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# Contribution of internet to a democratic society

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# CONTROLLING COMPUTER-BASED MULTITASKING THROUGH PROVISIONING SYSTEMS IN CO-LOCATED LEARNING SETTINGS

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## Abstract

*Computer-based multitasking behavior has become commonplace, however its efficacy in co-located settings is disputed. An important question therefore is how computer-based multitasking can be controlled when traditional organizational control mechanisms are infeasible or unavailable. We conceptualize and operationalize computer-based multitasking in terms of on-task and off-task uses. Our research objective is to examine a provisioning system's effectiveness with respect to restraining off-task uses while leaving on-task uses unaffected in a co-located learning setting. We conclude that provisioning systems alone are not sufficient to effectively control computer-based multitasking—to restrain off-task use, so it may be advisable to augment provisioning systems with behavioural modification and reform efforts.*

*Keywords: Multitasking, provisioning systems, co-located learning, technology-mediated learning, e-learning, agency theory, longitudinal, field study*

# 1 INTRODUCTION

Technological advances related to information and communication technologies are transforming learning processes in various contexts (Hiltz and Turoff 2005, Alavi and Gallupe 2003, Alavi 1994, Young 2005, Arbaugh 2000). Of assorted nature, these transformations have generated interest among information systems, management education, education and education psychology researchers (Balkovich, Lerman, and Parmelee 1985), and have created a field of inquiry called technology-mediated learning (TML). In this paper, we follow Leidner and Jarvenpaas' (1995) characterization of TML as learning experiences that are modified in some way through use of information and communication technologies.

TML learning is facilitated by applications such as email, chat, blogs, virtual whiteboard, video-conferencing, document management, assessment facilities, and the Internet in general among others (Tu 2000, Navarro and Shoemaker 2000, Ross and Schulz 1999). These applications may be combined into one system or “package” (Arbaugh 2000, Hiltz and Wellman 1997), which we refer to here as technology-mediated learning applications (TMLAPP). TMLAPP running on contemporary computing platforms are expressly designed to facilitate computer-based multitasking. As a result, computer-based multitasking behaviour has attained a commonplace nature in both virtual and co-located learning settings.

In this paper, we are specifically interested in examining computer-based multitasking in *co-located* learning settings. We argue that the co-located setting is critical to study, because it is *this* setting that appears to heighten contention over both the appropriateness and efficacy of computer-based multitasking behaviour (Gomolski 2006, Wallis et al. 2006, Chudoba et al. 2005, Wasson 2004, Shellenbarger 2003, Hwang 2002). While the reasons for this are likely manifold and not entirely understood, one can reasonably claim that co-located settings produce behavioural norms with respect to participants' attention and effort. In co-located learning settings, where people organize with the intention of performing some learning task, behavioural norms produce expectations that each participant will give undivided attention and effort. Since computer-based multitasking in co-located learning settings is palpable, and may suggest—although is not definitive of—*diversion* of attention and effort, contention over multitasking appropriateness and efficacy heightens. For instance, approaching the issue from an anthropological perspective, Wasson (2004) concludes that multitasking behaviour may require or effect change in standards of politeness to the extent that it becomes culturally embedded.

# 2 LITERATURE REVIEW

Currently, there is no consensus regarding the efficacy of engaging in computer-based multitasking in co-located settings. Some suggest that a potential of bringing TMLAPP into co-located settings, especially ones of large numbers of participants, is to establish back-channel conversations, where participants' attention and effort may be stimulated through enhanced content sent over back-channels. On the other hand, some question whether it is possible to concurrently multitask and pay attention to others in effective ways (Gomolski, 2006). Due to its very nature, multitasking behaviour may create distraction effects for other participants. In fact, in some co-located contexts computing devices or Internet access are altogether banned (Guernsey, 2003).

Consequently, an important question is—how can computer-based multitasking be controlled such that the attending advantages are maximized and disadvantages minimized? In this paper, we conceptualize and operationalize use behaviour in terms of on-task and off-task uses vis-à-vis the use context. Our research objective is to examine the effects and effectiveness of employing a

provisioning system (PS) for the intended purpose of restraining *off-task* uses. We utilize agency theory to *frame* our hypotheses and we use longitudinal data from a quasi-experimental field study to operationalize objective measures on *actual* use in a co-located setting.

