Time, Efficacy and Cost Considerations of e-Collaboration in Online University Courses (part IV)

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Personnel costs

Considering what might be viewed as straightforward personnel expenses attributed to this project was also an exercise in judicious allocation. For example, the principal investigator also had several other responsibilities including program chair, doctoral student research project advising, course redesign, instructor in other courses and teaching assistant supervisor. How much of this jointly proposed time to attribute to this project, his course or non-Mellon Project ventures required careful consideration.

Graduate assistants supported by the Mellon Project or by the institution were dedicated to various activities including teaching assistance, data collection and analysis, knowledge management systemsupport, and other non-instructional roles related to the project or the courses. Guiding them to document their time and to allocate the time devoted to the project across multiple activities (planning,delivery, evaluation) required some practice and revision of time estimate allocations.

A separate graduate assistant cost issue relates to the calculation of total costs attributable to a graduate student's time. In a private institution such as Syracuse University, graduate tuition rates are as high if not higher than in most state supported institutions. This applies whether the state supported institution student is charged in-state or out-of-state tuition rates. Thus, cross-institutional comparison of graduate assistant costs for e-learning applications must be viewed with caution although all such students may be engaged in the same or similar activities. For purposes of this study, it may make more sense to review graduate student reported time devoted to various tasks than to compare costs of their time when both stipend and graduate tuition are indexed in the financial allocation.

Faculty costs, likewise, should be considered with care. Faculty for the three courses included in this study were not selected with academic salaries in mind - all were full professors. The quantitative salary figures) and qualitative (experience) characteristics of all three instructors involved in this study reflect substantial academic and administrative experience. In a more conventional application, wherein technology interventions are substituted for high-cost personnel, differences between salaries paid to relatively new and inexperienced faculty versus those to senior experienced faculty would have major cost implications. This study did not address the substitution strategy but instead focused on a supplementation strategy with e-learning resources serving as supplements to the conventional faculty (salary) driven delivery system. In either case, selection of new, adjunct, inexperienced (less costly) faculty rather than full-time equivalent experienced faculty would have considerable cost implications. Cost saving studies of e-learning technology application, thus, must address starting assumptions about the criticality (or not) of faculty experience (and cost).

Hardware costs

Existing Web-based course management system servers, knowledge management services, Internet connection vehicles and digital multimedia development and delivery equipment were all made available to support the three courses in this study. Some servers, for example, were relatively new installations with less than capacity usage. How, then, to determine the extent of current operating costs or initial investment costs to allocate to each of the three Mellon project courses? If all the equipment were operating at peak levels of use, would the allocation process then reflect many more users and the lower front end (investment) and operating expense allocations? These questions are not easily answered.

New equipment (e.g., laptops, Web cameras, scanning devices) was not required for this project. However, if new equipment had been required, then how should one allocate the cost of any such equipment? Once the project is completed, how much of the cost of each piece of equipment can reasonably be attributed to future applications, thus reducing the costs allocated to this project? In some ways this is a situation similar to attributing the relative cost of partial use of a server to various projects and users. In many cases, such a distribution is seen as arbitrary; as new users are added, the cost appears to be negligible, since the purchase decision has been made and the capacity already acquired. However, the purchase of equipment expressly to support a specific project when that equipment will most likely support other, as yet unplanned, efforts creates a challenge for attribution of costs in a life cycle cost model.

Software and courseware tools

No new or additional pieces of content-related courseware, design, development or production software or delivery support software were required for this project. Communication support protocols (chat, threaded discussion, e-mail) were either included in the Web-based course management systems or supported

separatelyas part of the University system (e.g., external e-mail for BlackBoard). Few additional texts, referencesor design manuals were required as well. Web accessible resources and sites were included but the directcosts for such resources were negligible.

New courses with completely new content, strategies and Web applications may require procurement of relevant courseware, rights to online resources, faculty training manuals and the like. These could all then find their way into this cost classification category.

