

What Are the Relevant Costs of Online Education?

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September 22, 2002

This work is supported by a grant from the Andrew W. Mellon Foundation's Cost Effective Uses of Technology in Teaching (CEUTT) program initiative. The authors wish to acknowledge the useful comments and contributions of Ian Blake, Robert J. Blake, Lorna Kunnath and Gerald Russell.

Abstract

This paper compares the costs of traditional lecture and online course offerings for a large undergraduate course at the University of California, Davis. Following research in the cost literature, it elaborates an important distinction between the costs of *acquiring* resource capacity and the costs of *using* that resource capacity in measuring the cost-effectiveness of online and traditional education. The cost of *acquiring* resource capacity closely relates to costs in university budgets and is an important input for budgeting and cash flow analyses. Consequently, university administrators often use the cost of acquiring resource capacity in their analyses of educational costs. However, the literature on the economics of education clearly recommends that cost-effectiveness measures be based on the costs of *using* resource capacity. Both measures of cost—the cost of acquiring and the cost of using resource capacity—have particular significance for evaluating technological innovations because such innovations involve substantial development costs that benefit repeated course offerings. This paper demonstrates that neither measure of cost, by itself, provides an accurate picture of the cost of technological innovation; both measures are required to get the complete picture.

Conceptual Background

Can technology reduce the cost of education? The answer to that question requires an accurate assessment of the cost effectiveness of online education. Online education generally involve substantial costs that provide the capacity for repeated course offerings. These development costs comprise two parts: the cost of developing the capacity and the cost of using the capacity. The cost literature refers to the first as the cost of *acquiring* the resource capacity to perform activities and the second as the cost of *using* the resource capacity to perform activities.¹ Measuring both costs has particular significance for evaluating technological innovations.²

The cost of acquiring resource capacity refers to the institutions costs to obtain the capacity to perform activities, such as teaching courses. Examples of resource acquisition include the cost of programmers who prepare a course for online delivery, the cost of constructing a lecture hall and the cost of hiring instructors. Resource use refers to the use of those resources, say, to offer a particular course. For example, the cost of using an instructor's time to teach a course is the foregone benefit from using that time in other uses (e.g., research). In computing the cost of *using* resource capacity, one generally amortizes development costs across the repeated course offerings. While appropriate for an economic analysis of the cost effectiveness of a particular course (see Levin and McEwan, 2001; Ermann and Milan, 1999), the cost of using resource capacity for one course understates the cash flow impact of developing

¹ See Hilton, Maher and Selto (2003, ch. 4, 5), Kaplan and Cooper (1998), and Maher and Marais (1998).

² Resource capacity refers to the resources available to offer the course, in this context. Examples of resource capacity include lecture halls, faculty time, software developed for a course, and hardware acquired for a course.

the course for online delivery. On the other hand, the cost of *acquiring* resource capacity overstates the effect of using the resource capacity for one course offering.³

University administrators often use the cost of acquiring capacity to evaluate programs because the cost of acquiring capacity closely relates to the costs in university budgets. However, the literature on the economics of education clearly recommends that cost-effectiveness measures be based on the costs of *using* resource capacity, not the cost of *acquiring* resource capacity. The importance of measuring the cost of using resources is self-evident; one cannot make a meaningful cost evaluation of a program or course without measuring the cost of using resources. Measuring the cost of acquiring resources is also important as input to budget requirements and to cash flow estimates. Adding a lecture class in an existing lecture hall with empty classrooms has different short-term cash flow and budget considerations than does teaching the same class in a facility that the university must lease for the term.

Using either the acquisition or use cost concept can lead to very different conclusions about cost effectiveness. The cost of acquiring the resource capacity to develop an online course—content development, programming, software acquisition, hardware acquisition--can be high when faculty and staff develop online courses, and leads to administrative concern about cost effectiveness. On the other hand, analysts who compute cost-effectiveness ratios on the basis of using resource capacity amortized over the life of an online course will likely claim a reduction in cost.

Finally, both measures of costs are necessary to estimate the cost of unused capacity (see Jones, 2001), which is the difference between the capacity acquired and the capacity used. If a department acquires a server that has a capacity of 10 courses but is being used to support only

³ For the case of one course to be taught one time, then the cost of acquiring and using the software are identical. We address the typical case in which the software development costs benefit repeated course offerings.

one course, then that server has an unused capacity of nine courses. Efficient and effective use of resources means finding and exploiting unused capacity; the heart of modern cost analysis is to help managers identify and exploit unused capacity (Kaplan and Cooper, 1998).

