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Costs of asynchronous distance ventures

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Abstract

A simple mathematical model is described which provides estimation procedures for comparing college-level, distance teaching costs with on-campus operations. It distinguishes content distribution from interaction costs, where cost equals work time required of teachers. In ordinary classroom teaching, content distribution costs rise with student throughput in quantal units that depend on class size. Interaction costs rise only moderately with the number of students. In asynchronous distance courses with asynchronous interactions with students, content distribution expenses are independent of throughput, but the costs of instructive interactions rise sharply with the number of students. As a consequence, distance teaching costs can become high when interactive procedures are very time-demanding. High-quality institutions, that rely heavily on tuition income, will be more likely to survive in the competitive world of distance education, if scientific research and technological developments succeed in making the interactive components of instruction less effortful for teachers and in making content development more efficient.

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1. Introduction

Technological developments in computing and communications have made distance education pedagogically manageable and even attractive. Many schools of higher education have envisioned new and greater income in accommodating large numbers of new students through skillful use of technology, without further investments in their campus physical plan. Schools that are considering asynchronous distance instruction will want to compare the costs of such ventures with those of conventional on-campus teaching. This paper comments on costs of asynchronous distance ventures relative to customary on-campus teaching. My aims are: (a) to stimulate further discussions of economics of distance education ventures; and especially, (b) to underline the importance of research on labor-saving tools and procedures in distance education.

1.1. Taxonomy

Distance educational arrangements vary widely. Many do not fall exclusively into any single category, but involve a practical or theory-driven mix of methods and procedures. Several different taxonomies have been proposed (Johansen, Martin, Mittman, & Saffo, 1991; Vertecchi, 1998). Three very commonly used forms are:

(SA) Synchronous broadcast or narrowcast,[1] with asynchronous interactions. Examples are synchronous distribution of lectures or other materials by broad-

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[1] By narrowcast, I mean station to station transmission of content signals, e.g. video.

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cast or land lines with voice or e-mail interactions with subscribers at other times.

(SS) Synchronous narrowcast with synchronous interactions. Examples are cable-transmitted class room lectures or other presentations with two-way voice connections.

(AA) Asynchronous content distribution with asynchronous interactions. Examples are web distribution of instructional material with ad libitum access by clients to chat rooms and individual interactions.[2]

This paper focuses on the costs of asynchronous content distribution with asynchronous interaction (AA), [3] i.e., distribution of audio, video, or text content to subscribers on demand plus interactions with subscribers via queries, problems, discussions, etc. AA uses technological means for distributing content on demand for subscribers, and provides the technology for extensive, individualized interactions with and among participants. It is a widely used method judging by the number of commercial products such as *Assymetric*, *Learning Space*, and others, that have been created to support this mode of operation. Distance education providers have used computers and other electronic capabilities, in a variety of ways (McIsaak & Gunawardena, 1996), to support asynchronous interactions because they are known to be useful in maintaining cognitive engagement of students (Rothkopf, 1996).

2. Cost analysis

I will use the amount of time that a venture demands of school personnel as a measure of cost, without considering the conditions of employment for participating teachers or course managers. This seems to be a more useful measure of the demanded resources than direct dollar estimates because expenses and professional salaries vary substantially among institutions and regions. Administrative, marketing, and communications costs will be ignored.

A very simple conceptual model is assumed for the sources of costs of AA and of more conventional academic instruction. In order to determine the relative expense of the two types of instructional operations, the model assumes that the costs or expenses of any course, E, is due to only two factors. They are: content distribution (D), and interaction with students (I). For conventional instruction, the distribution costs, D, is the amount of time spent by instructors in class in a particular course. Interaction activities (I), in conventional courses, include time spent by instructors outside the class in test grading, counseling etc. For the purpose of this discussion, communication charges and other secondary charges will be ignored. The relationship between the two factors can be described by the following equation:

$$E = D + I \tag{1}$$

The main elements of the analysis will be based on the following assumptions: (a) in conventional college courses, distribution costs (D) increase as the number of students increases and becomes smaller as the class size becomes larger; (b) the distribution costs of AA courses are typically relatively independent of total number of students and usually involve a substantial, one-time content preparation investment; (c) interaction costs increase with student throughput for both conventional and AA courses, although AA interaction costs per student are usually substantially larger and therefore, increase more sharply with number of students than in conventional courses. For a typical classroom course, R, cost can be characterized as follows:

$$E_R = D_R.\, N/m + I_R.N \tag{2}$$

where N is the number of students in the lifetime of a course, and m is the modal or average class size, i.e. the enrollment number at which a new course section is started. D_R is the total number of minutes of class time per course section per semester.