Facilities costs

Arguments for cost saving and avoidance through the use of Web-related technologies focus typically on personnel or facility considerations. Costing out the use of a classroom for multiple sessions throughout a semester when addressing a conventional face-to-face course still requires some thought. For example, considerable classroom facility differences would exist if the three courses included in this study were offered face-to-face and the cost of classroom space was calculated. A classroom in a converted hospital built in 1900 versus a classroom in a newly constructed facility with comfortable chairs and full technology capacity might suggest some cost differential between the two.

These three courses, however, did not require classroom space but did make use of a range of technology-oriented delivery equipment and facilities. Of course, none of this equipment or these facilities were purchased or constructed solely for this project. Thus, the joint costing and cost allocation procedures apply when considering these resources.

Overhead costs

As in many other externally funded R&D ventures within an academic institution, decisions on what constitutes overhead expenditures and what overhead rate to employ merit comment in this study. For example, it is rare when the institutional expenditures to build, staff and maintain a library are defined as direct cost expenditures. It makes sense when specifically addressing the operations of the library, or the communications system or the accounting system but not when these are viewed as support functions to academic R&D and instructional activities.

For the purposes of this project then, how does one go about determining whether various support system functions should be defined as institutional overhead or as direct cost components? Examples include the following: a) Web access - student, faculty, in residence halls, at home (a contributed resource?); b) Technical support - within a school, institution wide, online help; c) Library resources - online, print, via the ERIC Clearinghouse, the campus library, special reference personnel; d) Web-based course management systems - licenses for multiple users, servers and maintenance thereof, training in the use of the systems, updates to the systems; e) Knowledge management support system - license for multiple users, multi-function (scan/photocopy, etc) equipment, procurement and maintenance, maintenance of server, training in the system (e.g., DocuShare was used to support this project; costs are not reflected herein).

Another way to view some of these institutional and program supported resources used in this study and by the three courses is to consider them inherited or contributed resources. In several instances, equipment,software, and even support personnel were procured and maintained through other external funding sources.How much of any of these resources then should be counted as contributing to the costs of the three Mellonstudy courses?

In a similar vein, additional contributions or volunteer resources were also employed in this study. Graduate students interested in the study, seeking a context for a relevant research apprenticeship, desiring experience in planning, implementing and evaluating e-learning applications or just seeking to cultivate potential dissertation committee chairs were active team members. Services provided by centers or agencies within the institution provided technical, data analysis, and other support assistance at below actual cost or at no direct cost to the project. In most cases, personnel time devoted (contributed or paid) to the project has been documented via journals, project diaries, online weekly logs or invoices for services. Costing each of these contributions, many with joint cost and multiple benefit implications, proved to be a challenge. Determining which if any of them should be aggregated under some overhead expense charge was also considered (but not reported) so as to acknowledge the contribution in some narrative accounting at least.

Cost and effectiveness evaluation criteria

The following exemplary outline or taxonomy of descriptive and evaluative criteria has been developed to show how a wide range of data could be used in an outcome or effectiveness analysis in a comprehensive, total cost-effectiveness (C-E) analysis of e-learning applications. This list is not meant to be exhaustive,but rather to illustrate the categories of measures that are typically encountered.

Table 10. Taxonomy of cost and effectiveness criteria.

