information technology has a pivotal role in distance education as the interface between the learner, the content and the instructor. This research investigates how the learner's perceptions of using the technology affects student acceptance of the new learning environment and its impact on related outcomes. Two theoretical approaches are used in the current research: the theory of planned behavior (Ajzen, 1985, 1991) and innovation diffusion theory (Rogers, 1995).

The theory of planned behavior (TPB; Ajzen, 1985, 1991) postulates three determinants of an intention to perform a behavior: attitude toward the behavior, subjective norm regarding the behavior and perceived behavioral control (Orbell & Hodgkins, 1997). Attitude toward using the system is defined as the positive or negative feelings toward behavior of putting the system to use; subjective norm "refers to the perceived social pressure to perform or not perform the behavior" (Ajzen, 1991, p. 188); perceived behavioral control is the perception of ease or difficulty associated with performing the behavior (see Ajzen, 1991). TPB has been widely applied across a range of disciplines such as marketing/consumer behavior, leisure behavior and medicine (see Ajzen, 1991 for a review). TPB has also been applied to study the adoption of new technologies (e.g. Mathieson, 1991; Taylor & Todd, 1995; Harrison, Mykytyn & Riemenschneider, 1997; Morris & Venkatesh, 2000; Venkatesh, Morris & Ackerman, 2000).

Innovation diffusion theory (IDT; Rogers, 1995) predicts acceptance based on the user's perceptions of the technology or innovation. Innovation diffusion has been defined as the process by which information about the innovation (e.g. technology) is communicated among individuals in a social setting (Rogers, 1995). Many studies have investigated the relationship between an information technology's perceived characteristics and its adoption (e.g. Agarwal & Prasad, 1997, 1998). IDT as applied to user acceptance and usage of technologies suggests six perceived innovation (technology) characteristics to be of relevance: relative advantage, ease of use, result demonstrability, visibility, trialability and compatibility (Moore & Benbasat, 1991). Relative advantage is the extent to which the system is superior to its predecessor; ease of use is the extent to which the system is perceived as being free of effort; result demonstrability is the extent to which one can understand and explain the output of the system; visibility is the extent to which the system is seen in the social setting; trialability is the extent to which the system can be tried out; compatibility is the extent to which using the system fits with one's existing value system (see Davis, Bagozzi & Warshaw, 1989; Moore & Benbasat, 1991).

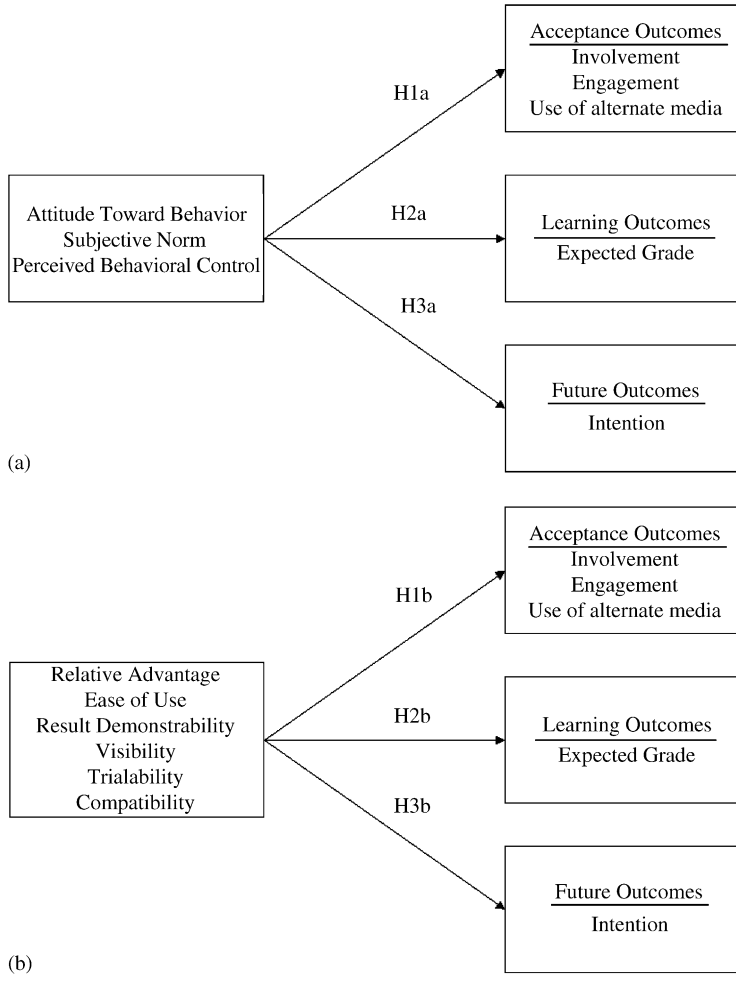

FIGURE 1. (a) Research model with theory of planned behavior. (b) Research model with innovation diffusion theory.

