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Virtual learning effectiveness

An examination of the process

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Abstract *This study defines, examines, and measures the effectiveness of a corporate virtual learning program. Initially, distinctions between traditional and virtual learning and university and corporate programs are defined. Then, based on the literature, an integrative model of the perceived effectiveness of a virtual learning environment is developed and examined. The demographics, perceptions, and success of participants in a practitioner certification instruction program sponsored by a* Fortune *50 firm are found to be related to persistence and success in the program, as well as to the effectiveness of knowledge transfer. Conclusions and recommendations for further study are offered.*

Introduction

The medium is the message.

It has been nearly four decades since Marshall McLuhan (1966) used the preceding quote to differentiate television, a "hot" media, from radio, a generally "cooler" medium. Yet, this hauntingly prescient comment remains valid today as academicians and corporate learning officers struggle to enhance participant integration in virtual learning programs. Many have witnessed the impacts of virtual technology on the learning (meaning both education and training) market and the blurring of distinctions between formal academic and emerging corporate learning programs (Moore, 1997; Leonard, 1996; Porter, 1996). These changes are having a monumental impact on how knowledge is transferred from generation to generation by universities and among levels and across functions of an organization. However, though there has been much conceptualization, there is little high-confidence evaluation of the impact of technology on learning processes and outcomes. This paper evaluates the effectiveness of a virtual-learning program managed by a *Fortune* 50 corporation; it considers participant perceptions of technology impacts, the moderating effects of demographics, and the effectiveness of knowledge transfer.

Virtual learning is defined as the delivery of learning through electronic mediation which bridges the gap caused when the instructor and student are separated in either time or place (adapted from Leonard, 1996; Fell, 1996). The range of electronic mediation includes voice, video, data, and print through such formats as radio, television, Web-based programming, and streaming audio and video, as well as a variety of recording technologies. Given the multiplicity of mediating mechanisms and processes, it is not surprising that various classifications and stages of virtual learning development have emerged (Mandviwalla and Hovav, 1998; Moore, 1997; Smith, 2001; Meister, 1998; Greco, 1997; Bargeron *et al*., 2002). These technologies purport to permit delivery of learning which is "new, better, cheaper, and faster" (Bardach, 1997; Taylor, 2002) than traditional classroom methods.

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Traditional vs virtual learning

Though both traditional academic and virtual learning processes have notably converged in the past decade, they still can be differentiated. Larson (2002) categorizes traditional academic learning as teacher-centered instruction of synchronous and scheduled groups, constrained by classroom availability, while virtual learning is student-centered, asynchronous, and available anytime and anywhere. Similarly, Sauer (2001) describes virtual learning as adjusting to rapid obsolescence and requiring just-in-time training of transitory knowledge adaptable to a specific venue, as opposed to more stable and durable academic processes. A further elaboration by Smith (2001) distinguishes the spontaneous interaction of the traditional classroom from the extensive pre-preparation required by distance-learning formats. Kerka (1996) identifies advantages and disadvantages of virtual learning, summarizing that virtual learning can be both highly interactive and simultaneously isolating because of the inherent difficulties of developing cohesiveness and true connectedness among students. Unfortunately, as noted by Valenta *et al.* (2001), little serious research focuses on the use and effectiveness of virtual learning processes. Table I categorizes these distinctions between traditional academic and virtual learning environments.

The format evaluated by the present study is primarily a virtual learning environment. The company carries digitized voice and PowerPoint graphics on its Intranet to corporate participants across six time zones on both a real-time and delayed-access recorded basis. Participants use office desktop computers or laptops at home or elsewhere as the instructor "talks through the wire" to the group. They raise their hands, ask questions, indicate agreement or disagreement, or laugh, scowl, or applaud by clicking icons, and, if they need a break, they may "step out" of the virtual classroom. If they are not able to "attend" a session, they can review the digitized recording later and communicate with the instructor through phone or e-mail.