I. Learner-trainee outcomes

A. Cognitive and psychomotor data
1. Prerequisite (entering behavior) test data (entering skills and knowledge)
2. Pretest data
3. Criterion-referenced posttest data
4. Norm-referenced posttest data
5. Pre-post-test gain score data
6. Performance data
7. Criterion-referenced knowledge and skills retention data
8. Norm-referenced knowledge and skills retention data
9. Transfer of training data
B. Affective data
1. Pre-instruction attitude
2. Pre-instruction satisfaction
3. Post-instruction attitude
4. Post-instruction satisfaction
C. Other outcomes
1. Positive side benefits - system and learner
2. Negative side effects - system and learner
3. Absenteeism/attendance/participation
II. Efficiency/time criteria and considerations
A. System
1. Front end analysis time
2. Design/development/validation time
B. Learner
1. Chronological - lapsed time
2. Total active instructional time - time to learn
3. Retention time - intervening time between test and retest
C. Faculty
1. Pre-course delivery time
2. Time to learn new (e.g., digital literacy) skills
3. Time spent on line
D. Other considerations
1. Time sequence constraints: e.g., holidays-vacations-summer interruption
2. Replacement schedule for equipment and courseware
3. Depreciation - physical life cycle of equipment
4. Obsolescence - technological life cycle of equipment and software
5. Operational utility - content/doctrine stability and operating lifetime/content stability
III. Feasibility Criteria and Measures
A. Appropriateness/relevance
B. Availability
C. Capability
D. Convenience
E. Cooperability
F. Cooptability
G. Criticality
H. Dependability - hardware
I. Evaluability - measurability
J. Exportability
1. Diffusability
2. Marketability
K. Pervasiveness
L. Political-legal constraints

M. Reliability - assessments
N. Social/moral concerns
O. Uniqueness
P. Utility
Q. Validity - goals, assessments
IV. Dollar cost criteria
A. Design and Development costs (non-recurring expenses)
B. Investment and production costs (non-recurring expenses)
C. Replacement costs (per cycle - over multiple years)
D. Operation costs - one cycle and annual
E. Operation costs - lifetime
F. Total lifetime dollar costs

The notion of investment applied in contexts like higher education merits brief discussion as well. The institutional versus faculty versus student perspective of e-learning suggests somewhat differing views of what constitutes an investment. Whether an institution worries at length about the additional time required of a faculty member to design or manage a course or the time required of students to communicate online may depend upon the implications of the time expended. If it results in no greater institutional financial expenditure but leads to few, if any, new faculty electing to become involved, then that investment may be meaningful. If more student time or significantly improved student access influence future enrollment, then perhaps both the institution and faculty member may pay attention. Existing institutional infrastructure to support design and management of e-learning may be viewed by some as investment, overhead, administration support or critical components in the e-learning mix. Donated time, inherited equipment, existing networks or services can also be included as investments - or not. When the instructional and organizational model assumes that technology is a supplement to typical instructional expenditures (as in this study) or when it is viewed as a replacement (supplant) for expensive labor, advocates (or opponents) for whatever model is being considered may elect to include all so-called investments or view some of them as irrelevant or insignificant. Thus, the science, art and politics of cost analysis modeling must be considered carefully.

Cost analysis from an institutional perspective

Figure 20 is a representation of the costs by instructional phase for one cycle of offering an online course from an institutional perspective. The rows correspond to the major instructional phases discussed earlier and the columns break costs into major categories discussed earlier.

	Personnel Salaries & benefits	**Personnel GA/TA**	**Equipment**	**Software**	**Facilities**	**System & course admin**	**TOTAL**
Planning, design & development							
Investment & production							
Operation: one cycle							

Figure 20. Cost analysis matrix.

Cost analysis of one Mellon e-learning course

Although each of the three e-learning courses studied in this project employed somewhat similar approachesto delivery and supporting instruction, several cost-related components were included in some and not in others. For purposes of explanation and general cost model application demonstration, one of the coursesthat included most of the components will be used to display and explain the costs. A three-phase by multiple cost category matrix modeling scheme (Figure 20) is used to demonstrate which expenditures get allocated to various categories and phases. No attempt has been made to estimate prior course design time expended by faculty or staff nor has the cost of obtaining Web-based course management system servers and licenses been documented since such activities were completed well before the beginning of this project. This does not mean that these activities or portions thereof are irrelevant expenditures for this analysis; for this purpose, such after-the-fact cost estimation was not deemed particularly useful.