4. Hypotheses

The proposed research models are shown in Figures 1(a) and (b), respectively. Figure 1(a) is derived from TPB, and Figure 1(b) is derived from IDT. As discussed earlier, we examine three acceptance outcomes: involvement, engagement and use of alternate media. Alavi (1994) suggested that cognitive models characterize learning as an involved, active process where learners construct meaning from the material studied by processing it through existing mental models. Webster and Hackley (1997) stated that designing courses to be engaging encourages and facilitates learning. Consistent with the theory of planned behavior, Figure 1(a) suggests that acceptance of the technology is positively influenced by attitude, subjective norm and perceived behavioral control. Consistent with innovation diffusion theory, Figure 1(b) suggests

that acceptance is positively influenced by perceptions of the innovation characteristics. Therefore,

H1(a): Acceptance of the technology in an asynchronous, technology-mediated distance education environment will be positively influenced by attitude, subjective norm, and perceived behavioral control related to using the technology.
H1(b): Acceptance of the technology in an asynchronous technology-mediated distance education environment will be positively influenced by user perceptions of the innovation characteristics of the technology.

Further, the models suggest that these perceptions also influence learning outcomes. As noted earlier, DeLone and McLean (1992) suggested that the success of an information system is comprised of several facets, including system and information quality, system use, user satisfaction and individual impacts. Because the purpose of the technology under investigation in this research is to foster learning, we chose to focus on the primary individual impact, i.e. learning. This leads to our next pair of hypotheses.

H2(a): Learning in an asynchronous technology-mediated distance education environment will be positively influenced by attitude, subjective norm, and perceived behavioral control related to using the technology.
H2(b): Learning in an asynchronous technology-mediated distance education environment will be positively influenced by user perceptions of the innovation characteristics of the technology.

Students' intent to use technology-mediated distance education courses in the future is of vital interest to institutions that offer such courses. If students intend to continue taking courses this way, it can be deemed a favorable outcome in the long run. Further, understanding the factors that play a role in determining such intent will be helpful in designing the system. Thus, the intent of the student to continue to use the environment in the future will be predicted via the independent variables from the theory of planned behavior and the innovation diffusion theory. This leads to our third pair of hypotheses.

H3(a): Future intent to use an asynchronous technology-mediated distance education environment will be positively influenced by attitude, subjective norm and perceived behavioral control related to using the technology.
H3(b): Future intent to use an asynchronous technology-mediated distance education environment will be positively influenced by user perceptions of the innovation characteristics of the technology.

5. Method

5.1. PARTICIPANTS AND SETTING

The participants in this research were primarily part-time students in the graduate school of a large university in the United States. Oriented toward adult learners who work full-time, the university offers courses primarily at night, on weekends and

asynchronously via the web. Consistent with the graduate school's degree programs, classes had a managerial focus, although some courses had a large technology component. The school employed its own technology for delivery of the on-line courses. The technology was a web-based suite of software, utilizing Lotus Notes and Domino, as well as custom-developed applications. Students had email access and web access (via a Netscape browser).

A typical on-line course consistsed of weekly modules, where the instructor posted materials to supplement assigned readings from textbooks and articles. Questions were posted to a computer conferencing facility by the instructor and students, and students responded to these questions. Other student assignments included exams, projects and individual/group papers. Student–student and student–instructor communications were primarily asynchronous via email and the conferencing facilities. There were occasions when the student used synchronous communications channels (e.g. phone and personal visits), although this was very rare.

5.2. PROCEDURE

An email message was sent out to approximately 1800 graduate students registered in web-based courses at the university. The email asked students to voluntarily respond to a survey, and provided the web address for the on-line survey used in this research. Students accessed and completed the survey using their browser by clicking the mouse button on the choice that reflected their response to each question. In addition to these questions, the students also had an opportunity to provide open-ended feedback by sending an email to the senior author. After the completion of the survey, the student pressed the "Submit" button that displayed a second web page thanking her/him for the participation and providing the email address of the senior author, from whom they could request a copy of the results. The actual responses to the survey were forwarded anonymously to the senior author via email. The survey was open for approximately 3 weeks, during which time 540 responses were received. After this period of time, the data gathering was ended by replacing the survey web page with another page providing the email address of the senior author.