## 2.1 Controlling use through provisioning systems

In this study and for purpose of subsequent discourse, we assume that at least one co-located participant assumes the role of *facilitator*, who is responsible for organizing and coordinating participants' activity directed to task completion. Additionally, we define participants on-task (off-task) use behaviours as those that are (are not) related to the task at hand. Ideally participants will remain on-task however anecdotes and commonplace experience suggest that they will engage in off-task uses as well. While computing devices may be banned altogether, this is often not desirable or feasible for a variety of reasons. As an alternative and in an effort to restrain off-task uses, a facilitator may employ a dynamic provisioning system (PS) to limit participants' access to certain applications and devices. For example a facilitator may allow access to shared file servers and printers within the local network, while disallowing network-based applications such as email and chat. By selectively allowing some applications and devices while eliminating others, the practical value of computing devices in co-located contexts is presumably enhanced by balancing on-task uses against off-task ones.

In practice, the options of prohibiting computing device use altogether or allowing unimpeded use represent end-points on a continuum of various provisioning levels, each allowing access to some applications and devices to varying degrees. The assorted provisioning levels that are made available are determined by the PS's design, which may be customized for the user entity. Generally speaking a PS enables the facilitator to specify infrastructure or application service provisioning. The PS that we examine here offered provisioning options for email, shared (local) file servers, local printing, an Intranet application and the Internet. Each service could be denied or allowed, although the five provisioning options were not entirely independent of one another. For purpose of subsequent discourse, we use the term 'access setting' to refer to the applications and devices that are provisioned during co-located sessions. We qualify an unrestricted (restricted) access setting as less (more) impeded—allowing participants access to relatively more (fewer) applications and devices.

## 3 THEORETICAL FRAMEWORK

We argue that a generalized co-located context involving at least one facilitator and participant may create conditions that satisfy agency theory assumptions (Eisenhardt 1989, Eisenhardt 1985, Ouchi 1979). We predicate this argument on others' general assertions that agency theory is applicable to a broad range of organizational design issues with respect to *control mechanisms* (Eisenhardt 1985, Ouchi 1979). More specifically Eisenhardt (1989) states that "The agency structure is applicable to a variety of settings, ranging from macro-level issues [...] to micro-level dyad phenomena such as blame, impression management, lying, *and other expressions of self-interest.* (italics ours, p.58)", and concludes that researchers may "...use agency theory in their study of [a] broad range of principal-agent issues facing firms. (p.72)"

Broadly characterized, agency theory may be applied to any dyad relationship that involves cooperative behaviour between its members. Commonly members assume roles that exist in superior-subordinate, supervisor-worker or leader-apprentice arrangement with respect to one another. In addition the relationship typically involves the principal in delegation of a task to an agent, and in subsequent control over agent's task performance and/or outcomes. A frequent assumption about the principal-agent relationship is that the principal and agents' objectives or interests with respect to performance or outcomes will differ, diverge or depart. Consequently the principal's primary problem lies in extracting the agent's cooperative behaviour so *that* behavior serves the principal's objectives.

In reviewing agency theory's contributions to organization theory, Eisenhardt (1989) identifies similarities and differences between two research lines—positivist agency theory and principal-agent research. Both lines share assumptions about people, organizations and information. For instance, agency theory assumes that human behaviour and decision-making is driven by self-interest. Second, there exists at least partial goal conflict between principals and agents. Third, there exists information asymmetry between the principal and agent such that the principal cannot fully monitor the agent's behaviour and actions. Intentionally absent any mathematical rigor, our application of agency theory falls into the realm of positivist agency theory, where researchers are generally focused on identifying situations where the principal and agent have conflicting goals, and on describing control or governance mechanisms that restrict the agent's self-serving or opportunistic behavior. Positivist research broadly identifies two control or governance mechanisms for curbing opportunistic behaviour — outcome-based contracts and information systems (Eisenhardt 1989).

We argue that a co-located learning setting may create a situation where the goals of the facilitator (principal) and of the participants (agents) begin to conflict or diverge. For example, we assume that the facilitator has interest in engaging, soliciting input from, or imparting information to participants. Said differently, the facilitator wants the participants' attention and effort focused on the learning task in order to facilitate the learning process and to yield successful learning outcomes. While participants may fully comply with the facilitator's wishes, their behaviour may succumb to self-serving interest as they direct attention and effort to other work or personal tasks or leisure activity. To the extent that participants' engage in self-serving behaviour, co-located facilitator's and participants' goals begin to diverge or conflict.

The facilitator is able to monitor some of the participants' behaviour. However, from a practical perspective, the facilitator's monitoring capacity is constrained by assorted factors such as the number of participants, the nature of participants self-serving behavior, the facilitator's cognitive abilities, and the participants' physical arrangement among others. In short, there is in general information asymmetry between facilitators and participants with respect to participants' attention and effort and, consequently, to facilitator's and participants' goal alignment. Therefore when participants can engage in self-serving behaviour with minimal concern or regard for detection, they are likely to do so.