Participants are encouraged to take the five-course certified in production and inventory management (CPIM) examination preparation series offered by the Chicago Chapter of the American Production and Inventory Control Society (APICS). They are given instructions on how to sign up for the standardized CPIM certification examinations; however, there is no follow up by supervisors or other pressure to enroll in courses or to take the examinations. The program openly acknowledges multiple

	Traditional academic learning	Virtual learning
Focus of course	Group	Individual
Focus of content	Teacher-centered	Student-centered
Form	Synchronous	Asynchronous
Time	Scheduled	Anytime
Place	Classroom	Anywhere
Flexibility	Standardized	Customized
Content	Stable, durable	Dynamic, transitory
Number of students	Space delimited	Without limits
Instructor preparation	Some (transparencies)	Extensive pre-preparation
Distribution of materials	Hard copy	Electronic download
Interaction	Spontaneous	Structured
Range of interactivity	Full interactivity	Limited interactivity

Table I.
General classification of differences between traditional academic and virtual learning environments

reasons for taking the courses, including job-specific knowledge and general manufacturing/distribution system understanding.

The emergence of the corporate university

Virtual technology has made possible the rapid emergence of the corporate university, defined as: "the strategic management of a company's learning function, generally headed by a chief learning officer" (Vitiello, 2001). During the 1990s, corporate universities increased from barely a handful to more than one thousand (Moore, 1997). Today, most corporations either have embraced or are actively pursuing the idea, often as a supplement to traditional corporate education programs (Panucci, 2002; Meister, 1998; Leonard, 1996; King, 1997). Panucci (2002, p. 22) correctly notes that:

> E-learning will not meet all requirements and the classroom training that has proved a mainstay for most organizations will not be swept away by this technology. Certain skillsets, such as leadership and project management, cannot be taught properly via a purely electronic format.

Other areas where traditional corporate education would seem necessary are in applied and behavioral skills such as interviewing, health, safety, motivation, and decision-making.

According to Sweeney (2002), 40 percent of all US corporate training efforts were expected to be using virtual learning technologies by 2003. Some corporate virtual learning programs are designed for employee familiarization only, and tolerate "dropping in" or "on-the-spot" learning upgrades, while other programs approach learning more systematically. Taylor (2002) suggests that there are as many variations of virtual learning as there are programs. Budget increases for virtual learning have been equally dramatic. The total US corporate training budget, which was $62.5 billion in 1999, is projected to be $76.0 billion in 2005, a 3.9 percent compound annual growth rate. However, the technology component, a minuscule $0.9 billion in 1999, is projected to grow to $16.97 billion in 2005, a 63 percent compound annual growth rate (Sauer, 2001).

Academic universities have simultaneously adopted virtual technologies through a variety of formats, including on-line courses and programs, asynchronous learning, virtual supplements to course content, and executive and non-degree programs (Bardach, 1997). Moore (1997) argues that, for survival, academic universities must provide greater availability of asynchronous education, specialized courses, lifetime-based and interdisciplinary learning, and testing for demonstrated competencies in degree programs. Many universities have made progress in these directions. Bargeron *et al.* (2002) describe a multi-media program to provide asynchronous "on-demand" education, which is one of several Web-based programs designed to integrate classes or, more broadly, a learning community. Further, the ambitious Universitas 21 project expects to offer multi-language, Web-based, near-global masters degrees in several fields and certificates in many technical skills by 2005 (Arnone, 2002). However, concerns persist related to the traditional university education goals of inter-generational knowledge transfer based on embedded truth and the use of instruction in behavioral or motivational processes (Bardach, 1997; LeDuc, 1996; Montagu, 2001; Mandviwalla and Hovav, 1998).

Despite these competitive responses by both corporate and academic university programs, several clear distinctions remain. Higher education retains its primary role

as a form of intergenerational communication between society and the individual (Mandviwalla and Hovav, 1998; Hills, 1979). The exchange is essentially a dialogue involving generalized content that follows specific guidelines, methodologies, cognitive processes, and flows. Table II characterizes the distinctions between traditional corporate training and university education programs, with arrows suggesting a convergence of program criteria.

The convergence of corporate and university programs, as noted in Table II, is particularly important for several reasons. Development of virtual technologies has, of course, permitted greater access to programs at lower costs. More importantly, because knowledge is the key strategic competitive resource in many industries, improved methods of developing, deploying, and using knowledge constitute a competitive advantage (Baldwin *et al.*, 1997). More specifically, Ellinger *et al.* (2002) found that enhanced individual learning was strongly associated with customer service performance indicators.

The five APICS CPIM certification examination preparation courses exemplify the dynamics and convergence of virtual learning and traditional academic learning. The course content is founded on an evolving and regularly re-examined body of knowledge, not unlike the embedded truth and processes of university academic programs. Though the APICS program and courses are somewhat more applied than most university academic courses or programs, many universities and colleges do give academic credit for passing CPIM examinations. While the five courses vary in content, from foundations, to general and detailed operations planning and execution, and finally integrated resource strategy, they are based on a common body of knowledge and demonstrate a progressive increase in difficulty level and breadth of perspective.