5.3. MEASUREMENT

The survey used previously validated scales measuring the constructs of interest, where possible. In many cases, however, shorter versions of the scales were used in order to comply with the overall length restrictions imposed by the participating university and to enhance the response rate. This trade-off was deemed acceptable as it allowed for the opportunity to collect real-world data on the important phenomenon of distance education. Appendix A shows the scales used.

TPB predictors: Scales to measure attitude, subjective norm and perceived behavioral control were adapted from previous research (Taylor & Todd, 1995; Morris & Venkatesh, 2000; Venkatesh *et al.*, 2000). Students indicated their level of agreement or disagreement to each statement along a seven-point Likert scale.

Perception of innovation characteristics: Scales to measure user perceptions of innovation characteristics of ease of use, results demonstrability, visibility and

trialability were derived from the work of Moore and Benbasat (1991). These scales have also been used in Agarwal and Prasad (1997, 1998). Each of these scales consisted of a minimum of two items. An item measuring the perception of the innovation characteristic of compatibility was derived from Taylor and Todd (1995). As noted earlier, in order to keep the length of the survey within specified limits, the items measuring attitude were used as a measure of the innovation characteristic of relative advantage. This was deemed acceptable as much prior research has shown significant shared variance between these two constructs in rational decision-making situations related to technology (see Davis *et al.*, 1989; Morris & Venkatesh, 2000; Venkatesh *et al.*, 2000).

Acceptance outcomes: A one-item measure of involvement was adapted from Webster and Hackley (1997). A seven-item measure of engagement adapted from Webster and Ho (1997) was also included. To measure the usage of synchronous media, students were asked to indicate how often they resorted to synchronous communications (e.g. phone calls or personal visits) to communicate with their instructor.

Learning: Students were asked the grade s/he expected to receive in the course. The administration of the survey occurred toward the end of the semester, so students had received grades and feedback on assignments and possibly exam(s), and should have had a reasonable expectation of their final grade. Grades awarded by the school consist of "A", "B", "C" or "F". No plus or minus grades are awarded.

Future outcomes: A one-item scale of future outcomes was adapted from prior research (e.g. Davis *et al.*, 1989; Mathieson, 1991; Taylor & Todd, 1995; Venkatesh *et al.*, 2000). The students responded by indicating their level of agreement on a seven-point Likert scale to a statement that they intended to continue taking distance education courses in the future.

6. Results

Of the 1800 students solicited, 540 provided usable survey responses. Respondents to the survey answered a number of demographic and descriptive questions. Descriptive statistics of the sample are provided in Table 1. As the table indicates, the sample was more or less equally divided between female and male respondents. Most respondents were in their 30 s, which is representative of the student body of the subject institution. In terms of gender and age, the respondents were representative of the population of students enrolled in on-line courses enrolled at the university. Most students classified their jobs as managerial or technical, which was also expected, given the nature of the programs offered by the school. Although most students had already taken two or more courses at the school, almost half were taking their first on-line course.

Cronbach's alpha reliability estimates for the multi-item scales and descriptive statistics of constructs, including means, standard deviations and correlations are reported in Table 2. All multi-item measurements exhibited Cronbach's alpha values of at least 0.70, which is considered acceptable for psychometric research (Nunnally, 1978). This result was expected, given that the scales had been previously validated in other research (Moore & Benbasat, 1991; Taylor & Todd, 1995; Webster & Hackley, 1997; Webster & Ho, 1997).

TABLE 1
Descriptive statistics of the sample

	Number	% of total	
		Sample	All on-line Grad students
Sex			
Male	270	50.0	55
Female	270	50.0	45
Age			
Under 24	16	3	6
25–34	211	39	45
35–44	199	37	35
45–54	103	19	12
Over 55	11	2	2
Type of job			
Executive	35	6.5	*
Managerial	194	35.9	*
Supervisory	75	13.9	*
Admin/clerical	28	5.2	*
Technical	140	25.9	*
Other	68	12.6	*
Computer ability			
Novice	10	1.9	*
Intermediate	262	48.5	*
Expert	268	49.6	*
No. of on-line courses taken before			
None	256	47.4	*
1	124	23.0	*
2 or more	160	29.6	*
No of traditional courses taken before			
None	159	29.4	*
1	67	12.4	*
2 or more	314	58.1	*

Note: *University information not available.