With the introduction of computing devices into co-located learning settings, *participants' ability to pursue self-serving behaviours* is significantly expanded because much work and personal tasks and leisure activity is computer-mediated. For instance, a participant may check the value of personal stock holdings, compose a letter to a relative, or check the latest standings of local professional sports teams. To the extent that participants' self-serving behavior increases, agency theory predicts that goal conflict between facilitator and participants increases.

The facilitator's *ability to monitor participants' behaviour* is further compromised by introduction of computing devices. Assume a simulated learning task where participants take on the role of institutional investors at a financial brokerage firm and the task of revising company-wide investment guidelines. A participant may use the computing device to look up on-line information about investment instrument prices or holdings in order to provide input to the task. This use behaviour is on-task. In contrast that same participant may look up current information about his own investments. This use behaviour is off-task. From the facilitator's perspective, the participant's computing device use is virtually indiscernible with respect to on-task or off-task usage, unless the facilitator has view of the participant's computing device screen which is seldom the case. In short, because the *difference* between a participant's on-task and off-task uses is effectually indiscernible for the facilitator, information asymmetry effectively increases thereby exacerbating the monitoring problem.

In summary, from an organization design perspective, control or governance mechanisms ameliorate information asymmetry between the co-located facilitator (principal) and participants (agents) and thereby bring about goal alignment between them. Governance mechanisms take on at least two forms according to the positivist's research realm—outcome-based contracting and information systems (Eisenhardt 1989). The specific choice between these is generally guided by efficiency

considerations—i.e., which control mechanism is the least costly to implement. In co-located learning settings, neither outcome-based contracting nor information systems is a feasible alternative from a practical perspective.

Where these control or governance mechanisms are impractical, an alternative way to bring about goal alignment is through socialization (or clan) structures (Ouchi 1979). While socialization structures are many and varied in practice, on a conceptual level we envision socialization processes that correspond to Ouchi's (1979) description of "...a highly formalized and lengthy period of socialization during which [participants] are subjected not only to skill training but *also to value training or indoctrination.*" (italics ours, p.837)."

Absent any outcome-based contracting, information systems or socialization structures for attaining goal alignment between principal and agent, a co-located learning setting may offer the option of utilizing provisioning systems (PS) that can effect control through "brute-force." For instance, under the assumption that the facilitator wants to discourage participants' off-task behaviour, the facilitator can dynamically provision devices and applications so as to restrict access to select ones. By restricting use of some devices and applications for some duration of the learning task, the facilitator will effectively reduce the *potential* for participants' off-task behaviour. In short, the facilitator can provision a restricted access setting, which should lead to reduced off-task use levels among participants. We submit the following hypothesis.

*Hypothesis 1: Off-task use behaviors are lower under a restricted access setting when compared to an unrestricted access setting.*

By provisioning a restricted access setting, the facilitator is restricting specific devices and applications from participants' use. While this should have the intended effect of reducing off-task use, the devices and applications are no longer available for on-task use either. Since devices and applications can be used for both purposes, one may argue that on-task use behaviour will also be reduced. However, *dynamic* provisioning should allow the facilitator to provision an *unrestricted* access setting on opportune occasion, thereby providing access to devices and applications when their use is efficacious to the learning task's objectives and activities at hand. Therefore as another goal of facilitators is presumably to leave participants' on-task behaviour unimpeded or unaffected, we argue that the impact on participants' on-task uses should be negligible assuming that the facilitator dynamically provisions an unrestricted access setting on opportune occasions. We submit the following hypothesis.

*Hypothesis 2: On-task use behaviors are not significantly different between an unrestricted access setting and a restricted access setting.*

## **4 RESEARCH METHODOLOGY**

### **4.1 Research setting**

The research design is a longitudinal quasi-experimental field study that involves subjects who enrolled in a required freshmen course at a business college in the Northeastern United States. The setting is a two-semester integrated course that presents a multidisciplinary perspective by interweaving topics and concepts from different academic disciplines (or functional areas) into one course, which we refer to here as Business Introduction. The pedagogical approach of this course is heavily applied, and much of the curricula was designed and delivered under the assumption that each participant would have a dedicated laptop computer during co-located sessions. Business Introduction is offered in seven sections, and each section is capped at 60 participants. Two faculty members teach each section. In January 2006, the course received an Excellence in Education Award from the U.S. Association for Small Business and Entrepreneurship (USASBE) for its innovative and entrepreneurial pedagogical approach.