Taken together, the emergence of new technology and the dynamic repositioning of both corporate and academic learning suggest several fundamental questions. Specifically:

- Are virtual learning programs perceived by participants to be as satisfying as traditional programs; if so, what factors contribute to that perception?
- Does program satisfaction with virtual programs lead to course persistence and effective knowledge transfer?

Corporate →	Criteria	← University
Skills as needed	Learning goals	Intergenerational knowledge transfer
Embedded corporate culture	Foundation	Embedded truth and processes
For profit	Profitability	Generally not for profit
Return on investment	Basis for relevance	Reputation
Specialization	Method	Generalization
Contract specialist instructors	Teachers	Tenure track faculty
Lifetime learning	Time horizon	Time-bounded learning process
Interdisciplinary	Functional interactivity	Functional specialities
Applied	Means	Theoretic
Goal-oriented	Ends	Process-oriented

Table II.
General classification of differences between traditional corporate training and traditional university education

Review of the literature

The literature of virtual learning programs, as relevant to this study, can be broadly categorized as related to the general benefits of virtual learning, the demographic predictors of perception of virtual learning, and social- and community-related impacts of virtual learning. The primary studies, year of publication, and a brief summarization of that research are offered at Table III.

Regarding the general benefits of virtual learning programs, Greco (1997) identifies faster development, lower costs, and decreased disruption of the workplace. Bardach (1997) and Taylor (2002) suggest characteristics of "new, faster, better, and cheaper." While new, faster, and cheaper may be tough to challenge, "better" has become a notable concern for both corporate and academic managers. A clear benefit is that virtual learning does shift the focus of the learning environment toward corporate competitive advantage, and often toward the customer (Baldwin *et al.*, 1997; Ellinger *et al.*, 2002); however, though high-confidence outcome evaluation of any course is tenuous, it is particularly elusive in virtual learning formats for several reasons. Benigno and Trentin (2000), citing Thorpe (1998), note that virtual learning has a greater number of elements of evaluation, greater flexibility, a wider range of stimuli, and a broader component of resources for participants to use. To date, there is no high-confidence demonstration in a practitioner environment that virtual learning (measured by participant perceptions and effectiveness of knowledge transfer) is better than, or even equivalent to, traditional methods.

Regarding gender, several studies (Cheung and Kan, 2002; Lipe, 1989; Launius, 1997) found that women significantly outperform men, though other studies (Anderson *et al.*, 1994; Bouillon and Doran, 1992) report that men significantly outperform women. However, Larson (2002) failed to find evidence of gender-based performance differences in a study of marketing students, and Koch (1998) summarized some 150 distance learning courses with more than 12,000 students by noting that women only slightly outperform men. However, some of these studies may be driven by a non-representative population or the course topic. A sample population of predominantly male engineering students (Bouillon and Doran, 1992) may have biased that study. Additionally, courses in economics (Anderson *et al.*, 1994) and communications (Cheung and Kan, 2002) may have favored men and women, respectively. When larger samples, more gender-neutral topics, and more representative groups are considered, there is little evidence that gender is a significant discriminator of perceptions of effectiveness of virtual learning programs.

Regarding age and technology experience, younger students may outperform older students because they are more technologically competent than older persons (Peiperl and Trevelyan, 1997). Alternatively, greater age may be associated with a mature perspective that might counterbalance any technology advantage (Didia and Hasnat, 1998; Cheung and Kan, 2002). The effects of technology and maturity are not definitively clarified by these academic studies.

Regarding the perception of social and community-related measures, numerous studies (Kerka, 1996; Besser and Donahue, 1996; Twigg, 1997; Tinto, 1993) cite such components as physical separation, reduced sense of community, disconnectedness, isolation, distraction, and lack of personal attention as contributors to negative persistence and lack of success in various virtual programs. Carr (2000) reports that persistence rates among virtual students are notably lower (9 percent vs 5 percent for