To test the hypotheses, regressions were run using involvement, engagement, use of synchronous media, expected grade and intent to use in the future as dependent variables. The results of these regressions are shown in Table 3. Hypotheses H1(a) and H1(b) were partially supported—they were supported when studying involvement and engagement as the dependent variables, but were not supported when the use of synchronous media was the dependent variable. Specifically, from the perspective of TPB, the results suggest that attitude and subjective norm have a significant influence on the acceptance outcomes of involvement and engagement; from the perspective of innovation diffusion theory, only relative advantage had a significant effect on involvement, while only relative advantage and visibility had a significant effect on engagement. Hypotheses H2(a) and H2(b)—i.e. hypotheses related to learning outcomes—were not supported by the data. Although the sign of most of the beta coefficients was negative, as was predicted by theory, the coefficients were small in

TABLE 2
Descriptive statistics and correlations

	Mean	S.D.	ATT	SN	PBC	EOU	RD	VIS	TR	COMP	INVOLV	ENGAG	ALTUSE	GRADE	INTENT
ATT	5.87	1.37	1.00												
SN	4.69	1.49	0.59**	1.00											
PBC	6.26	0.85	0.49**	0.31**	1.00										
EOU	5.87	1.07	0.57**	0.40**	0.67**	1.00									
RD	6.10	0.83	0.43**	0.41**	0.56**	0.62**	1.00								
VIS	4.36	1.60	0.26**	0.36**	0.26**	0.31**	0.34**	1.00							
TR	3.50	1.81	0.30**	0.27**	0.28**	0.28**	0.24**	0.36**	1.00						
COMP	2.48	0.54	−0.05	−0.05	0.18**	0.10*	0.19**	0.05	0.01	1.00					
INVOLV	4.99	1.77	0.62**	0.47**	0.36**	0.41**	0.32**	0.27**	0.21**	0.09*	1.00				
ENGAG	4.84	1.51	0.72**	0.53**	0.37**	0.47**	0.37**	0.26**	0.29**	−0.14**	0.71**	1.00			
ALTUSE	1.30	0.69	−0.11*	−0.04	−0.06	−0.07	−0.08	0.07	−0.01	−0.03	−0.02	−0.06	1.00		
GRADE	1.48	0.54	−0.07	−0.02	−0.06	−0.01	0.04	0.01	−0.02	−0.02	−0.11*	−0.06	0.06	1.00	
INTENT	5.87	1.70	0.80**	0.51**	0.42**	0.48**	0.37**	0.19**	0.26**	−0.01	0.51**	0.60**	−0.10*	−0.11*	1.00

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Note: ATT = attitude, SN = subjective norm, PBC = perceived behavioral control, EOU = ease of use, RD = result demonstrability, VIS = visibility, TR = trialability, COMP = compatibility, INVOLV = involvement, ENGAG = engagement, ALTUSE = extent of use of alternate (synchronous) media, GRADE = expected grade, INTENT = intent to continue to use.

TABLE 3
Results of regression analyses

		Acceptance outcomes						Learning outcomes		Future outcomes	
		Involvement		Engagement		Use of synchronous media		Expected grade		Intention	
Models	I.V.s	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β
Theory of planned behavior	ATT	0.405	0.496*	0.536	0.611*	0.007	−0.122**	0.006	−0.066	0.646	0.750*
	SN		0.156*		0.163*		0.036		0.029		0.053
	PBC		0.067		0.027		−0.012		−0.038		0.044
Innovation diffusion theory	RA	0.394	0.546*	0.531	0.643*	0.039	−0.017	0.013	−0.064	0.682	0.628*
	EOU		0.046		0.040		0.011		−0.007		−0.005
	RD		0.018		0.032		−0.064		0.094		0.016
	VIS		0.111*		0.047		0.129*		0.012		−0.036
	TR		−0.018		0.058		−0.007		−0.009		0.025
	COMP		0.025		0.015		−0.151		−0.060		0.258*

*Significant at $p < 0.01$.