## 4.2 Research design

For this study, subjects came from four Business Introduction sections, which were instructed by two lecture teams. Each team instructed one section in unrestricted access and another in restricted access to avoid confounding effects between lecture team and access restrictions. Unrestricted access allowed use of all applications including course management application, shared file servers and printers, the email system and the Internet. Restricted access prohibited network applications such as Internet browsing, email and chat, except on occasions where the facilitators deemed them to be pedagogically relevant. This exception normally involved allowing Internet access for some learning sessions. In addition, lecture teams alternated between sections to control for order effects and eliminate the second section advantage of receiving the lecture after it had been delivered to the first section.

The lecture teams shared teaching materials. Their efforts to ensure uniform course requirements across sections resulted in a relatively standardized curriculum. However, curriculum delivery was not scripted and was subject to idiosyncratic lecturing styles and the emergent nature of discussion periods. Facilitators were generally non-directive in controlling participants' computer use however. The subjects were free to use their laptop without limitations under unrestricted access setting and with email, chat and Internet access limitations in the restricted access setting.

## 4.3 Sampling

Taught by two facilitators, *each* of seven sections capped enrolment at 60 participants. We solicited four sections for participation, and 122 subjects volunteered to participate. This represents a 51% (=122/240) participation rate. From these 122 subjects, we obtained 95 monitoring log files and 89 surveys of which 72 overlapped. Four subjects switched sections after term onset, so we have primary data on 68 subjects.

Although the subjects were not informed about the specific research questions, they were made aware that participation involved unobtrusive monitoring of their computer use during Business Introduction sessions (primary data), filling out a survey (primary data), and releasing course performance data (secondary data). Monitoring occurred only during the first term. While subjects were not randomly assigned to sections, the access setting was designated for each section well after the participant registration period, so no self-selection bias with respect to "getting into" an unrestricted section could have occurred.

## 4.4 External Validity—Monitoring Awareness

To the extent that monitoring affected subjects' behaviour, external validity is undermined thereby yielding no generalizable conclusions. Thus, we took several measures to reduce subjects' monitoring awareness. First, recruitment during a May-June timeframe provided a three to four month lag between consent and onset of monitoring to mitigate awareness effect over use behaviour. The research project was never raised by the facilitators, and subjects were not reminded of their participation until asked to fill out the survey at monitoring conclusion. Finally, the monitoring program was installed and uninstalled through an unobtrusive SMS (server-side) procedure, and it was configured to run in stealth mode—the monitoring program icon never appeared on the desktop, task bar or task list. Log files were copied from the learners' computers' hard drives by an undetectable server-side custom program called the "harvest" program. Thus, no subject was ever alerted to the monitoring program.

Responses from a relevant survey item strongly suggest that most subjects did not change their use behaviour in response to being monitored. Eight-four percent of subjects disagreed with the statement "I changed how I used my computer because I know that I was being monitored." Fifty-seven percent

*strongly* disagreed with the statement. In addition, a consensus opinion emerged from the four facilitators, three of whom had previously taught Business Introduction, that subjects' did not alter their use behaviour due to monitoring awareness. Altogether then—the lag between monitoring consent and onset, the monitoring and harvest programs being undetectable, and other efforts to keep the research project at low profile helped to mitigate subjects' awareness of being monitored.

#### 4.5 Variables and Measures

Subjects' use was monitored only during co-located sessions, and use activity is logged to the local drive so all use is recorded independent of any network connection. Periodically, the log file was copied from each subject's local hard drive to a file server by a custom-designed server-side program called the “harvest” program. The “harvest” program required that the subject establish a network connection, but that connection could occur at any time. The precise timing of log file “harvesting” was jointly determined through the random occurrence of subject network login and time of last harvest, and generally occurred about every seven to ten days. The harvest program operated inconspicuously.

Sample use logs are shown in Tables 1 and 2. Fields include application name, window title and keystrokes among others. Each time a subject set the window focus, a log record was created. The window focus start and end times are recorded as AppGotFocus and AppLostFocus, respectively. Divided into active and inactive parts, elapsed time is the difference between focus times. Active time generally reflects the amount of time that the subject operated any input device, which in this context includes the keyboard and mouse. Inactive time generally reflects idle time with respect to input device manipulation.