Author(s)	Year	Brief summarization
General benefits of virtual learning programs		
Baldwin *et al.*	1997	Experience at Motorola identifies the evolution of learning strategies
Benigno and Trentin	2000	Virtual learning evaluation requires different methods and a broader scope
Ellinger *et al.*	2000	Individual learning is related to customer service performance indicators
Greco	1997	Virtual learning methods are faster, reduce costs, and increase convenience
Taylor	2002	Virtual learning methods permit new, better, faster, and cheaper learning
Demographic predictors of perception of virtual programs		
Gender		
Anderson *et al.*	1994	Survey of economics course finds men significantly outperform women
Bouillon and Doran	1992	Survey of accounting course finds men significantly outperform women
Cheung and Kan	2002	Survey of communications course finds women significantly outperform men
Koch	1998	Surveys of 150 courses find no significant gender-based performance difference
Larson	2002	Survey of marketing course finds no significant gender-based performance differences
Launius	1997	Survey of psychology course finds women outperform men
Lipe	1989	Survey of accounting course finds women outperform men
Age and experience		
Cheung and Kan	2002	No age difference; posited that technology advantage balanced by maturity
Didia and Hasnat	1989	Older, more mature students significantly outperform younger students
Peiperl and Trevelyan	1997	Younger students outperform older students because of technology orientation
Social- and community-related impacts of virtual learning programs		
Benigno and Trentin	2000	Sense of community variables are participative, social, interaction, and cognitive
Besser and Donahue	1996	Separation, disconnectedness, and distraction are problems of virtual methods
Carr	2000	Persistence among virtual students lower than among traditional students
Fulford and Zhang	1993	Perceptions of interaction are predictor of satisfaction in survey of teachers
Hoffman and Novak	1996	Theoretically, interactivity, utility, and increased learning related to satisfaction
Koch	1998	Satisfaction among virtual students is equivalent to that of traditional students
Rovai	2002	Sense of community variables are spirit, trust, interaction, and common learning

Table III.
Classification of key virtual education literature

traditional classes) because virtual students need more interaction to sustain their interest. The development of a sense of community may be a very important way to counter these symptoms of malaise and improve persistence. Rovai (2002) conceptualizes four characteristics of a learning community and posits that they enhance participant satisfaction and program effectiveness:

- spirit – friendship, bonding, cohesion, sense of connectedness;
- trust – credibility, social integration, benevolence, shared faith and nurturing;
- interaction – task interaction or socio-emotional-focused behaviors; and
- common learning expectancies – sharing of purposeful activities, job relatedness, level of learning.

Benigno and Trentin (2000) analyze four variables that generally correspond to Rovai's characteristics:

(1) participative (in Rovai, spirit);

(2) social (trust);

(3) interactive; and

(4) cognitive (common learning expectancies).

The literature then suggests the importance of sense of community variables to virtual learning programs and their potential negative impacts on persistence.

Satisfaction can be defined and interpreted in various ways, though three dimensions of satisfaction are supported in the virtual learning literature. Hoffman and Novak (1996) use the term "proactive subjective experiences" and associate it with positive mood, greater satisfaction, and higher degrees of pleasure and involvement. This definition emphasizes the individual dimension of satisfaction. Alternatively Rovai (2002), associates satisfaction with group efforts, and emphasizes the importance of belonging, trust, and shared values. This second approach to satisfaction emphasizes the group interactive context. Note that these two definitions of satisfaction are subjectively oriented and focus on either individual or group perceptions. They may, however, be antecedents of a third emphasis (Fulford and Zhang, 1993) which objectively considers satisfaction to be the perceived value and quality of instruction, more directly addressing instructional outcomes. Koch (1998), in an aggregation of the results of almost 150 courses, uses course satisfaction and reports that university participants are as equally satisfied with virtual courses as with traditional courses.

Research generally supports relationships of demographic and perception of community measures with satisfaction, persistence, and course success. Specifically, perceived level of learning, perceived job relevance, a sense of cohesiveness, opportunities for task interaction, and opportunities for social interaction predominate prior studies as predictor variables. Additionally, satisfaction with course outcomes is used extensively in prior studies as the dependent variable, and is further associated with course persistence. However, as previously noted, the literature is based on theoretical and academic contexts, not studies of corporate populations.

Theoretical framework and hypotheses development

This section addresses the typology, the hypotheses that emerge from that typology, and the methodology for evaluating the research questions. Subsequent sections address the findings, conclusions, and applications of this study.