Note: ATT = attitude, SN = subjective norm, PBC = perceived behavioral control, RA = relative advantage, EOU = ease of use, RD = result demonstrability, VIS = visibility, TR = trialability, COMP = compatibility.

magnitude and were non-significant. Hypotheses H3(a) and H3(b)—i.e. hypotheses related to future outcomes—were partially supported by the data. From the perspective of TPB, only attitude had a significant influence over future intent to use the on-line learning environment. From the perspective of innovation diffusion theory, only relative advantage and compatibility were significant. In sum, although two of the dependent variables were not predicted well by independent variables from either theory base, involvement, engagement and intention were predicted well with the variance explained ranging from 39 to 68%.

6.1. POST-HOC ANALYSIS

As mentioned in Section 5, survey respondents could provide additional feedback on what factors they found important in their learning experiences. Students had an opportunity to provide open-ended responses via email to the senior author, and over 60 respondents did send an email, thus presenting other factors that the respondents deemed as influencing their experience in this environment. Although a quantitative analysis of these other factors and the frequency of their citation was beyond the scope of this research, a review of the comments revealed some important themes of interest to human–computer interaction researchers and practitioners:

- Organization of the course: knowing where to find materials, having a clear idea of what is where, when assignments are due.
- Instructor characteristics: responsiveness, "value-added" to textbooks and other materials, clear feedback on graded assignments, frequency and nature of interaction with students.
- Individual learning style of the student: preferences for textual vs. graphic representations, verbal vs. written preferences.
- Nature of interaction with fellow students.
- Social presence of fellow students and instructor.

For each of the themes identified above, Table 4 provides representative comments received from the respondents.

7. Discussion

This investigation applied the theory of planned behavior and innovation diffusion theory to a new application domain—technology-mediated, asynchronous distance education. Following the theory bases, the hypotheses suggested that user reactions to the technology from the two theories would influence individuals' current acceptance outcomes, learning outcomes and future outcomes. The data provided empirical support for the proposed research models, with theory of planned behavior and innovation diffusion theory determinants explaining significant variance in acceptance outcomes and future intent outcomes. Thus, the current work helps delineate the important factors, drawn from two dominant theory bases, that play a role in influencing a wide range of outcomes related to technology-mediated asynchronous distance education.

TABLE 4
Themes represented in open-ended answers

Theme	Sample comments
Course organization	. . .there should be a standard format for posting items—left to individual instructors, Lectures, Modules, suggested readings, items of interest, student input, syllabus, grading, and other postings are scattered about the many Web pages.
	. . .there are hypertext links and what amounts to ''hidden'' information all over the place.
Instructor responsiveness, ''value-added'' and interaction	[There are] several critical items that I feel are important to a successful learning experience such as instructor involvement, the instructor's ability to present information in a Web environment, etc.
	While [the user interface] is important, and WebClass has made vast improvments in this area, there is also the student/instructor aspect which is much more important.
Student learning style	. . .those I have spoken to who learn via reading versus involvement in classroon discussion etc, have improved their grades, and others have struggled and lost a letter grade.
	This medium precludes those learners who rely on personal interaction, sound and sight. This medium is well suited for those who prefer to take in information via reading.
Interaction with fellow students	Our [study] group uses email at least 3 to 4 times a week
	Of the sixteen people enrolled in my class, I have only communicated with three.
	[I feel that on-line] classes don't provide me with the level of information and knowledge I gain from personal, face-to-face interaction with the professor and other students. The system, however, is very appropriate for those who cannot go to a class and provides them access to the program
	I have found [my teammates and I] use WebClass to read the material placed on WebClass by the instructor but tend to email each other directly rather than using the study discussion groups.
Social presence of other participants	In a classroom setting, this perception of the teacher's ability to teach and or level of helpfulness to the student may be completely different but as an on-line student, the only way to judge this is by the written words of the instructor.
	There is no immediacy in communication and it makes dialogue almost impossible.

The emergence of a small set of factors helps provide some important insights into human–computer interaction in this context. The influential factors across the two theories that emerged were attitude, subjective norm, relative advantage, visibility and compatibility. The importance of attitude, relative advantage and compatibility can be related to the convenience of taking courses via the web vs. going to a class. Because the courses are delivered asynchronously the students are able to schedule their educational activities around their other responsibilities without having to meet a prescribed class

meeting schedule. The salience of visibility can be related to the extensive press coverage that has touted the importance and benefits of distance education via the web. Subjective norm refers to the students' perception of social pressure to perform the behavior. Its salience may be attributable to the fact that taking courses on-line makes the individual more available to persons important to them, either at work or at home.