Each sample highlights use that is either predominantly on-task or off-task. Table 1 illustrates mostly on-task use where the subject is taking notes on a problem-solving exercise involving breakeven analysis. Table 2 shows mostly off-task use where the same subject at a different time is in an instant message dialog. (See Keystrokes column.) If the record represents on-task (off-task) use, then the on-task column is coded as ‘1’ (‘0’) and the off-task column is coded as ‘0’ (‘1’). Some records are coded ‘0’ in both columns, because they represent neither on-task nor off-task use, or they are indeterminate with respect to use behaviour. In no case was a record coded as ‘1’ in both columns, because no use can be simultaneously characterized as on-task and off-task. The coding process was partly subjective and not entirely error free, so the data were reviewed by two independent coders. Agreement level was 82% (89,260 out of 109,057), and the records in non-agreement were removed for subsequent analyses.

Four measures each for on-task and off-task uses are computed from the data—focus change, keystroke, active time and inactive time. Focus change is a count on the number of records, and represents the number of times that a subject sets focus to an application (window). Keystroke is the sum on the key counter column, and represents the number of keystrokes made by the subject. The key counter values include nonprintable character key depressions, such as shift, control, alt and function keys among others, despite these being absent in the keystrokes columns. Active (inactive) time is the sum of the active (inactive) time column, and represents the amount of active (inactive) time in seconds. All use measures are ratio scaled.

Aggregate results are shown by on-task, off-task and neither use activities in Table 3, which presents nominal and proportional figures. These results indicate that about two-thirds (one-third) of all use activity is off-task (on-task). Records coded as neither account for a small percentage, and these are removed from subsequent analyses. We also eliminate inactive time due to a critical interpretability problem.

#### 4.6 Data Analysis

Our hypotheses require that we test for differences between groups on a set of ratio-scaled measures.



Name	MainAI	Date	AppGotFocus	AppLostFocus	ApplicationName	Keystrokes	WindowTitle	AppKeyCounter	ElapsedTime	ActiveTime	InactiveTime	On-task	Off-task
CNXX01	363	30-Sep	9:56:17 AM	9:57:45 AM	WINWORD.EXE	salSales-Variable bCost-Fixed Cost= Profit x-.45x-175=30	Quantitative P.1CORR - Microsoft Word	69	00:01:28	00:00.43	00:00.45	1	0
CNXX01	364	30-Sep	9:57:45 AM	10:04:48 AM	WINWORD.EXE	Pruurchaes (increase Inv.) C.ost G>.S> (decreases Inv.)= -\$ - z9(322) OurPurchaes (invcreases A.P_) sPyayments (decreases A.P_) (\$312454)  - 328178+x-322=184	Quantitative P.1CORR - Microsoft Word	258	00:07:03	00:03.02	00:04.01	1	0
CNXX01	365	30-Sep	10:04:48 AM	10:05:02 AM	Explorer.EXE		Program Manager	0	00:00:14	00:00.07	00:00.07	0	0
CNXX01	366	30-Sep	10:05:02 AM	10:05:05 AM	WINWORD.EXE		Quantitative P.1CORR - Microsoft Word	0	00:00:03	00:00.03	00:00.00	1	0
CNXX01	367	30-Sep	10:05:05 AM	10:06:42 AM	AcroRd32.exe		Acrobat Reader - [ProblemAssign.pdf]	0	00:01:37	00:00.04	00:01.33	1	0
CNXX01	368	30-Sep	10:06:42 AM	10:07:53 AM	WINWORD.EXE	FIDOF0- LIFO- last in, firsr out	Quantitative P.1CORR - Microsoft Word	45	00:01:11	00:00.54	00:00.17	1	0
CNXX01	369	30-Sep	10:07:53 AM	10:24:55 AM	WINWORD.EXE	No Units Unit Cost \$ NOv. P. 100 \$5 500 CostGS 60 \$5 \$300 End. Bal 40 \$5 \$200  Beg. Bal  Dec. P. 100 \$4 \$2100 Cost GDS 80 \$4 \$320 End. Bla.	Quantitative P.1CORR - Microsoft Word	762	00:17:02	00:06.22	00:10.40	1	0
CNXX01	370	30-Sep	10:24:55 AM	10:25:00 AM	Explorer.EXE		Program Manager	0	00:00:05	00:00.00	00:00.05	0	0
CNXX01	371	30-Sep	10:25:00 AM	10:25:02 AM	aim.exe		AOL(R) Instant Messenger(TM)	0	00:00:02	00:00.02	00:00.00	0	1
CNXX01	372	30-Sep	10:25:02 AM	10:25:19 AM	aim.exe		XXX02's Buddy List Window	0	00:00:17	00:00.01	00:00.16	0	1
CNXX01	373	30-Sep	10:25:19 AM	10:32:08 AM	WINWORD.EXE	FC/ Unite ocntcontributuion= ( 33120/18 units  Sales Sales - Fized xed Costs - vaeiriable costs= profits DaSales -33,120 -(Sales *.40)=0 saSales=55,200 Sales= 1,840/price	Quantitative P.1CORR - Microsoft Word	314	00:06:49	00:03.21	00:03.28	1	0
CNXX01	374	30-Sep	10:32:08 AM	10:33:08 AM	WINWORD.EXE	Quantative Prooitive Preoblems NOTESatit  notes9/.30 Quantatvive	Document1 - Microsoft Word	92	00:01:00	00:00.47	00:00.13	1	0
CNXX01	375	30-Sep	10:33:08 AM	10:38:20 AM	WINWORD.EXE	Ex: Car A is going 60 MPH, Ccar B is trabegoing 60 mMPH.. They are 6 mi apart. A fly is traveling at 12-0MPH. When are they cougoin to cg to collide? 3 minustes , wchi which wso the fly will be 6 miles away from the point it left.statrits original point	notes9.30 Quantitative - Microsoft Word	326	00:05:12	00:01.40	00:03.32	1	0