The typology

The literature is mixed and not conclusive on gender, age, and prior experience with technology as bases for satisfaction and persistence. With the exception of more narrow, potentially topic- or population-biased, often university-based populations, the research generally points to minor and not significant contributions of the demographic characteristics, particularly gender. Thus, this study will not offer hypotheses on these variables; rather they will be treated as "overarching research questions" and moderating variables. Further, the literature does suggest, albeit in more homogeneous academic environments and as conceptualized and theoretical contributions only, that individual and group perception (independent) variables notably impact overall satisfaction with the course and course persistence (dependent) variables.

Additionally, the effectiveness of the program in transforming knowledge is measured by this study. The self-reported taking of the five CPIM examinations and achieving passing scores is evaluated. Because, in this population, there are a number of reasons for taking and completing courses other than examination preparation, a direct relationship between course completion and taking the test is not expected. An integrative model of the variables in this study is shown at Figure 1.

Hypotheses

This study hypothesizes that sense of community variables are related to satisfaction and persistence. Specifically, perceived level of learning, job relevance, sense of cohesiveness, and opportunities for task and social interaction are proposed as predictors of overall course satisfaction and course persistence. Measures of effectiveness of knowledge transfer are also considered. Benigno and Trentin (2000) and Rovai (2002) address, with minor connotational differences, the five predictor variables. Benigno and Trentin (2000) made use of a questionnaire to evaluate the perceptions of community dimensions by an adult learning group in an academic environment, and Rovai (2002) theorizes that virtual classrooms can build a sense of community through the above five mechanisms, thus reducing malaise and improving persistence. Based on these arguments, we hypothesize:

H1. The use of virtual technologies notably changes participant perceptions of the class environment, when compared with a "live" class format.

H2a. The perception of level of learning, when compared with a "live" class format, is positively related to overall satisfaction with the course.

H2b. The perception of job relevance of course materials is positively related to overall satisfaction with the course.

H2c. The perception of ability to develop a sense of cohesiveness, when compared with a "live" class format, is positively related to overall satisfaction with the course.

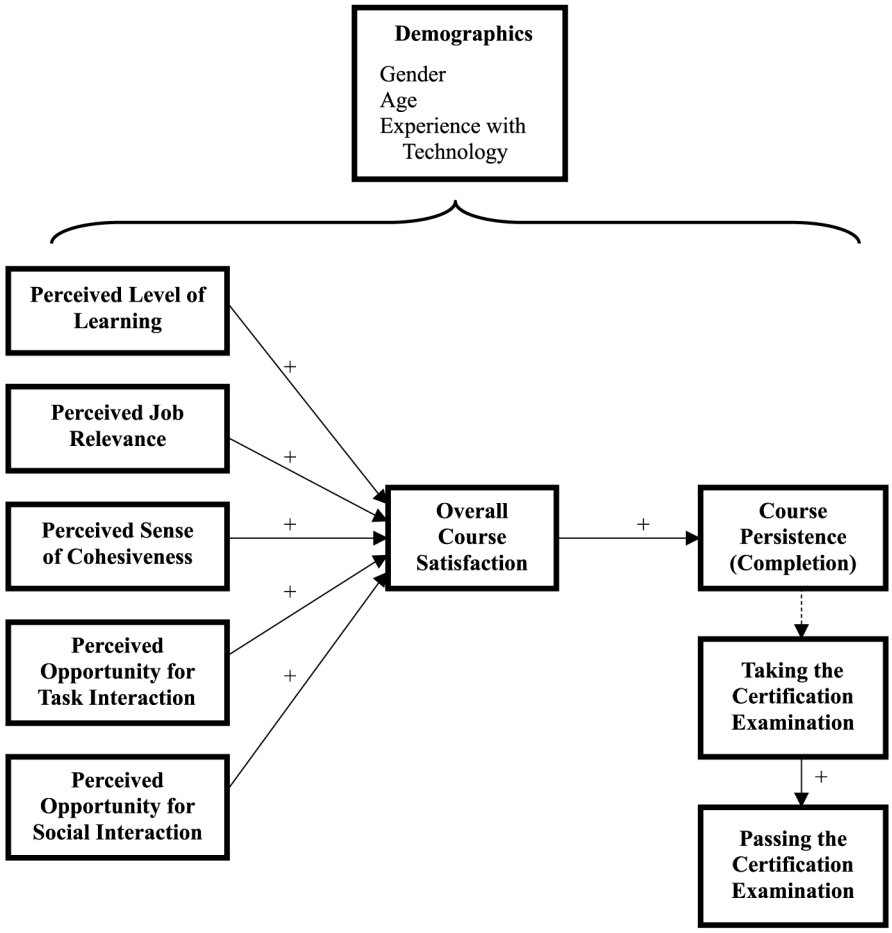

Figure 1.
An integrative model of perceived effectiveness of virtual learning activities

H2d. The perception of the opportunity for task interaction, when compared with a "live" class format, is positively related to overall satisfaction with the course.