Technological innovations in education provide particular promise in creating unused capacity, for example, by freeing faculty and teaching assistant time, and by freeing lecture hall and laboratory space.

Application of Cost Concepts

The above discussion lays the conceptual foundation for distinguishing between the costs of acquiring and using resource capacity. In cost analyses, the devil is in the details. We provide a specific case study that compares and contrasts the costs of acquiring resource capacity to the costs of using resource capacity for an online course. This course was one of the first to be put online at the University of California, Davis as part of a research project funded by the Andrew W. Mellon Foundation. The objective of the grant was to compare the cost-effectiveness of online and traditional lecture offerings for large undergraduate classes. To illustrate the application of the two cost measures, we selected a popular general education course, Introduction to Food Science and Technology 2 (FST 2). FST 2, which enrolled 430 students in the term that we studied, provides a description of how raw agricultural commodities are preserved and converted into edible foods.

The instructor offered FST 2 in two versions: a traditional lecture offering and an online offering. The online course offering was constructed from lecture videotapes recorded in class during the term prior to the online course and PowerPoint presentations used in the lecture course that was offered in the same term as the online course. The staff redrew the PowerPoint slides as Flash animations and designed a template for slides with a uniform layout that was built

dynamically on demand using Flash Generator to merge information from the database with the animation. Using the videotapes as a guide, the technical staff broke up the sound and text into blocks that corresponded to slides, or steps (such as bullet points), within the slides. The technical staff stored these components, together with the graphics, in a relational database and used Cold Fusion templates to display the modules on the course web pages.

Basic approach and findings

We constructed two estimates of the acquisition and usage costs: 1) as-if the instructor had offered a stand-alone online course and 2) as-if the instructor had offered a stand-alone traditional lecture course.⁴ According to these estimates, the cost of using resources was slightly lower for the online course compared to the traditional lecture course. The online course provided cost savings in the use of lecture hall space, which more than offset the online course's increased costs to put the course on the web and use server capacity. Instructor and teaching assistant time were about the same for the online and traditional lecture courses. The overall analysis implies that a stand-alone online offering would have provided a small cost savings, but student performance would be somewhat lower compared to the traditional lecture course. (See Maher, Sommer, Russell, Acredolo and Matthews [2002] for detailed analyses of cost and student performance.)

The cost of *acquiring* resources for the online course included the cost of purchasing a server and the entire development costs of putting the course on the web. Consequently, the cost of acquiring resource capacity was higher for the online course than for the traditional course.

⁴ Because of university policy, students could migrate back and forth between the online and the traditional lecture course. As the cost estimates did not depend on the number of students in either offering, this migration did not affect our cost estimates.

We base our evaluation on 'differential costs.' Differential costs are those that we expect to be different between the online and traditional course offerings.⁵ We examine the following five categories of costs that we considered, *ex ante*, potentially to be different between online and traditional course offerings:

1. Instructor time.
2. Staff and programmer time to put the course online.
3. Hardware and software costs of the online course.
4. Space costs.
5. Teaching assistant time.

We exclude non-differential costs such as departmental administration, faculty space, and costs that are part of the university infrastructure, such as security, library, student housing, and computer labs, as recommended by Twigg (1999).

Instructor time

Perhaps the most problematic task in computing educational costs is to obtain accurate measures of instructor time. To estimate instructor time, we required that the instructor be willing to complete daily time logs as part of the buy-in for this study. We started sending a daily e-mail prompt to fill out a time log three months before the October 1 start date of the course.⁶

The instructor filled out the daily time log in 0.5 hour increments in the 12 categories shown in Figure 1. We developed these 12 categories from a more detailed list of teaching activities compiled by 15 faculty members in science, social science, business and humanities.

⁵ We use the term 'differential' to encompass the concept of incremental costs (cost increases) and decremental costs (cost decreases). To us, differential analysis is the same as marginal or incremental analysis (Levin and McEwan, 2001, pp. 101-102).

⁶ The instructor spent 40% of his time on the course during the year before our study, so we retrospectively collected information about that use of his time.