$D_R \cdot N/m$ is cost in terms of the amount of faculty time in minutes to teach all the sections during the life of a conventional course. I_R is the average number of minutes spent with each student in outside-of-class interactions such as test grading and office visits.

In the graduate institutions in which I work, a typical class meets 14 times during a semester, for 100 min each, for a total D_R of 1400 min. Plausibly, I_R is one-hundredth of this, or 14 min per student per semester. In undergraduate colleges, D_R may be as high as 2250 min (15 weeks × three meetings of 50 min each) with about 22 min of interaction. The absolute values are, however, not critical to our analysis.

For an AA distance course, T, costs can be estimated as follows:

$$E_T = D_T + I_T \cdot N \tag{3}$$

Preparing content for an asynchronous distance course is usually more expensive than the conventional kind because AA content materials such as computer-stored texts, graphics, video and audio materials require substantial greater efforts for development and testing. But the most important difference between a campus and an

[2] We did not consider synchronous broadcast with synchronous interaction (e.g. a subscription, cable-net panel discussion with call-ins) at all because it is impractical to implement and of limited educational utility. Nor did we consider asynchronous distribution with synchronous interaction, which is interesting but probably rarely used.

[3] As will be seen later, much of what follows also pertains to other distance instruction arrangements.

AA distance course is that the distribution cost *for a campus course depends on class size*, while it typically does not in AA distance courses. If the modular class size is 30 in a campus course, the distribution costs are twice as large than if the class size is 60. For AA courses, content distribution is a one-time investment that is independent of the number of students. Another difference is that for an AA distance course, the interaction costs rise more rapidly with enrollment than in an ordinary campus course or in most courses with synchronous interaction arrangements.

In order to simplify the comparisons between conventional and AA courses, all cost factors will be described as proportions of *conventional* course costs. We define three constants of proportionality, as follows:

- g is the ratio of content distribution cost of the distance course to the campus offering

$$D_T = D_R \cdot g \tag{4}$$

- h is the ratio of distance interactivity costs to interactivity costs of campus offering

$$I_T = I_R \cdot h \tag{5}$$

- i is the ratio of interaction cost to distribution cost for campus instruction

$$I_R = D_R \cdot i \tag{6}$$

Using these constants of proportionality, we can rewrite Eq. (2) as:

$$E_R = D_R \cdot N/m + D_R \cdot i \cdot N \tag{7}$$

and we can rewrite Eq. (3) as:

$$E_T = D_R \cdot g + D_R \cdot i \cdot h \cdot N \tag{8}$$

Factoring the two equations, we have:

$$E_R = D_R(N/m + i \cdot N) \tag{9}$$

and:

$$E_T = D_R\,(g + i \cdot h \cdot N) \tag{10}$$

These two linear equations specify how conventional, E_R, and AA distance instruction, E_T, costs rise with the size of the total student throughput. D_R is our basic cost constant, namely the time spent in class by an instructor of a particular conventional course. Dividing the two equations by this cost constant, shows the factors which determine the relative costs of conventional and AA distance instruction.

$$E_R/D_R = 1/m \cdot N + i \cdot N \tag{11}$$

$$E_T/D_R = g + i \cdot h \cdot N \tag{12}$$

Three factors will determine the relative costs of conventional and AA distance instruction. They are (m) the average class size in conventional instruction, (g) a factor that depends on the upstart costs of the distance course, and (h) the proportional increase in interaction costs in the distance course over conventional instruction.[4]