An ingredients approach to cost analysis promoted by Levin & McEwan (2001) and others was used to identify and classify resources used to prepare and deliver the course via the Web management system. Brief descriptions and explanations of selected expenditures should ultimately be included where decisionson amounts of a resource (cost estimation), the classification of the resource (Design vs. Investment vs. Operation), or special implications for e-learning applications merit comment.

As discussed previously, not all elements of a full life-cycle cost analysis were included in this particular study and the course selected for this example. Much of the typical curriculum planning, content decision making, initial instructional strategy consideration and general pre-production activities required when a new course is scheduled was not a part of this venture. In addition, the experienced faculty member had previously taught the course in both face-to-face and online formats suggesting that minimal professional development (investment) time was required to get ready to shift the course to a different Web-based course management system. Little attention was given in this study to the ease (or challenge) of shifting from any Web-based course management system to any other system, but some faculty time, system support personnel time and graduate teaching assistant time was no doubt devoted to the shift. In a typical cost analysis, this time might get reflected in time log reports submitted by those required to keep such records but might not get included at all, for example, if the faculty effort devoted to this participation and transfer occurred during summer or other break periods. The online diaries and logs kept by personnel in this project reflect some of this effort but then matching this timeto actual paychecks or not (summer 'volunteer' time for example) was not attempted.

A simplified cost analysis matrix reporting scheme (Figure 20) reflects some of the somewhat arbitrary cost allocation decisions made when we considered whether faculty or support personnel time allocations belonged in the Planning, Design and Development (one-time expense) phase or the Investment and Production(also one-time expense) phases. It was somewhat easier to determine when personnel time and expendable course material costs should properly be allocated to the Operation (repeatable or recurring expense) phase. Deciding which resources were to be viewed as one-time expenses (not added in repeatedly when subsequent cycles of the course were offered) and which resources were directly related to delivering (operation) the course and could be counted on to appear each cycle was not as simple.

Which cost categorization scheme to use was not viewed as critical for this study nor was some deeper level of cost detail. Special e-learning related expenditures, however, were important to include within each relevant category. A cost categorization scheme (Table 11) can be used to guide decisions on where toreport various resources or expenditures. Even a scheme such as this still requires some deliberation when, for example, a pro-rated share of the cost of a Web-based course management system license agreement is to be documented. Would such an expense best be included as a recurring expense as part of each course cycle or perhaps a part of institutional overhead? If this cost is included as a course delivery cost, then whatother institutional resources should also be calculated and reported. Computing systems, communication systems and the library come to mind. Careful and continuous security of computer labs and computer work stations so as to prevent theft or vandalism could also be viewed as an e-learning related expense. For this study, none of these expenses were included.

What did make sense in this study was to document the additional (incremental) costs associated with planning, producing and delivering one online course. Since e-learning for this course can be viewed as a supplemental (additional) resource requirement, traditional one quarter of a faculty member's semester salary (0.25 FTE) plus benefits were not viewed as incremental, but as the typical personnel expense for the delivery of any instructor-led course. For one particular course, but not for the other two, a graduate teaching assistant was assigned to assist with course administration, materials redesign, communication and assessment. In most instances with a course with this relatively low enrollment, no teaching assistant would be required or available. The other two course faculty members, both with more experience with online instruction, elected to allocate project-supported graduate assistant positions to the research and evaluation components of the study. Thus, those two graduate assistantships (@$10,000 stipend and $16,800 tuition - 24 hrs x $700) would not show up anywhere in the cost analysis of these three courses.

Table 11. Cost categorization scheme for e-learning.