We reduced the list to the 12 categories shown in Figure 1 to reduce the complexity of the task for the instructor. The e-mail prompt included instructions for recording time.⁷

Figure 1 shows how the time sheet divided into ‘direct time’ and ‘indirect time,’ with the first eight subcategories under direct time. Direct time refers to time easily associated with a particular course offering in a particular term. Indirect time refers to time spent on teaching that benefited teaching the course but could not be easily associated with a particular course offering in a particular term, for example, the time spent attending a seminar on teaching technology.

The timesheet’s columns divided into ‘online,’ traditional’ and ‘joint’ time. Joint time refers to time spent on the course that the instructor could not easily identify as pertaining to only the online offering or only to the traditional offering, for example, the time spent preparing an examination that would be given to both sets of students.

Cost of acquiring and using instructor time

Table 1 shows the cost to the university to acquire the resources to teach the course in Panel A. We compute the resources acquired by the university to be $1/9$ of the instructor’s salary plus benefits. The university assumes the faculty workload to be equivalent to three courses per quarter for the three quarters of the academic year. Of course, most faculty members teach less than three courses per quarter with the teaching reduction made up by research and service activity. Because the university pays the same whether the course is online or traditional, there is no differential cost of acquiring resources between the traditional and online course.

In Panel B of Table 1, the instructor time reported in the two sets of columns labeled "Traditional, Cost Driver Volume" and "Online, Cost Driver Volume" is the sum of the joint time plus the separable time for the traditional and online versions, respectively. ‘Joint time,’

⁷ Detailed information about the time log appears in Mathews, Maher and Sommer (2001).

which is time that the instructor could not identify as attributable only to the online course offering or only to the traditional lecture course offering, would be required in either of the stand-alone online or traditional courses.

The traditional column shows 325.0 hours required for a stand-alone traditional course and 312.0 hours for a stand-alone online course. The online course eliminated preparing and delivering lectures, but it took more of the instructor's time to deal with problems students encountered in getting access to the online material. In the end, we estimated that a stand-alone online course would require 13 fewer hours than the stand-alone traditional course.

To compute the cost driver rate, we used the instructor's actual hourly pay, including benefits, based on his annual salary divided by an assumed 1,500-hour (nine month) work year. We believe this rate, \$61 per hour, is a reasonable proxy for the opportunity cost of the instructor's time.

The first category of instructor time, row 1.1 in Panel B, refers to tasks that generally take place prior to course delivery. Our interviews with the instructor indicated that he would likely be more efficient in preparing the course content of the online version in subsequent years, so the amount reported in the online column in row 1.1 likely overstates the amount of time that would be required in subsequent years for the online course offering. The numbers reported in row 1.2 refer to the time spent delivering the course, which are likely to be about the same whether this was the first or subsequent offering of the online course.

Note that the costs of resources used by the course (Panel B) are nearly double the costs of resources acquired by the university (Panel A). In a sense, the instructor overused the capacity that the university has made available for this course because he spent more time on the course than was compensated by the university, assuming 1/9 of salary and benefits is the correct

measure of resources supplied by the university. Consequently, either the instructor took time from other university activities or from personal time to work on this course.

Cost of acquiring and using staff and programmer time to put the course on the web

Table 2 presents the cost of programmers, content developers and supervisors who did the work to launch the online course. Panel A shows the university's costs of acquiring resources; namely, the salaries and benefits paid to the people who did the work to put the course on the web.⁸ All of this time is for the online course.

Panel A shows the costs of acquiring resource capacity to be \$23,025. This resource capacity enables the university to offer FST 2 online for both the term that we studied and for future course offerings. Consequently, the *use* of this acquired resource capacity requires amortizing the cost of acquiring the capacity, just as the use of a building requires amortizing the cost of constructing the building over its life. To estimate the cost of using the resource capacity that programmers, content developers and supervisors created to put the course online, we first divided the cost of acquiring resource capacity into two categories: annual update costs and startup costs. We computed these costs using the time sheets and actual salaries and benefits for the staff that put FST 2 on the web.

Based on our interviews with the course instructor and the technical staff, we estimated the portion of the work done that would be done for an annual update to be 172 hours of staff time for content development, no time for programming and 69 hours of supervisor time. Based on student demand for the course, the university offers FST 2 twice per year; consequently, we assigned 1/2 of the staff and supervision annual update time and cost to the one FST 2 course in our study. Rows 1.1 and 1.2 show the share of the annual update cost that we assigned to FST 2.