These several factors may be estimated with fair accuracy in most situations. Inserting them in Eqs. (11) and (12) makes it possible to estimate the relative costs of conventional and AA distance arrangements for particular instructional ventures. For example, we might estimate that (1) startup costs for a distance course take twice as long as the time to teach a class in conventional course during a semester ($g = 2$); (2) interactive time per student in a conventional course was one percent of total class time ($i = 0.01$); and (3) interactions in a distance course took four times longer than in a conventional course ($h = 4$). Given these estimates, costs for campus courses with basic class sizes (m) of 30 and 60 students, respectively, and for a AA distance course, are plotted in Fig. 1. The values shown on the ordinate are appropriate for a 1400-min course. As can be seen, the distance course becomes increasingly more costly relative to the $m = 60$ campus course. The $m = 30$ campus course, on the other hand, is closer in cost to the distance course. The AA distance will become less costly than the $m = 30$ campus offering when the student throughput reaches *608*.

The cost pattern for SS and SA can be expected to be of similar character. The intercept values in synchronous distance courses resemble those of conventional on-campus courses except that content distribution costs may be higher because of media opportunities and/or demands. The slope values of synchronous interactions will also tend to be like those of conventional courses. Interaction costs for SA will be similar to AA.

3. Concluding observations

The present model focuses on the relative cost of instructional methods without considering relative benefits. This is a deliberate omission. Benefits in college instruction are difficult to assess because teaching is based on a vague contract with the student/clients. Analysis founders on at least four issues: (1) the institutional promise to students is unclear and responsibility

[4] In writing about the model, it was assumed that the interaction costs in conventional instruction, I_R, was relatively low. It is clear, however, that there are practically no limits to the scope of interactions between students and teachers in conventional college instruction. Many imaginative and often effortful and very time consuming procedures have been used. Some are known to be effective and cannot be easily implemented in asynchronous distance education. But low time expenditures for I_R are customarily very low. Most take place during class time and do not increase the total time investment in a course.

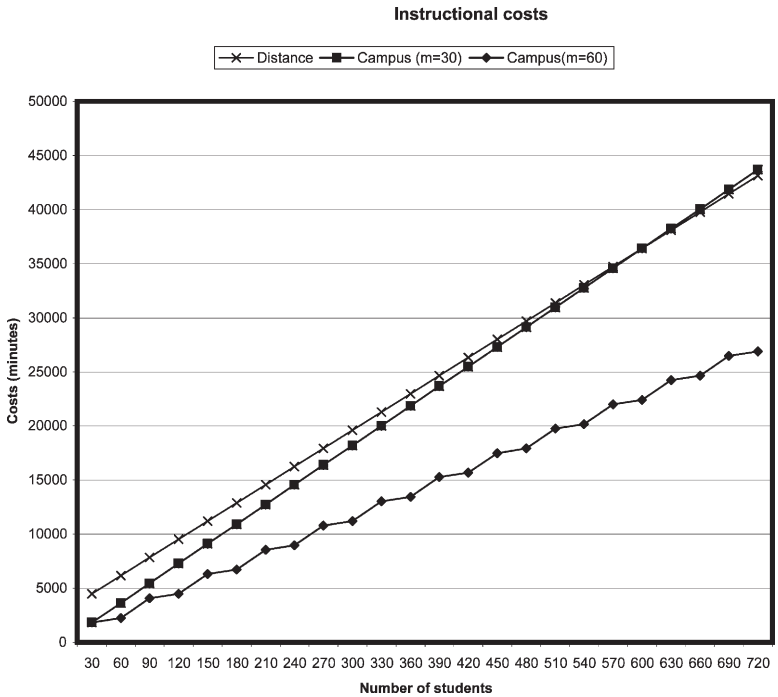

Fig. 1. Estimated cost in teacher minutes of an asynchronous distance course ($g = 2$, $h = 4$) and conventional courses with modal class size, m, of 30 and 60. The value of g indicates that the development cost of the distance course's content was twice as time-consuming as an ordinary semester's total class time. The value of h indicates that interactivity of the distance course requires four times as much teacher time as the interactivity of an ordinary campus offering.