Table 1: Mostly on-task use

Name	MainAI	Date	AppGotFocus	AppLostFocus	ApplicationName	Keystrokes	Window Title	AppKeyCounter	ElapsedTime	ActiveTime	InactiveTime	On-task	Off-task
CNXX01	159	27-Sep	9:47:00 AM	9:47:03 AM	aim.exe		XXX01 - Instant Message	0	00:00:03	00:00:03	00:00:00	0	1
CNXX01	160	27-Sep	9:47:03 AM	9:47:05 AM	aim.exe		XXX02's Buddy List Window	0	00:00:02	00:00:02	00:00:00	0	1
CNXX01	161	27-Sep	9:47:05 AM	9:47:08 AM	aim.exe	hey	XXX01 - Instant Message	4	00:00:03	00:00:03	00:00:00	0	1
CNXX01	162	27-Sep	9:47:08 AM	9:47:09 AM	IEXPLORE.EXE		Business College - Information Technology - Microsoft Internet Explorer	0	00:00:01	00:00:01	00:00:00	1	0
CNXX01	163	27-Sep	9:47:09 AM	9:47:10 AM	Explorer.EXE		Program Manager	0	00:00:01	00:00:01	00:00:00	0	0
CNXX01	164	27-Sep	9:47:10 AM	9:47:12 AM	msmsgs.exe		MSN Messenger	0	00:00:02	00:00:02	00:00:00	0	1
CNXX01	165	27-Sep	9:47:12 AM	9:47:14 AM	msmsgs.exe		XXX03 - Conversation	0	00:00:02	00:00:02	00:00:00	0	1
CNXX01	166	27-Sep	9:47:14 AM	9:47:14 AM	msmsgs.exe		MSN Messenger	0	00:00:00	00:00:00	00:00:00	0	1
CNXX01	167	27-Sep	9:47:14 AM	9:47:19 AM	msmsgs.exe	hey! what time is ur flight?	XXX05 - Conversation	31	00:00:05	00:00:05	00:00:00	0	1
CNXX01	168	27-Sep	9:47:19 AM	9:47:20 AM	IEXPLORE.EXE		Business College - Information Technology - Microsoft Internet Explorer	0	00:00:01	00:00:01	00:00:00	1	0
CNXX01	169	27-Sep	9:47:20 AM	9:47:27 AM	aim.exe	ya u?	XXX01 - Instant Message	7	00:00:07	00:00:07	00:00:00	0	1
CNXX01	170	27-Sep	9:47:27 AM	9:47:29 AM	IEXPLORE.EXE		Business College - Information Technology - Microsoft Internet Explorer	0	00:00:02	00:00:02	00:00:00	1	0
CNXX01	171	27-Sep	9:47:29 AM	9:47:48 AM	aim.exe	campus at 2:45	XXX04 - Instant Message	16	00:00:19	00:00:06	00:00:13	0	1
CNXX01	172	27-Sep	9:47:48 AM	9:47:52 AM	IEXPLORE.EXE		Business College - Information Technology - Microsoft Internet Explorer	0	00:00:04	00:00:04	00:00:00	1	0
CNXX01	173	27-Sep	9:47:52 AM	9:48:04 AM	aim.exe	5:55	XXX04 - Instant Message	6	00:00:12	00:00:05	00:00:07	0	1
CNXX01	174	27-Sep	9:48:04 AM	9:48:09 AM	IEXPLORE.EXE		Business College - Information Technology - Microsoft Internet Explorer	0	00:00:05	00:00:05	00:00:00	1	0
CNXX01	175	27-Sep	9:48:09 AM	9:48:26 AM	aim.exe	im in fme i know	XXX01 - Instant Message	17	00:00:17	00:00:03	00:00:14	0	1
CNXX01	176	27-Sep	9:48:26 AM	9:48:29 AM	IEXPLORE.EXE		Business College - Information Technology - Microsoft Internet Explorer	0	00:00:03	00:00:03	00:00:00	1	0
CNXX01	177	27-Sep	9:48:29 AM	9:48:41 AM	aim.exe	wuolouldnt that take forever?	XXX04 - Instant Message	35	00:00:12	00:00:07	00:00:05	0	1
CNXX01	178	27-Sep	9:48:41 AM	9:48:59 AM	aim.exe	not really u?	XXX01 - Instant Message	15	00:00:18	00:00:04	00:00:14	0	1
CNXX01	179	27-Sep	9:48:59 AM	9:49:09 AM	aim.exe	how long would that take?	XXX04 - Instant Message	27	00:00:10	00:00:10	00:00:00	0	1
CNXX01	180	27-Sep	9:49:09 AM	9:49:18 AM	IEXPLORE.EXE		Business College - Information Technology - Microsoft Internet Explorer	0	00:00:09	00:00:00	00:00:09	1	0
CNXX01	181	27-Sep	9:49:18 AM	9:49:47 AM	msmsgs.exe	what? no.. u did? where did u go? n	XXX05 - Conversation	48	00:00:29	00:00:15	00:00:14	0	1
CNXX01	182	27-Sep	9:49:47 AM	9:49:55 AM	aim.exe	an hour?	XXX04 - Instant Message	10	00:00:08	00:00:08	00:00:00	0	1
CNXX01	183	27-Sep	9:49:55 AM	9:50:09 AM	aim.exe	haha	XXX01 - Instant Message	5	00:00:14	00:00:08	00:00:06	0	1
CNXX01	184	27-Sep	9:50:09 AM	9:50:13 AM	aim.exe	ok cool	XXX04 - Instant Message	8	00:00:04	00:00:04	00:00:00	0	1
CNXX01	185	27-Sep	9:50:13 AM	9:50:25 AM	msmsgs.exe	oh! =( guess what? my p	XXX05 - Conversation	30	00:00:12	00:00:06	00:00:06	0	1