⁸ We do not distinguish the source of funds for these activities, but refer to all costs as if paid by the university.

Startup time benefits future offerings of the course until an instructor completely redesigns the course. The instructor informed us that the course should be completely redesigned in five years, so we amortized these "startup" costs over five years. Startup time includes time for content development, programming and supervision/administration of the project.

We calculated the amortization of this amount over the five-year use of the startup time using the capital recovery factor as recommended by Levin and McEwan (2001, pp. 65-70). This capital recovery factor takes into account both the annual cost amortization and the interest that could have been earned on the money spent in a lump sum at the start of the project instead of spread over the life of the project.⁹ For our computations, we used the university's assumed interest rate on long-term bonds of 6.5 percent.

Rows 2.1, 2.2 and 2.3 of Table 2 show the share of content development, programming and supervision costs that we assigned to FST 2. These costs derive from amortizing the startup costs over five years, as explained above, then dividing the resulting amortized amount by two because the university offers two courses per year.

Taking into account both the annual update and the startup costs, the cost of using resource capacity to put the course online is \$3,803. Of course, this estimate is highly sensitive to assumptions about the resource capacity developed. Consider an extreme example. Suppose the resource capacity provided only for one offering of the course. In that case, the cost of the course would be the entire \$23,025 required to put it on the web.

Note that, while the university's total expenditures for salaries and benefits to put FST 2 online equal \$23,205, as shown in panel A of Table 2, we assume a cost of only \$3,803 for one offering of FST 2. This discrepancy creates confusion for users of cost information. To university administrators concerned about budgets, the \$23,205 cost of acquiring personnel

⁹ The capital recovery factor uses the same principle as the amortization of a home mortgage.

resources to put the course on the web is relevant. To economists concerned with computing the cost of using resources, the \$3,803 cost of using resources for one offering of FST 2 is relevant.

Which costs are relevant?

Considering the large differences between the cost of acquiring the resources to put courses online and the costs of using those resources, one expects administrators to vary in their view of which costs are relevant, depending on their time horizons. The shorter the administrators' time horizon, the more likely they will view the costs of acquiring resources to be more relevant than the costs of using resources.

Cost of acquiring and using computer hardware and software

This project required obtaining computer hardware; namely, a server and two computers for programming and software. The computer hardware cost \$5,800, the software cost \$1,600, and maintenance on the server cost \$2,200 per year. These costs of acquiring resource capacity appear in panel A of Table 3.

To compute the cost of using resources, computer experts noted that the server provided a capacity of 10 courses per quarter and had a useful life of three years. Therefore, we first computed an annual amortization amount using the capital recovery factor in Levin and McEwan (2001, p. 69) for a 6.5 percent interest rate, which is the rate used by the university in estimating long-term project costs, and a three-year asset life. Then we assigned 1/30 of that annual amount to the FST 2 course because the annual server capacity was 30 courses (10 courses per quarter times three quarters per year). This computation resulted in a cost of \$73 per course, which appears in row 1, panel B of Table 3.

Using the software's estimated life of 18 months, and the same approach as above to compute the annual amortization, we assigned 1/30 of the annual amount to FST 2. This computation resulted in a cost of \$41 per course, which appears in row 2, panel B of Table 3. The maintenance cost of the computers is \$2,200 per quarter. Therefore, we charge each course for 1/10 of the costs of maintenance, or \$220 per course (see row 3, panel B of Table 3) because the server has the capacity to handle 10 courses.

Cost of acquiring and using instructional space

The cost of acquiring space was problematic. We believed that the cost of acquiring or building a lecture hall that would provide the capacity to teach just one course was excessive. Therefore, we estimated the cost of obtaining space to offer the course in its regular configuration—one hour per day, three days per week for 10 weeks plus two hours in the 11th week for a final examination. We obtained estimates from University Extension, which rents out facilities for courses, and from local nonprofit organizations that had conference room facilities. Based on these estimates, and adding one hour for classroom setup to the regular class schedule, we estimated the rental charges, including charges for presentation equipment, to be \$400 per day. For a 29-day quarter (allowing one day for holiday) plus one day for final examination, we estimated the cost of acquiring the off-campus space to offer the traditional course to be \$12,400 as shown in panel A, Table 4.