In terms of acceptance outcomes, both involvement and engagement were well predicted by independent variables from both theories. Such a result is particularly positive as it gives us a good window into the specific factors that are important in determining key user-acceptance outcomes. The factors from the theory of planned behavior and innovation diffusion theory would influence the use of synchronous media. There was little variance in this measure (mean = 1.30 out of 4, S.D. = 0.69), and it seemed to indicate that there was little interaction between the students and their professors outside of the asynchronous learning environment. Students may have felt little need to call or visit with their instructors, or it may have been impractical; most students work full-time and many students live outside the metropolitan area where the school is located. This supported our conceptualization of the learning environment as more completely asynchronous than environments studied in previous research. In terms of the prediction of learning, little support was found. Using expected grade as a measurement of learning, little variance was explained by the independent variables. Similar to the use of synchronous media, this may also be attributable to limited variance in the dependent measure (mean = 1.48 out of 4, S.D. = 0.54), and that expected grade was a self-reported measure. Support was found for hypotheses relating the independent variables to future outcomes. Attitude, relative advantage and compatibility were found to be significant determinants. As with acceptance outcomes, their influence could be related to the fact that taking courses asynchronously allows students to schedule their educational activities around their other responsibilities, without having to meet a prescribed class meeting schedule.

8. Implications for research and practice

The use of a web-based form to gather survey data resulted in a good response rate of about 30%. Once the students received the email, they could point their browser to the form and fill out the survey quite easily. Most responses could be made with mouse clicks; little text-entry was required. Over a third of the responses were received the same day that the survey form was available. With this population of students already using the web for classes, the use of a web-based survey form was appropriate, and is recommended for future research in this area. One of the key practical constraints the researchers faced was the instrument length that was constrained by the participating university. Therefore, short scales, even one-item scales, had to be used in order to meet the length restriction imposed. However, the researchers felt this compromise was justified by the opportunity to collect a "large, real data set" related to distance education. Future research should address this limitation of the current work by employing a more complete measurement instrument. Because of the anonymity of the survey, all data collected were via the student. Thus, the data collected were limited to perceptual data. Future research might gather more objective data on the survey

respondents, such as actual grade in the course taken (as a measure of learning), number of courses taken and performance in other courses. A caveat, however, is that the response rate could possibly drop if the respondents knew that their responses would not be anonymous.

From a practical standpoint, removing place and time constraints on learning opens up vast new possibilities to create "virtual learning spaces" (Leidner & Jarvenpaa, 1995). Virtual learning spaces sustain discourse through interruptions and across distance and give it continuity over time (Scaramadalia & Bereiter, 1993). Of the ways information technology is used to aid learning, facilitating asynchronous learning perhaps has the most potential to transform the learning process (Leidner & Jarvenpaa, 1995). Research in this area would benefit from a conceptualization of the role of technology in an asynchronous distance education environment. What new modes of instruction are possible with modern information technologies? Can the learning experience be transformed to be better and more effective than traditional classroom instruction? If so, how? Under what circumstances? These are but some of the interesting questions to be asked and answered in this area.

9. Conclusion

Based on the established theory bases of the theory of planned behavior and innovation diffusion theory, the current work presented a first step toward building guidelines for the design of effective technology-mediated asynchronous learning environments. The current research represents one of the first efforts to collect a large real-world data set from graduate students regarding asynchronous web-based distance education. With the population of on-line learners, who pursue advanced degrees, vocational education or other courses (including executive education), growing rapidly, the current work's importance is underscored by its relevance to the successful design of learning environments and ultimately, success of courses offered on-line.

References

Agarwal, R. & Prasad, J. (1997). The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decision Sciences*, **28,** 557–582.

Agarwal, R. & Prasad, J. (1998). A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research*, **9,** 204–215.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckman, Eds. *Action Control: from Cognition to Behavior* . New York: Springer-Verlag.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, **50,** 179–211.

Alavi, M. (1994). Computer-mediated collaborative learning: An empirical evaluation. *MIS Quarterly*, **18,** 159.

Alavi, M., Wheeler, B. C. & Valacich, J. S. (1995). Using IT to reengineer business education: An exploratory investigation of collaborative telelearning. *MIS Quarterly*, **19,** 293–312.

Alavi, M., Yoo, Y. & Vogel, D. R. (1997). Using information technology to add value to management education. *Academy of Management Journal*, **40,** 1310–1333.

Davis, F. D., Bagozzi, R. P. & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, **35,** 982–1002.