Table 2: Mostly off-task use

More specifically, the independent variable has two levels—restricted and unrestricted. For each hypothesis, the dependent variable has three measures—focus change, keystrokes and active time. When one must test for significant differences between two groups on two or more dependent variables, one may use Hotelling's T-square statistic.

	Nominal Figures			Proportional Figures		
	Focus Change	Keystrokes	Active Time	Focus Change	Keystrokes	Active Time
Off-task	69,027	1,265,658	680,022	79.3%	65.8%	67.5%
On-task	15,362	652,371	315,403	17.6%	33.9%	31.3%
Neither	2,706	6,238	11,352	3.1%	0.3%	1.1%
Total	87,095	1,924,267	1,006,777	100.0%	100.0%	100.0%

Table 3: Use Measures

## 5 RESULTS

The results in Table 3 show that about two-thirds of all use is off-task and about one-third is on-task. Thus, a majority of use behaviour is off-task although a sizeable amount is on-task. When given tools to be more effective in a co-located learning setting, subjects appear to gravitate toward off-task use behaviours. This is unfortunate from a facilitator's perspective.

Use Behaviour	Access Setting	Hotelling's T <sup>2</sup>	Focus Change	Keystrokes	Active Time
Off-task	Restricted		681	12,859	7,588
	Unrestricted		1,279	23,155	11,905
	Significance	p<.05	p<.01	p<.05	p<.05
On-task	Restricted		246	13,277	5,560
	Unrestricted		222	7,057	4,128
	Significance	n.s.	n.s.	p<.05	n.s.

Table 4: Use Measures by Use Behaviour, Access Setting

The Hotelling's T square test results are shown in Table 4. The results indicate that off-task use was significantly different between restricted and unrestricted access settings on the three use measures at p<.05. Off-task levels were higher in the unrestricted access setting, which is consistent with expectations. Levels of focus change (p<.01) and keystrokes (p<.05) in the unrestricted group were almost twice that of the restricted group. The unrestricted group had a greater level of off-task active time (p<.05) compared to the restricted group as well. Hypothesis 1 is supported. On-task use was not significantly different between unrestricted and restricted groups on the three use measures. This is also consistent with expectations, assuming that the facilitator dynamically provisions services as needed. Hypothesis 2 is also supported.