To estimate the opportunity costs of using existing campus space, we used amounts provided by the University's Department of Budget and Planning, which were derived from plans for a new lecture hall to be built on campus. These costs represent the opportunity cost of students' using space in lecture halls. Taking into account the projected cost of the new lecture hall, an annual debt service rate of 6.5%, a 30-year life, and an assumed allowance for utilities

and maintenance, the university figured the total annual cost of the lecture hall to be \$430,000. Using standard university assumptions about the number of hours that lecture halls are used, the personnel from the Department of Planning and Budget converted this annual cost of \$430,000 into a cost per student of \$17.86 per student for a course meeting three hours per week. For a class of 430 students, the total space cost was \$7,680, as shown in Panel B of Table 5.

Cost of acquiring and using teaching assistant time

For this course, the instructor used three Teaching Assistants to help write and grade examinations. Because of this use, we assume that both the online and traditional course offerings would each use three teaching assistants (TAs) for a class of 430 students. We chose not to differentiate between resources acquired (three TAs) and the resources used (the time of three TAs) both because of the difficulty in collecting time sheet data and because we expected to find no difference between the traditional and online courses because of the way that the TAs were used.

Excluded costs

The space costs do not include the cost of land nor the cost of campus infrastructure, such as roads, pathways, libraries, grounds-keeping, and security. We take the perspective of the university in our cost analysis, so the costs to students (e.g., enrollment fees, using computers, time spent attending lectures or studying online, purchasing textbooks and other course-related materials) is outside of the scope of this study and remains a potential area of inquiry for future research.

We also excluded the time spent by the instructor meeting with us to discuss the study and working with us to develop the research protocol. We excluded “indirect instructor time”

from our estimates, which is time spent on teaching in general, but not for the particular course being studied.

Summary of the Results

Table 5 summarizes the results. One interprets these data differently depending on the cost concept used. If one uses the notion of costs as resources *acquired* by the university—expenditures, in this case--then the online course cost of \$59,352 exceeds the traditional course cost of \$40,127 by 47%. If one uses the notion of costs as resources *used* by the university, then the online course costs 9% less than the traditional course (\$41,051 for the online course compared to \$45,390 for the traditional course). Decisions about the efficacy of online education depend on the cost concept used.¹⁰

Extension: Subsequent Year Costs of Acquiring Resources

The costs presented in Tables 1 – 5 present our estimates for the first time that FST 2 is put online. Table 5 shows that the costs of acquiring the resources for the online FST 2 were \$59,352. Some of these costs would not be required for subsequent offerings of FST 2.

To estimate the costs of acquiring resources in the second year, we constructed a hypothetical offering that we call the ‘Year 2’ online course. This course would assume offering FST 2 in the fall quarter of Year 2, the year after the course was put online in the fall quarter of Year 1. Table 6 presents our estimate of the cost of acquiring resources to offer FST 2 in this hypothetical ‘Year 2’. The results show a substantial decrease in the costs to the university to acquire resources for the Year 2 offering; specifically from \$59,152 in Year 1 to \$34,245 in Year 2. Decreased staff and programmer time accounts for most of this decrease because nearly 90

¹⁰ The difference in applying the two cost concepts was mostly in the cost of putting the course online (rows 2 and 3 in Table 5).

percent of staff and programming costs were to get the course online. Once the course was online, these costs would not be incurred again until the course was torn down and rebuilt.

The computations in Table 6 assume no change in the costs to the university for instructor pay or TA time. The hardware had an expected life of three years, so we include no cost to acquire hardware in Year 2. The software had an expected life of 18 months, so we assume new software would be purchased in Year 2. Somewhat conservatively, we assume that purchase would be made at the beginning of Year 2, so we include the cost of acquiring software in the Year 2 estimate. Server maintenance costs would be incurred each year.

Comparing Year 2 to Year 1 helps demonstrate a limitation of the use of the costs to acquire resources in making decisions whether to implement technology. Clearly, the costs to acquire resources are much higher in Year 1 because of the costs to put the course online. This phenomenon speaks to the use of multi-period budgets or budgeting a separate line item for technology development. In economics language, the average cost of the course over several years is lower than the marginal cost in Year 1.