Major Activities

A. Planning Design and Development (one time expenditures)
1. Needs assessment - front end analysis - initial planning
2. Task analysis - job analysis
3. Curriculum design
4. Prototype development and testing
5. Formative evaluation - preliminary product and program review

6. Materials validation
B. Investment and Production (one-time expenditures)
1. Acquisition - Installation - Start up costs
2. Procurement of initial stock of hardware and software
3. Duplication of production masters
4. Construction - Renovation of facilities
5. Purchase of initial spare components
6. Modifications of existing systems
7. Initial deployment of hardware and software
8. Server acquisition and setup
9. Web support system license(s)
C. Replacement (one- or several-time expenditures)
1. Replacement as a result of:
a. Obsolescence: Content, technology, strategy
b. Depreciation: Normal use
c. Theft - vandalism - breakage
2. Periodic (scheduled or unscheduled) updating of:
a. Content - materials
b. Equipment
c. Procedures - management
D. Operation (multiple time/each cycle expenditures)
1. Personnel
a. Instructional: salary - travel - benefits (including retirement)
b. Administrative - managerial
c. Maintenance - support
2. Materials: consumables inc. regular updating and revision of instruction
3. Ongoing instruction, assessment and evaluation
4. Ongoing distribution and deployment of hardware, software and courseware
5. Facilities
6. Overhead: general institutional indirect costs and special distance learning overhead

In addition to the additional cost of one teaching assistant, presumably for only the first cycle of the online course, other incremental expenses focused on the support apparatus required to run and maintain the Web course management system. Depending upon the number of courses being served by this support system, the estimated life expectancy of the servers and other related equipment (prorated across the many courses and several years of equipment use), the percentage of allocated or actually devoted time of system support personnel, perhaps some relatively small percentage of computing and media services administrative (supervisor) time and some percentage of security and computing services, janitorial services time, some estimate of incremental costs for e-learning support for one course could be generated. This was not done.To do so would have required time to be devoted to judicious resource allocation and pro-ration with relatively meaningless results.

The lack of detailed, exquisitely documented evidence on the incremental costs to support one online course should not be seen as a rejection of the importance of these resources and services. Without Internet access, Web-based course management systems, telephone service, heating, parking, and so on, little e-learning would occur. What is important to note in this instance is that many indicators suggest that the three courses should be viewed as successful. The incremental costs to support the online components were minimal and are likely to diminish over time with increased numbers of online courses and greater efficiencies in course development. The time logs and diaries, however, suggest another kind of incremental cost that will require much attention. Documented faculty time for the three volunteer, experienced, leading-edge faculty members will not convince large numbers of additional faculty to allocate their little remaining flexible time to online chats, answering e-mail questions from impatient students or learning the intricacies of a Web-based course management systems.

Conclusions and recommendations

Responses to hypotheses

This study addressed five hypotheses. Responses to each are summarized as follows:

1. The specific forms of communication and collaboration in online settings effect the time demands placed on students and instructors - online courses create an additional time burden for instructors.
2. Learning outcomes in online university courses are not significantly different from those in traditional university classrooms - not refuted by this study.
3. Time required to design, develop and deliver online courses are major factors in the cost effectiveness of online instruction - this warrants further study as much of the front-end effort associated with these three courses had already been accomplished.
4. Student and faculty experience with online instruction effect perceptions of effectiveness - both students and faculty liked the time flexibility afforded by online courses.
5. Student and faculty perception of the benefits of online instruction improve with experience in online environments - there is no evidence to confirm or refute this hypothesis, and it deserves further investigation.

General conclusions

It can be very hard to conceptualize time and then to categorize one's time in terms of time devoted to a particular task when one is online; the Mellon weekly logs asked instructors to do just this. It does take time and energy to address certain course-related issues that students might have. Managing time is an important issue when teaching online courses. Cost in terms of time is perhaps the greatest concern in adopting new methods of teaching. Teachers and students have to deal with time issues related to the use of new methods of learning and instruction.