DeLone, W. H. & McLean, E. R. (1992). Information systems success: the quest for the dependent variable. *Information Systems Research*, **3,** 60–95.

Edwards, J. (1998). Innovative training tools. *CIO Magazine*, **11,** 110–116.

Ganzel, R. (1998). The monster in the basement. *Training*, **35,** 69–60.

Gubernick, L. & Ebeling, A. (1997). I got my degree through e-mail. *Forbes*, June 16.

Harrison, D. A., Mykytyn, P. P. & Riemenschneider, C. K. (1997). Executive decisions about adoption of information technology in small business: theory and empirical tests. *Information Systems Research*, **8,** 171–195.

Hillman, D., Willis, D. & Gunawardena, C. (1994). Learner-interface interaction in distance education: an extension of contemporary models and strategies for practitioners. *American Journal of Distance Education*, **18,** 30

Hiltz, S. R. (1994). The Virtual Classroom: Learning Without Limits Via Computer Networks. Norwood, NJ: Ablex Publishing Corporation.

Kyounghee Lim, C. (2001). Computer self-efficacy, academic self-concept, and other predictors of satisfaction and future participation of adult distance learners. *American Journal of Distance Education*, **15,** 41–51.

Leidner, D. E. & Jarvenpaa, S. L. (1995). The use of information technology to enhance management school education: A theoretical view. *MIS Quarterly*, **19,** 265.

Lohman, J. S. (1998). Classrooms without walls: three companies that took the plunge. *Training and Development*, **52,** 38–40.

Mathieson, K. (1991). Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior. *Information Systems Research*, **2,** 173–191.

Mood, T. A. (1995). *Distance Education: an Annotated Bibliography*. Englewood, CO: Libraries Unlimited.

Moore, G. C. & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, **2,** 192–222.

Morris, M. & Venkatesh, V. (2000). Age differences in technology adoption decisions: Implications for a changing work force. *Personnel Psychology*, **53,** 375–403.

Nunnally, J. C. (1978). *Psychometric Theory* (2nd edn.). New York, NY: McGraw-Hill.

Orbell, S. & Hodgkins, S. (1997). Implementation intentions and the theory of planned behavior. *Personality and Social Psychology Bulletin*, **23,** 945.

Roberts, B. (1998). ://training via the desktop://. *HRMagazine*, **43,** 98–104.

Rogers, E. M. (1995). *Diffusion of Innovations* (4th edn.). New York: The Free Press.

Russell, T. L. (1998). *The No Significant Difference Phenomenon*. Raleigh, NC: Office of Instructional Telecommunications.

Scaramadalia, M. & Bereiter, C. (1993). Technologies for knowledge-building discourse. *Communications of the ACM*, **36,** 37–41.

Schaaf, D. (1997). A pipeline full of promises: distance training is ready to deliver. *Training*, **34,** A6–A12+.

Spooner, F., Jordan, L., Algozzine, B. & Spooner, M. (1999). Student ratings of instruction in distance learning and on-campus classes. *Journal of Educational Research*, **92,** 132–140.

Storck, J. & Sproull, L. (1995). Through a glass darkly: what do people learn in videoconferences? *Human Communication Research*, **22,** 197–219.

Taylor, S. & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research*, **6**, 144–176.

Tucker, R. W. (1995). Distance learning programs, models and alternatives. *Syllabus*, **9,** 48–51.

Venkatesh, V., Morris, M. & Ackerman, P. (2000). A longitudinal field investigation of gender differences in individual technology adoption decision making processes. *Organizational Behavior and Human Decision Processes*, **83,** 33–60.

Webster, J. & Hackley, P. (1997). Teaching effectiveness in technology-mediated distance learning. *Academy of Management Journal*, **40,** 1282–1309.

WEBSTER, J. & HO, H. (1997). Audience engagement in multimedia presentations. *The Database for Advances in Information Systems*, **28,** 63–77.
WEGNER, S., HOLLOWAY, K. & GARTON, E. (1999). The effects of internet-based instruction on student learning. *Journal of Asynchronous Learning Networks*, **3,** 98.
WHITING, R. (1999). Lotus boosts learning options. *Informationweek*, January 11, 30.

Paper accepted for publication by Associate Editor, Philip Barker.

Appendix A. Survey

Notes:

- The survey was formatted as a web page in which participants (i.e. students) could indicate their answers.
- Shown below are the scales with construct names.