## 6 DISCUSSION, CONCLUSION AND LIMITATIONS

The collective findings are largely consistent with expectations, but it is important to remain mindful that overall use is characterized by a preponderance of off-task use. Viewing the data differently (see Table 5), we see that in restricted access off-task use is significantly higher than on-task use at p<.01 across the three measures. This highly significant finding stems from the large difference on focus change (p<.01), where the off-task level is almost three times the on-task level. Thus, despite the PS's infrastructure and application restrictions, participants continue to find ways to engage in off-task uses. Additionally, for participants who were provisioned all infrastructure and application services

(unrestricted), their use was overwhelmingly off-task as indicated by  $p < .01$  significance levels for the overall Hotelling's T square test and for each use measure.

Access Setting	Use Behaviour	Hotelling's T <sup>2</sup>	Focus Change	Keystrokes	Active Time
Restricted	Off-task		681	12,859	7,588
	On-task		246	13,277	5,560
	Significance	$p < .01$	$p < .01$	n.s.	n.s.
Unrestricted	Off-task		1,279	23,155	11,905
	On-task		222	7,057	4,128
	Significance	$p < .01$	$p < .01$	$p < .01$	$p < .01$

Table 5: Use Measures by Access Setting, Use Behaviour

Our findings support the view that PS are effective at reducing off-task use while leaving on-task use unimpeded. Stated differently, PS may offer one means to balance the advantages and disadvantages of computer-based multitasking. Nevertheless, a preponderance of computer-based multitasking was off-task despite restriction of certain devices and applications to reduce off-task use. A main explanation for this breach lies in participants' use of local applications, which lay outside the PS's "reach." Another explanation lies with some users devising clever ways to circumvent the PS control, although this was *relatively* uncommon. In either case, the findings suggest that PS are *only partially effective* as an organizational control mechanism for bringing about goal alignment between facilitator as principal and participants as agents in a co-located learning setting. Consequently, additional ways to control computer-based multitasking are needed.

Considering established theories, we contend that socialization structures as described in Ouchi's (1979) theoretical work may be necessary to restrain off-task use. Extending from Ouchi's (1979) description of them as "...a highly formalized and lengthy period of socialization during which [participants] are subjected not only to skill training but also to value training or indoctrination. (p.837)," we imagine value training and indoctrination could manifest in *formal procedures* to bring about behavioural modification and reform with the objective of restraining off-task uses. We envision formal procedures that would inform about appropriate computer-based multitasking uses, where notions of appropriateness encourage participants to stay on-task and resist off-task uses. These formal procedures would be executed at the onset of the learning process in order to establish behavioural norms at the beginning, and be delivered on a repeated and frequent basis for continual reminder until conclusion of the learning sessions. The formal procedures would include punitive measures, which would be clearly communicated and reliably enforced in case of violation.

An additional option may be the use of a "public" display that is large and viewable by all participants, where the "public" display could show any participant's personal screen. While simultaneously showing all participants' personal screens on the public display is not practical, skilful design and implementation of contemporary infrastructure and applications can allow the facilitator to selectively put one participant's personal screen on "public" display. A viewing of a personal screen by all participants would likely be effective at discouraging off-task use, assuming that procedures were fully disclosed to participants beforehand. On a theoretical level, this is akin to using an information system such that the principal (facilitator) is informed about the agent's (participant's) actions (computer-based multitasking behaviour) in an effort to bring about goal alignment (reduce off-task use).

We conclude that participants' computer-based multitasking is characterized by greater levels of off-task use when compared to on-task use by a significant margin. We also conclude that provisioning systems alone are not sufficient to effectively control computer-based multitasking—i.e., to restrain off-task use, so it may be advisable to augment provisioning systems with behavioural modification and reform efforts.

One obvious limitation relates to generalizability of these results. The data were collected from co-located settings of a college-level classroom setting. The roles of instructors as principals and students

as agents, and the attendant role dynamics, may not adequately overlap or correspond to those of co-located facilitators and participants in ordinary business co-located settings. Thus, the findings may not generalize to this situation.

Another limitation relates to an implicit assumption in our hypotheses development that off-task and on-task use behaviours are independent of one another. It may be that some dependency exists in that as off-task use increases then on-task uses may decrease or vice versa. This may occur under circumstances where a user has no slack cognitive resource, so that any increase in off-task use will result in a decrease in on-task use. While this may be true in some instances, we argue that it is more likely that slack cognitive resources are available *in co-located contexts*, thereby allowing off-task and on-task uses to increase or decrease independent of the other.

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