H2e. The perception of the opportunity for social interaction, when compared with a "live" class format, is positively related to overall satisfaction with the course.

H3. The perception of overall satisfaction with the course is positively related to course persistence (completion).

For some participants, the reason for taking the courses was to pass the CPIM exams. The pass rate for those participants is a measure of program success. Comparing the pass rate against estimates of national pass rates, as well as performance in other courses taught by the instructors and courses using varying methods gives a tenuous representation of program effectiveness. Based on these arguments, we hypothesize:

H4. The APICS CPIM certification examination pass rate by participants in this program compares favorably to international society pass rates and to performance in other classes taught by the same instructors and with different technologies.

Methodology

The company sent an electronic questionnaire to 338 individuals who participated in at least one of the APICS CPIM test preparation courses offered in seven "semesters" during a two-and-one-third year period. After two weeks, one reminder was sent to non-respondents. Participation, as used here, means that, at a minimum, a person signed up for a course, but may not have attended any sessions. Because course participants are primarily involved with supply chain activities, such as demand planning, inventory control, manufacturing or distribution supervision, scheduling, transportation, and the like, they are a rather homogeneous group as regards job activities; in fact, several had previously worked together and a small number had personally met each other.

During the courses, some illustrations of course concepts were drawn from company situations, but due to the generalized nature of the APICS body of knowledge, many examples were drawn from other industries. Further, the APICS body of knowledge imposed a highly integrated and inter-disciplinary focus, including functions of marketing, engineering, finance, and human resources among other business disciplines. Thus, to some notable degree, the instruction, although application-based, contained elements of theory, process, generalization, and embedded truth associated with more traditional academic education. Because the company discouraged participants from taking more than one course at a time, many participants have not yet been able to complete the five-course program.

Findings

After four weeks, 147 responses were received, of which, depending on the question, between 124 and 145 were usable – a usable response rate of between 36.7 and 42.9 percent. Of the 338 course participants, 177 (52.5 percent) were women. The gender of one participant could not be determined. Of the 142 survey respondents who indicated their gender, 83 (58.4 percent) were women. A chi-square test found that the gender of the sample was not significantly different ($p = 0.16$) than that of the population of course participants. The distribution of survey respondents across time zones was similarly compared to that of the population; differences were not significant. Thus, by these measures, the sample is believed to be representative of the population and more broadly of working populations of large and stable companies. The gender, age, education, tenure with the company, and experience with technology courses are summarized in Table IV.

This study evaluated perceptions of level of learning, sense of cohesion, and social and task interaction of a virtual learning process, compared with "live" class formats. Because a five-point Likert scale was used for the "comparison with live course" questions, with a middle value of "about the same", deviation of responses from the "about the same" position can be measured. Those results are shown in Table V.

Table V clearly demonstrates that perceptions of sense of cohesion, social interaction, and task interaction among participants of this virtual course are

significantly less than those of a "live" class. However, perceptions of ability to learn new knowledge are only marginally different than those for the "live" class. Simply put, there is a notable degradation of the social processes in virtual learning formats; however, this degradation did not significantly impede the perceived ability to learn. For mature corporate learners, and for materials that relate to their jobs, the virtual-learning format provides an equivalent learning opportunity as the "live" format. On this basis, *H1* is strongly supported.

Pearson correlation coefficients among the moderating variables, the independent variables, and the outcome variables are shown in Table VI.

The moderating variables, age, gender, and prior technology experience, were expected to show inconsistent and generally not significant effects. In fact, there were six significant relationships among 33 possible relationships of moderating variables. Prior experience with technology proved to be the most notable of the moderating variables in that it resulted in significant relationships with four of the variables of concern:

(1) job relevance;

(2) level of learning;

(3) satisfaction; and

(4) persistence.