But this assumes repeated course offerings. If that is not the case, perhaps because the course was not successfully mounted online or a new instructor teaches the course, then university administrators should not presume the lower costs in subsequent years. University administrators face an uncertainty when investing in new technology: will the development costs provide benefits to repeated course offerings or just to the one-time initial course offering? If it is the latter, then investment in technology could be extraordinarily expensive for universities. To gain the benefit of development costs over repeated course offerings, university administrators should consider incentive packages that will motivate departments and faculty to offer repeated offerings of online courses.

Conclusions and Discussion

The answer to the question: "Did the online course offering cost more than the traditional lecture offering?" depends on which cost concept one uses. And the answer to the question "Which concept should one use?" is "It depends on the use of the cost information." To administrators concerned with annual budgets and cash flows, the costs to *acquire* resources might be all-important. This would be particularly the case if administrators account for annual expenditures on a single period basis instead of a project basis. To economists and educators interested in the cost of education, the cost of *using* resources is correct and consistent with the economics of education literature.

In the end, comparing the cost of online to traditional courses is not as simple as 'online courses cost more initially because of the cost of putting the course online.' First, one must specify which cost concept: cost to *acquire* or cost to *use* resources. Second, one should apply the chosen concept to both the traditional and online courses; one should not compare the costs of *acquiring* resources for online courses to the costs of *using* resources for traditional courses.

Figure 1. Faculty Time Log

| Direct Time: | Online | Traditional | Joint |
|--|---------------|--------------------|--------------|
| 1. Working with project staff. | | | |
| 2. Planning the course , developing materials, developing lecture content. | | | |
| 3. Preparing the course for online delivery. Reviewing materials for online delivery. | | | |
| 4. Delivering the course in a particular term. Preparing for lectures, delivering lectures, dealing with problems with the online and traditional delivery of course content to students. | | | |
| 5. Interacting with students outside of class. | | | |
| 6. Evaluating student performance. Preparing and grading examinations, grading papers and projects. Assigning grades. | | | |
| 7. Training and supervising TAs and other assistants. | | | |
| 8. Other (please specify). | | | |
| Indirect Time: | | | |
| 1. Attending seminars, reading, collecting materials useful for teaching. | | | |
| 2. Interacting with students that cannot be identified with a particular course offering. | | | |
| 3. Planning and developing materials for future offerings of the course. | | | |
| 4. Other (please specify). | | | |
| Expenditures (Please describe briefly and put \$ amounts in the spaces to the right). | | | |

Table 1. Analysis of Instructor Costs: Traditional and Online Courses**Panel A: Cost of Instructor Resources Acquired by the University**

| | <u>Traditional Course</u> | <u>Online Course</u> |
|---|-------------------------------|--------------------------|
| Instructor time (1/9 of annual salary and benefits) | \$10,167 | \$10,167 |

Panel B: Cost of Instructor Resources Used by the Course

| <u>Activity</u> | <u>Cost Driver</u> | <u>Traditional Course Cost Driver</u> | | <u>Online Course Cost Driver</u> | |
|--|---------------------|---|------------------|--------------------------------------|------------------|
| | | <u>Volume</u> | <u>Cost</u> | <u>Volume</u> | <u>Cost</u> |
| 1. Instructor time: | | | | | |
| 1.1 Course planning and development | Instructor hours | 112.0 hours | \$6,832* | 107.0 hours | \$6,527* |
| 1.2 Delivering the course | Instructor hours | <u>213.0 hours</u> | <u>\$13,206*</u> | <u>205.0 hours</u> | <u>\$12,710*</u> |
| 1.3 Totals | | <u>325.0 hours</u> | <u>\$20,038</u> | <u>312.0 hours</u> | <u>\$19,237</u> |

* Cost driver rate = \$61 per instructor hour based on the instructor's nine-month salary plus benefits divided by a 1,500 hour (nine month) work year.

Table 2. Analysis of Staff and Programmer Costs to Put the Course on the Web**Panel A: Cost of Resources Acquired by the University**

| | <u>Traditional Course</u> | <u>Online Course</u> |
|--|---------------------------|----------------------|
| Salaries and benefits of staff time to put course on the web | \$ 0 | \$23,025* |