Cost-effectiveness issues

Analyzing the life cycle cost of e-Learning is a challenge. Although there are many resource-related issues that are shared by face-to-face, blended and totally online instructional delivery or management approaches, the considerable expansion of types and amounts of e-learning delivery and communication approaches present interesting challenges for those seeking to document and evaluate online learning ventures. Shorter-term investment decisions, although important, may be less important than other issues when longer-term perspectives are considered. Life cycle costing, for example, presumes that some estimate of the life expectancy and number of cycles (offerings) of a course can be determined. Absent some agreement on these critical life cycle factors, this leads to short term decisions based on course design and initial delivery costs with no consideration given to allocating or prorating the front end, non-recurring costs over multiple course offerings. Without any opportunity to consider if initial investment will result in reasonable average expenditures over multiple years or cycles of a course, short-term perspectives on initial investment costs will typically lead to status-quo maintenance rather than innovation or change. The following issues represent some of the resource-related components of this study that merit brief discussion. How they might apply in other e-learning application contexts will vary but may still require attention.

Faculty Technology Ramp-Up

Although, again not an immediate cost analysis issue in this study context, considerations of faculty recruitment, selection and prior experience with technology (web applications, shopping on E-bay) and especially with online learning can have significant front-end cost implications. Whether an institution or a program elects to invest in faculty development for e-learning (not the case in this study) or a faculty member elects to invest her or his own time in preparing to design for and deliver instruction online, there is a cost to consider. The three experienced faculty members recruited for this study had varying levels of experience teaching their selected courses in both face-to-face and technology supported venues. None of them would be labeled new to their respective course content, course delivery or technological literacy. Consideration of the time and other resources devoted by them and their programs (previous institutions as well) to their preparation for this study would be a challenge to cost. Prorating these costs in time and energy across multiple years, multiple courses and assorted projects in order to identify some attributable figure for initial preparation for these three courses did not make sense. It does make sense, however, to carefully consider how much time and energy to devote when recruiting faculty who are new to online learning or when selecting courses that have not been previously offered in any format. All such considerations will have initial cost (investment) implications. Of course this is not much different from decisions that must be made about selecting new faculty for any program when their teaching and instructional design experiences are limited or absent. In this case, adding e-learning expertise to the mix makes the calculations more complicated.

Enrollment, Retention and Attrition

Although not immediately apparent, considerations of which courses or series of courses to include in some e-learning investment scheme must be informed by enrollment projections. Courses with limited enrollment projections, infrequent offering plans or projected short content life spans must rely on arguments other than life cycle cost savings for inclusion. Economy of scale arguments such as those

supporting replacing costly personnel with cost-efficient technologies will not be well addressed when a high level, low enrollment, infrequently offered, content unstable course is proposed for significant front-end investment. This concern applies whether the investment is to support a face-to-face strategy, a blended approach or an entirely online venture.

In a related, but quite different enrollment issue, the notion of retention and/or attrition in an online course merits discussion. In the three courses with multiple cycles in this study, retention was exemplary by almost any measure. Whether this was influenced in any way by the considerable opportunities offered for communicating, interaction, feedback and the like was not addressed but frequently discussed concerns about dropouts from other e-learning courses and programs still are relevant. Issues such as matriculated versus non-matriculated enrollees, required or elective courses, graduate or undergraduate students, and especially students enrolling with reasonable technological literacy skills versus those who do not may all influence retention and economy of scale considerations.

Measuring retention and attrition in any context merits brief comment in relation to this study. When (early or later in the semester) an institution or a faculty member elects to define a starting course enrollment list can have a significant influence on reported course attrition. For the online courses in this study, there were few initial "tire kickers" who reviewed the online syllabi, course requirements and initial dialogues and then elected not to participate. Whether such students elect to observe the first session or two of a face-to-face course or obtain approval to sign on to an online initial chat, if they do not officially enroll or drop before the formal initial class list is created, they typically are not included in the attrition list.

A similar attrition measurement issue is related to course completions whether they are on time (by the stated course deadline for assignments) or eventually via taking an incomplete grade and finishing assignments whenever the faculty negotiation plan determines. In this instance such incomplete grades are not reported as dropouts or attrition students and only later can it be determined if the student completed the course or not.