Thus, familiarity with the technology is directly associated with course satisfaction and persistence (completion), and may have further facilitated learning and a greater perception of relevance of the course to the job. Surprisingly, prior experience with technology was not related to either cohesiveness or task or social interaction. Individuals who had more experience with course technology may have understood

Gender	*N*	Age	*N*	Education level	*N*	Tenure with firm (years)	*N*	Experience with technology (hours)	*N*
Women	83	25	7	< 12 years	1	< 5	30	< 25	47
Male	59	26-35	43	High school	1	5-9	36	26-50	49
		36-45	55	Some college	21	10-14	11	51-75	19
		46-55	35	2-yr degree	10	15-19	23	76-100	11
		> 56	0	4-yr degree	86	> 20	24	> 100	12
				Masters/higher	21				
Total respondents	142		140		140		124		138

Table IV. Demographic frequencies of the sample

	N	$\bar{x}$	Difference of $\bar{x}$ from 3.0*	Φ	*t*-test	Significance
Level of learning	135	2.94	− 0.06	0.667	− 1.033	0.303
Sense of cohesiveness	135	2.25	− 0.75	0.853	− 10.194	0.000
Social interaction	135	1.85	− 1.15	0.824	− 16.185	0.000
Task interaction	135	2.24	− 0.76	0.857	− 10.344	0.000

Note: *3.0 is "about the same" or no difference

Table V. *t*-test statistics of perceptions of virtual courses compared with "live" courses

and accepted the limitations of technology and thus not expected extensive cohesion or task or social interaction.

Age was found to be associated at marginally significant levels with task interaction and significantly associated with satisfaction, suggesting that older participants perceived the course as a greater opportunity to task interact, *vis-à-vis* "live" formats, than younger participants and that older participants were overall more satisfied than younger participants. Regarding gender, no significant, or even marginally significant, differences are found. This outcome was not surprising considering the maturity and homogeneous job focus of the population.

As hypothesized, the predictor variables were found to be extensively and significantly related to course satisfaction, the dependent variable; thus, any improvement in any predictor variable could be expected to enhance satisfaction. However, the predictor variables were also extensively correlated with each other. For this reason, step-wise regression was used to eliminate collinearity and identify key contributions. Regression analysis found that, in sequence, the three significant and non-collinear variables were:

(1) perceived level of learning – which explained 32.3 percent of variation;

(2) perceived job relevance – which added 10.2 percent of variance explained; and

(3) sense of cohesiveness – which added 3.5 percent of variance explained.

In total, these three variables explained 46 percent of the variance in satisfaction. This conclusion is consistent with Table VI, which found social interaction to be highly correlated with cohesiveness and cohesiveness to be highly correlated with satisfaction. Similarly, task interaction is highly correlated with level of learning and cohesiveness, and is less significantly related to satisfaction than either of those variables.

Regression analysis also found that course satisfaction explains 12 percent of variance in course completion. The relationship, though weak, is significant at the 0.05 level. This study also found supervisor and peer support as a contributor to course completion (significant at 0.05 with a coefficient of 0.20), but did not consider numerous other possible contributors toward course completion, among them: time availability, job conditions, family or social considerations, and personal motivation factors. On these bases, *H2* and *H3* are supported.

H4 considered self-reported success rates in taking and passing the examinations. Table VII gives the taking and passing rates for the five CPIM examinations.

Overall, 133 examinations were taken by 60 participants, or an average of 2.22 examinations per test-taker. Note that, in this on-going program, recent participants have not yet had the opportunity to take later courses in the sequence. The participants report an overall pass rate of 86 percent, with higher pass rates for later tests in the series. Though APICS has not recently published society-wide test pass rate statistics, earlier data suggest a society pass rate generally between 50 and 65 percent, depending on the course and the time frame. Of course, the APICS pass rate data includes all test takers, many of whom have different preparation and backgrounds. Additionally, instructors of these courses have achieved self-reported student pass rates in other "live" classes of between 76 and 92 percent; thus, the self-reported overall 86 percent pass rate of this group is within that range and generally above the APICS society pass rates. These findings, based on self-reporting, suggest that there is little loss of

	Gender	Age	Tech.	Job relevance	Learn	Cohesiveness	Task	Social	Satisfaction	Completion	Take	Pass
Gender												
Age							0.16*		0.17**			
Prior tech. exp.				0.30***	0.21**				0.34***	0.72***		
Job relevance									0.37***			
Level of learn.						0.54***	0.49***	0.43***	0.57***	0.17**		
Cohesiveness							0.49***	0.53***	0.48***			
Task interact.								0.67***	0.40***	0.16**		
Social Interact.										0.35***		
Satisfaction										0.36***	0.22***	0.22***
Course completion												
Take test												0.95***
Pass test												

Note: *0.10; **0.05; ***0.01

Table VI.
Pearson correlation coefficients with significance

information transfer to this type of group and in this type of course, *vis-à-vis* "live" formats. As would be expected, this high examination pass rate is reflected in a highly significant relationship between taking and passing the examination, as shown previously in Table VI. Notably, to date, four individuals (two men and two women) have taken and passed all five tests and have earned the CPIM certification though this program.