Panel B: Cost of Resources Used by the Course

| <u>Activity</u> | <u>Cost Driver</u> | <u>Traditional Course</u> | | <u>Online Course</u> | |
|-----------------------------------|--------------------|---------------------------|-------------|----------------------|-------------------|
| | | <u>Volume</u> | <u>Cost</u> | <u>Volume</u> | <u>Cost</u> |
| 1. Costs of annual course update: | | | | | |
| 1.1 Content development | Staff hours | 0 | \$ 0 | 86.0 hours | \$ 715** |
| 1.2 Supervision | Supervision hours | 0 | \$ 0 | 34.5 hours | \$ 644** |
| 2. Amortized startup costs: | | | | | |
| 2.1 Content development | Staff hours | 0 | \$ 0 | 68.8 hours | \$ 688*** |
| 2.2 Programming | Programmer's hours | 0 | \$ 0 | 54.0 hours | \$ 650*** |
| 2.3 Supervision | Supervision hours | <u>0</u> | <u>\$ 0</u> | <u>49.1 hours</u> | <u>\$1,106***</u> |
| Totals | | <u>0</u> | <u>\$ 0</u> | <u>292.2 hours</u> | <u>\$3,803</u> |

* This amount is the total salaries and benefits paid to non-instructional content developers, programmers and supervisors for the work required to put FST 2 online.

** This amount is one-half of the annual update costs each year because the course would be updated once per year and the department offers the course twice per year.

*** These are startup costs for content development, programming and supervision to develop the course for the web. According to the instructor, the course would last for five years, subject to the annual update costs in rows 1.1 and 1.2 in this table. We amortize this development cost over 5 years using the Levin and McEwan (2001, pp. 65-70) amortization factor to get an annual cost. This amortization of the development cost takes into account both the annual cost amortization and the foregone interest on money (assumed to be 6.5% by the university) that the university spends in a lump sum up front instead of spread equally over the life of the course. We divide this annual cost by two to derive a cost per course because the course is offered twice per year. The calculations follow:

Total startup cost _ amortization factor = annual cost.

Annual cost/two course offerings per year = cost per course.

Amortization factor = $[r(1+r)^n]/[(1+r)^n - 1]$.

Here is an example of the calculations for the content development costs shown in row 2.1.

Annual costs = development costs _ amortization factor

= $\$5,718 _ 0.065[(1+0.065)^5]/[(1+0.065)^5 - 1] = \$5,718 _ 0.24063 = \$1,376.$

Cost per course = annual costs/ two

= $\$1,376/2 = \$ 688.$

Table 3. Analysis of Hardware and Software Costs**Panel A: Cost of Resources Acquired by the University**

| | <u>Traditional Course</u> | <u>Online Course</u> |
|------------------------------|---------------------------|----------------------|
| 1. Hardware | \$ 0 | \$5,800* |
| 2. Software | \$ 0 | \$1,600** |
| 3. Maintenance of the server | <u>\$ 0</u> | <u>\$2,200***</u> |
| Totals | <u>\$ 0</u> | <u>\$8,600</u> |

Panel B: Cost of Resources Used by the Course

| <u>Activity</u> | <u>Cost Driver</u> | <u>Traditional Course Cost Driver</u> | | <u>Online Course Cost Driver</u> | |
|------------------------------|--------------------------|---------------------------------------|-------------|----------------------------------|------------------|
| | | <u>Volume</u> | <u>Cost</u> | <u>Volume</u> | <u>Cost</u> |
| 1. Hardware | Number of online courses | 0 | \$ 0 | 1 | \$ 73* |
| 2. Software | Number of online courses | 0 | \$ 0 | 1 | \$ 41** |
| 3. Maintenance of the server | Number of online courses | <u>0</u> | <u>\$ 0</u> | <u>1</u> | <u>\$ 220***</u> |
| | | <u>0</u> | <u>\$ 0</u> | <u>1</u> | <u>\$ 334</u> |

* The server, which cost \$5,800, has a capacity of 30 courses per year (10 courses per quarter _ three quarters per year) and a useful life of three years. We first computed an annual depreciation rate using the amortization method recommended by Levin and McEwan (2001, pp. 65-70) based on a 6.5% interest rate and a three-year amortization period. Then we assigned 1/30 of that annual amount to FST 2 because the server has a capacity of 30 courses per year. The calculations follow:

Annual costs = development costs _ amortization factor

Amortization factor = $[r(1+r)^n]/[(1+r)^n - 1]$.

So, annual costs = $\$5,800 _ 0.065[(1+0.065)^3]/[(1+0.065)^3 - 1] = \$2,190$.

Cost per course = $1/30 _ \$2,190 = \73 .