Course design issues such as content and contextual relevance, proper program sequence and career focused when appropriate all are important regardless of delivery strategy employed. Attributing retention or lack thereof to the use of technology thus does not appear to be a worthwhile conversation when discussing cost or effectiveness of e-Learning.

Institutional Infrastructure and e-Learning Support

This study was not initiated in an institution where no previous online experience or support expertise existed. Multiple support systems, organizations, licenses and committed personnel were available to assist as required, and were supported by additional Mellon resources. Some cost-related issues in such a context are different than would be the case where an institution decided to initiate a new e-learning enterprise with little or no previous personal or organization experience and with no outside funding support.

How to allocate a prorated cost for relevant institutional infrastructure, organizational capacity, technical expertise and even commitment was a challenge. Starting the three courses in the study from scratch with no Web-CT or Blackboard licenses, no organizational expertise, no course design or redesign capacity, or limited data analysis expertise would have multiplied the project workload (and costs) by a factor of three (or eight!). Thus, determining the front-end costs for design, development, infrastructure design, Web-tool licenses, support personnel training and the like in this setting versus one with little previous experience and existing infrastructure presents challenges. The fact that little attention was given to costing out the capacity of the institution to support this project does not eliminate that issue from consideration by others seeking to get into or continue the e-learning business. Again, economies of scale issues (such as the number of courses that can be supported by one licenseor by one server, or the enrollments expected for a course, or the number of times a course will be offered before major revisions) will impact resource requirements whether or not these costs are made explicit.

Learning issues

With regard to the three courses involved in this study, there were no obvious improvements or impairments to learning related to the online course environment. If this finding is generalized, then the conclusion is that online learning is not inherently inferior or superior to traditional face-to-face learning. Such a conclusion is consistent with what researchers noted in the so-called 'great media debate' (Clark, 1994; Kozma, 1994a, 1994b; Russell, 1999). This is good news because it means that those who have no option other than distance education are not necessarily doomed to a second-rate education.

However, not all of the news is good. If it is generally the case that what is learned is primarily dependent on issues other than media and setting, such as coherence of instructional design, then training faculty to make proper use of Web-based delivery mechanisms becomes very significant. Training takes time and money, and in this case such training would have to be considered a supplemental development cost. If one concludes that learning issues are not a major factor in deciding to offer a course in an online versus a

face-to-face setting, then the issue of additional or supplemental costs in comparison with supplanting costs becomes very significant. Additional research is required to confirm the outcome that students learn as well in online settings as in face-to-face settings.

Institutional issues
A number of institutional issues were identified, but not directly addressed, in this study. First, university administration should address fair compensation of faculty to teach online. If distance learning and online teaching is a university priority, then faculty who engage in online teaching should not be penalized in the tenure and promotion process. The administration should establish standard procedures for evaluating online teaching.

Recommendations for future studies
Several findings provide a foundation for further investigation about the efficacy of distance education and the cost-effectiveness of online learning. In addition, many practical lessons were learned about collecting and analyzing cost- and learning-effectiveness data, especially in online courses.

Online versus face-to-face
There is no reason to expect significant differences in learning outcomes in online versus face-to-face college courses based on our findings and those published to date in the literature. As a consequence, it is our recommendation that future comparisons of online and face-to-face teaching focus on other issues, such as sustainable improvements in access to higher education, skill and competencies required of teachers and learners in different settings and more in-depth analysis of life-cycle costs.

Multiple forms of online learning
Online teaching and learning is not a simple or discrete activity. There is a family of online learning and instructional forms. There are a number of forms of online instruction, including asynchronous Web-based instruction, synchronous Web-based instruction, and mixed methods. Moreover, each of these major categories has a number of dimensions, including individual versus group activities and different forms of interaction with multimedia representations, simulations and other instructional materials. Future research should address a rational framework for determining which forms and dimensions fit well with specific instructional contexts, taking into account cost considerations as well as desired learning outcomes.