Conclusions and applications

This study is among the first to find significant relationships in a corporate virtual learning environment among the variables that explain course satisfaction and persistence. We applied the perception of sense of community variables defined by prior studies to a mature corporate population using high-confidence processes. As such, this study contributes to the understanding of the variables associated with successful learning programs in the dynamic virtual learning environments that are increasingly encountered as corporations broaden their training function and increase the academic content of their programs. The identification of specific non-collinear predictor variables (level of learning, job relevance, and cohesiveness) with course satisfaction, and of satisfaction with course completion, in a high-confidence evaluation process, will assist and focus the efforts of corporate and academic administrators and educators in future virtual learning program development.

As such, this study shows that virtual learning technologies, though not better than the "live" class format, are not associated with notable degradation of knowledge transfer and do permit significant cost and access efficiencies in corresponding learning situations. Further, given the very significant correlations between the sense of community variables and satisfaction and success found here, any improvement in the perceptions of cohesiveness and task and social interaction would be expected to improve perception of learning, satisfaction, and course persistence. Thus, techniques such as "group discussion breakouts", interaction on common job-related concerns, and timed competitions to solve and report problems all could improve the sense of community and ultimately satisfaction and success.

Further, this study finds that self-reported learning outcomes of these courses are in line with those of reported outcomes for "live" courses, and are notably above APICS society test performance rates. This is significant because it suggests that a minimal corporate investment in virtual learning activities, compared with "live" activities, can

Course sequence	Take examination	Pass examination	Percent pass
First			
Basics of supply chain management	55	46	83
Master planning of resources	37	32	86
Detailed scheduling and planning	25	21	84
Execution and control of operations	8	8	100
Strategic management of resources	8	8	100
Last			
Overall total	133	115	86

Table VII.
Examination performance

make an important contribution to employee satisfaction and success and to employee self-worth measured by the receipt of an internationally recognized certification.

The results found here are generalizeable only to the degree that this population corresponds to other populations. The specific population, as noted, is made up of employees of a *Fortune* 50 business, which uses elaborate technology to manage its supply chain in all 50 states and in several international regions. Thus, though these findings may offer guidance, they may not apply to smaller, less-technologically integrated regional businesses or to younger or traditional university student populations. However, to the degree that university populations involve more non-traditional students, these results are expected to be increasingly representative. Further, members of this population were predominantly involved in supply chain management activities. For that reason, the findings of this study may not be generalizeable to less focused, more cross-functional, and more behaviorally-oriented groups or courses. Nevertheless, this study clearly demonstrates the effectiveness of virtual learning programs in a highly generalizeable corporate learning environment, and the further potential applicability among populations of some university programs.

The development and management of virtual learning programs in corporations certainly involves a much broader scope than the topics discussed in this article. Because of the design of the research model, in several cases, these topics could not be considered. Program assessment was conducted on an on-going basis through electronic feedback, but not formalized. Because of the homogeneity of the group and the nature of the APICS courses and testing process, the program could not address adaptive learning and testing processes that have been proven in other studies. Further, the potential for plagiarism is very carefully managed in the APICS testing process, but could not be addressed here. Additionally, no attempt was made to estimate the overall economies of this program. Given the many locations that were serviced by these courses, the travel, lodging, and job-disruption costs would have been extremely high. The courses did generally reinforce a corporate culture of high customer responsiveness; however, this was not specifically measured. Clearly, these are important considerations in the development of any learning program, but simultaneously, they are topics beyond the scope of the present effort.

This research, then, is among the first to model the learning activities in academic and corporate environments and to document factors that contribute to overall participant satisfaction with virtual learning programs, *vis-à-vis* traditional "live" programs. Additionally, this research has demonstrated the contribution of moderating variables, particularly experience with technology, and the relationship between satisfaction and course completion, and program success. As such, it establishes a model and is the foundation for further study in university and business environments.

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