** The software, which has a cost of 1,600, has a useful life of 18 months. Using the same approach as in footnote * above to compute the annual amortization, and using 1/30 of the annual amortization because the server has an annual capacity of 30 courses, we assigned a cost of \$41 to FST 2.

***Maintenance costs are \$2,200 per quarter for the server, which has the capacity to serve 10 courses. Therefore, we computed the cost for FST 2 as follows:

Cost = $1/10 _ \$2,200 = \220 .

Table 4. Analysis of Lecture Hall Space Costs**Panel A: Cost of Resources Hypothetically Acquired by the University**

| | <u>Traditional Course</u> | <u>Online Course</u> |
|--|---------------------------|----------------------|
| Rental of lecture hall space for one quarter | \$12,400* | \$ 0 |

Panel B: Cost of Resources Used by the Course

| <u>Activity</u> | <u>Cost Drivers</u> | <u>Traditional Course</u> | | <u>Online Course</u> | |
|---|--|--|-------------|----------------------|-------------|
| | | <u>Cost Driver</u> | <u>Cost</u> | <u>Cost Driver</u> | <u>Cost</u> |
| Use of lecture hall space for one quarter | Number of students, number of hours that class uses lecture hall | 430 students, 3 one-hour classes for 10 weeks plus two-hour exam | \$7,680** | 0 | \$0 |

* Because of complications in separating the resources supplied for one class in a classroom used for numerous courses, we used an estimate of \$400 per day for 30 days (29 days of instruction plus one final examination) based on hypothetically renting off-campus facilities that would house 430 students.

** We estimate the opportunity cost of lecture hall use based on the campus Office of Planning and Budget cost projects for a new lecture hall. The university assumed a 30 year building life, 6.5% cost of capital, and a 48 hour per week usage. Based on those assumptions plus costs of building, maintaining and operating the lecture hall, the university computed a rate of \$17.86 per student enrolled for a course meeting three hours per week for a quarter. The cost for FST 2, with an enrollment of 430 students, follows:

$$\begin{aligned} & \text{Cost per student} \times \text{number of students enrolled} \\ & = \$17.86 \times 430 \text{ students} = \$7,680 \end{aligned}$$

Table 5. Differential Costs of Online Versus Traditional Courses

| Activity | Cost of Resources Acquired by the University | | | Cost of Resources Used by the Course | | |
|--|--|-----------------|---|--------------------------------------|-----------------|---|
| | Traditional | Online | Savings (Traditional Minus Online) | Traditional | Online | Savings (Traditional Minus Online) |
| 1. Instructor time (Table 1) | \$10,167 | \$10,167 | \$ 0 | \$20,038 | \$19,237 | \$ 801 |
| 2. Staff and programmer time (Table 2) | \$ 0 | \$23,025 | \$(23,025) | \$ 0 | \$ 3,803 | \$(3,803) |
| 3. Hardware and software (Table 3) | \$ 0 | \$ 8,600 | \$(8,600) | \$ 0 | \$ 344 | \$(344) |
| 4. Lecture hall space (Table 4) | \$12,400 | \$ 0 | \$ 12,400 | \$ 7,680 | \$ 0 | \$ 7,680 |
| 5. TA time | \$17,560* | \$17,560* | \$ 0 | \$17,560* | \$17,560* | \$ 0 |
| Total | \$40,127 | \$59,352 | \$(19,225) | \$45,390 | \$41,051 | \$ 4,334 |

* Annual salaries and benefits for 3 teaching assistants.

Table 6. Decrease in the Cost of Resources Acquired by the University in Year 2 for the Online Course

| Activity | Year 1 | Year 2 | Decrease: Year 1 Minus Year 2 |
|---------------------------|-----------------|-----------------|--------------------------------------|
| Instructor time | \$10,167 | \$10,167 | \$ 0 |
| Staff and programmer time | \$23,025 | \$ 2,718* | \$20,307 |
| Hardware and software | \$ 8,600 | \$ 3,800** | \$ 4,800 |
| TA time | \$17,560 | \$17,560 | \$ 0 |
| Total | \$59,352 | \$34,245 | \$25,107 |

* Annual update costs = \$2,718 = \$1,429 for content development + \$1,289 for administrative and supervision

** Second year cost = \$3,800 = \$2,200 for server maintenance + \$1,600 for software purchase midway through second year.

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