Multiple forms of face-face-learning
Face-to-face instruction is changing on account of technology and especially due to the vast amount of information available on the Internet. Just as research ought to address mixed online methods and approaches, it is worth investigating how the traditional face-to-face instructional paradigm can be augmented and incrementally modified to produce cost-effective outcomes. The research literature appears to be fixated on an either-or approach in terms of either online or face-to-face and then either learner-centered and open-ended or highly structured teacher-centered models. The reality is that the extremes do not map well onto reality and that face-to-face instruction is rapidly evolving in multiple directions. These variations deserve investigation to see what sustainable learning and cost benefits are occurring.

Communication modality and time requirements
This study is one of only a few to investigate the time demands associated with different forms of communication. While there are certainly benefits to online instruction (more flexibility with regard to when and where teaching and learning occur), the time burden placed on students and especially on teachers should be further investigated. Our primary finding is that online teaching places additional time demands on instructions and often requires additional support above what is required in face-to-face settings. This is a preliminary finding for which we have found only one major, empirically-based, corroborating study (Gervedink Nijhuis & Collis, in press). This area is ripe for exploration using both qualitative and quantitative methods. We made use of interviews with faculty as a way to gain confidence in our findings, and such qualitative studies should be continued (indeed are continuing as a direct consequence of this study). Moreover, quantitative studies of the kind reported herein or in Gervedink Nijhuis & Collis (in press) are required in order to gain deeper insight into the effects of communication methods in online courses on overall cost effectiveness.

Before and after faculty and student perceptions
The before-and-after student perceptions reported here reveal few major changes over the course of one semester. Longer studies should be conducted to determine what long-term changes in attitudes about online learning might be evolving. Moreover, studies with larger numbers of students are required in order to be able to correlate changes with various types of demographic information; while we collected these data, the numbers were too small for analysis. In addition, a completely neglected area is faculty perceptions. The concomitant interviews conducted with the three instructors involved in this study and with nine others did approach a before and after perception analysis. Those interviews lacked the comprehensiveness of the demographic survey and end-of-course evaluation, but they did provide depth and richness not easily obtained from simple surveys. How faculty views about online teaching and

learning evolve as they gain experience warrants further study.

Reusable learning objects

At several points in the cost effectiveness of this report there were direct and indirect references to reusable learning objects (Wiley, 2001a, 2001b). The nature of design in general has changed with the introduction of object-oriented design in computer science. Small-scale objects (such as a drop-down menu box) are now routinely developed so that they can be reused in different settings. Instructional design is slowly adopting similar methods, although only in computer- and Web-based instructional settings. As these enterprises scale up, the advantages of having digital objects that can be used to support a variety of learning goals and objectives becomes obvious. However, adoption across institutional boundaries and by a significant number of instructional designers and instructors remains a challenge. A deeper challenge pertains to the specification of a learning object in a way that it will be meaningful to and accessible by a large number of teachers and learners. There is every reason to expect that increased use of learning objects will impact the cost effectiveness of instruction. Determining how to design effective learning objects and then measuring their effects on learning and costs are important areas for future research.

Life cycle cost-effectiveness

The general conclusion arrived herein is that some things are known about a limited life-cycle cost-effectiveness analysis of e-learning based on these three cases. Limitations include the following: (1) only one complete cycle was reported; (2) initial start-up requirements have not been reported; and, (3) gains due to economies of scale as more courses are offered more often have not been investigated. Future studies must eventually address these additional factors.

Finally, it is surely true that technology changes. It is also true that technology changes what people do and what they can do. Technology is changing the nature of teaching and learning. It remains our hope that technology will have a positive impact on education, although assessing learning outcomes, attributing improved outcomes to specific interventions and experiences, and determining the costs of those interventions remain a huge challenge.

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