for failure is uncertain; (2) student have diverse instructional goals and poor tools for determining whether they have been met; (3) instructional benefits are usually linked to very specific procedures rather than broad rubrics such as *conventional classes* or *asynchronous distance education*; and (4) it has been impossible to find a metric for benefits that is commensurate with cost measures. Although it may pain the conscientious educator, we must recognize the brutal fact that, despite the earnest dedication of idealistic teachers, the administration/management of colleges is governed pre-eminently by cost and by student acceptance. It is quite clear that acceptance can be increased by other factors besides the quality of instruction, e.g. propaganda, winning football teams, and butter-smooth credentialing.

Our cost analysis rested on three simple, but plausible assumptions. These were that content distribution costs in conventional teaching depend strongly on class size and that interaction costs per student contribute relatively weakly to the total instructional costs. It is also assumed that asynchronous content distribution tends to have fairly heavy one-time startup costs and that asynchronous interaction costs per student are substantially higher than the interaction costs in conventional instruction. Our analysis showed that AA distance courses can result in substantially greater real costs than campus teaching in the ordinary style, particularly when the campus class sizes are large. Of course, other assumptions about g or h may produce somewhat different results. Nevertheless, the analysis suggests that increased reliance on technology to promote student–teacher interactions, while pedagogically very desirable, links steep cost increases to the size of the student throughput. This may result in greater costs than ordinary teaching, mainly because personalized interactions are quite time-consuming and because conventional instructional forms are a very cheap form of teaching.

It should be noted here that the costs of teaching was defined as the actual time required by teachers to do their job. The actual "money" costs of teaching, however, are also determined by the conditions of employment of teachers. The actual costs of 1000 h of instructional time is halved if teachers are required to work twice as long for the same salary or if their pay is cut in half. This may tempt entrepreneurially-inclined institutions, in their reach for market share, to alter the conditions of employment for teachers or strip instruction of pedagogically sound but expensive interactive features.[5] As a conse-

[5] It would not be surprising if internal economic logic would gradually force all the schools that undertake distance education

quence, socially responsible, high-quality colleges and universities, *that depend strongly on tuition income*, are placed in a difficult, competitive position in some sectors of the world of distance education. It is fairly clear that they can operate safely in synchronous narrowcast operations, with synchronous interactions (SS). This is the world of narrow-casts from the school to well-organized satellite stations at which students are gathered. Such SS arrangements have some good applications, but they are only modest departures from ordinary, grouped classroom instruction. They are not very exciting pedagogically and they are certainly not the hailed revolution in education.

The more radical and more promising distance operation with asynchronous content distribution and asynchronous interactions will be more attractive to the teachers in high-quality institutions if scientific research and technological developments succeed in two enterprises. The first is to make the creation of instructive content more efficient. One promising candidate here is the gradual but systematic development of content for distance distribution from running conventional courses. Second is to make the interactive components of instruction less effortful and time-demanding for teachers. Needed relief may be provided here by the emergence of more intelligent interactive systems, perhaps through the development of extensive boiler plate response libraries. Both of these efforts deserve creative and energetic efforts.

References

Johansen, R., Martin, A., Mittman, R., & Saffo, P. (1991). *Leading business teams: how teams can use technology and group process tools to enhance performance*. Reading, MA: Addison–Wesley.

McIsaac, M. S., & Gunawardena, C. N. (1996). Distance education. In D. Jonassen (Ed.), *Handbook of Research on Educational Communications and Technology* (pp. 403–437). New York: Simon and Schuster McMillan.

Rothkopf, E. Z. (1996). Control of mathemagenic activities. In D. Jonassen (Ed.), *Handbook of Research on Educational Communications and Technology* (pp. 879–896). New York: Simon and Schuster McMillan.

Vertecchi, B. (1998). *Elemente einer Theorie des Fernunterichts*. Ziff Papiere 109. Hagen, Germany: Fernuniversitaet.

towards such measures. This is a matter that should be of some concern to the professorate.