Dear student:
Please take a few minutes to fill out this survey. In most cases, you can click on the appropriate selection to indicate your choice. Please be assured that your answers will be kept strictly confidential. When you are finished, click on the "Submit" button on the bottom of this page to send your survey.
Thank you for your support.

What webClass course did you take in the fall semester? (If you took more than one, please complete a separate survey for each course.) ————
Please indicate your level of agreement with the following statements in accordance with the scale below:
1. Strongly disagree
2. Disagree
3. Slightly disagree
4. Neither disagree nor agree
5. Slightly agree
6. Agree
7. Strongly agree

Attitude toward using the system
Using webClass is a good idea.
I like the idea of using webClass.
Using webClass is a wise idea.
Taking courses via webClass is pleasant.

Subjective norm
People who influence my behavior would think I should take courses via webClass.
People who are important to me would think that I should take courses via webClass.

Perceived behavioral control
I am able to use webClass.
Using webClass is entirely within my control.
I have the resources, knowledge and ability to use webClass effectively.

Relative advantage
Same items as attitude.

Ease of use
My interaction with webClass is clear and understandable.
I believe it is easy to get webClass to do what I want it to do.
Overall, I believe that webClass is easy to use.
Learning to operate webClass is easy for me.

Result demonstrability
I would have no difficulty telling others about the results of using webClass.
I believe I could communicate to others the consequences of using webClass.
The results of using webClass are apparent to me.
I would have no difficulty explaining why using webClass may or may not be beneficial.
Visibility
I have seen what others do using webClass.
It is easy for me to observe how others use webClass.

Trialability
Before deciding whether to use webClass, I was able to properly try it out.
I was able to use webClass on a trial basis long enough to see what it could do.

Compatibility
Using webClass fits into my work style.

Acceptance outcomes
(a) Involvement
I felt personally involved in the course.
(b) Engagement
Using webClass keeps me totally absorbed in the presentation.
Using webClass holds my attention.
Using webClass excites my curiosity.
Using webClass arouses my imagination.
Using webClass is fun.
Using webClass is intrinsically interesting.
Using webClass is engaging.
(c) Use of alternate media
During the semester, how often did you talk with the professor in person or by phone?
——Never ——Once ——Occasionally ——Frequently
Was there a group assignment in your class? ——Yes ——No

If so, how often did you talk with your classmates in person or by phone about class matters?
——Never ——Once ——Occasionally ——Frequently

Learning outcomes
What grade do you expect to get in this course?
——A ——B ——C ——F
Future outcomes
I intend to continue taking courses via webClass.

Other questions
What degree program and track are you in?————
What is your age?
——18–24 ——25–29 ——30–34 ——35–39 ——40–44 ——45–49
——50–54 ——55+
How would you classify your job position?
hExecutive/top management
——Middle management
——Supervisory
——Administrative/Clerical
——Technical
——Other
What is your sex? —Male —Female
What is the zip code of your home? ——
If you wanted to, could you take traditional (classroom) courses offered by this school?
——Yes ——No
How many webClass courses have you taken before this one?
——None ——One ——Two or more
How many traditional (classroom-based) graduate-level courses have you taken before this one?
——None ——One ——Two or more
How would you rate your ability to use personal computers and the World Wide web?
——Novice ——Intermediate ——Expert

About the Author. ALAN CARSWELL is a Collegiate Professor and Director of the MIS track in the MS in Management degree program at the University of Maryland, University College, in Adelphi, Maryland. He holds a Bachelor of Science in Civil Engineering from Northwestern University, an MBA from Harvard Business School and received his Ph.D. from the University of Maryland, College Park in 2001. His research interests include knowledge management and systems development. His dissertation research focused on facilitating student learning in an asynchronous learning environment.

About the Author. VISWANATH VENKATESH is a Tyser Fellow and Assistant Professor in the Robert H. Smith School of Business at the University of Maryland, College Park.

He received his Ph.D. in Business Administration (Information and Decision Sciences) from the University of Minnesota in 1998. His research focuses on understanding technology implementation. In addition, he has a keen interest, from a research and teaching perspective, in developing effective methods of training. His research has been published in *Management Science*, *Information Systems Research, MIS Quarterly, Organizational Behavior and Human Decision Processes, Personnel Psychology, Decision Sciences* and *International Journal of Human–Computer Studies*. He was a recipient of the Smith School's "Krowe Award for General Teaching Excellence" in 2000 and the "Teaching Innovation Award" in 1998 and 2001.