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# Some Economics of Teaching

Sherwin Rosen, *University of Chicago*

Rosen uses a lot of dollar values and inflation has made it hard to understand the context. This was written in 1987 when the CPI was 113.6. In Dec 2014, the CPI was about 235. See <http://stats.bls.gov/news.release/> Thus, multiply all prices quoted in this article by 2 to get a rough idea of what he is saying in today's dollars. For example, the sentence in the abstract below would be, "The implicit student fees necessary to support annual salaries average \$2.60 per class meeting . . . and rise to \$8.00 per lecture . . ."

Adam Smith's discussion of the payment of teachers is reviewed in terms of industrial organization and agency theory. The implicit student fees necessary to support annual salaries average \$1.30 per class meeting in primary and secondary schools and rise to \$4.00 per lecture and up for college teachers. While salaries in teaching are much smaller than in the large-scale visual media, implicit valuations per contact hour in teaching are at least 600 times larger than in television. Classroom teaching is expensive because a teacher's scale of operations is sharply constrained by the student-teacher ratio.

My esteemed colleagues Aaron Director, George Stigler, and Max Hartwell and I share enthusiasms for several imports from Scotland, chief among them being the writings of Adam Smith. It gives one pause to contemplate what factors in Scotland account for the common origins of economics, golf, the Aberdeen Angus, and whiskey. An economist can only take refuge and small comfort in knowing the virtues of specialization and the division of labor before passing on to a more specialized problem. Because the quality of education is a subject of perennial discussion, and because Director, Stigler, and Hartwell regret-

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tably have not publicly revealed their thoughts on the matter, it is of some interest to consider Smith's radical ideas about the payment of teachers.

It would have been uncharacteristic for Smith to suggest improving teacher quality through periodic competency tests and tighter screening of entrants, and he did not do so. Instead, he sought ways in which contractual obligations would improve performance. In what would be recognized as an agency problem today, he advocated a method that tied a teacher's income to teaching quality as assessed by students. There has never been a keener observer of economic phenomena than Smith. Having spent some unhappy and unproductive years at Oxford, he roundly criticized the system (imported by Oxford from Continental universities) of paying teachers annual salaries. Compensation by annual salary was seen to affect adversely teachers' incentives to give time and attention to their students. Directly rewarding superior teaching would increase its supply. As many generations of anonymous professors have thought, if not said, A university would be a very comfortable place were it not for the students. It is well known that Oxford and Cambridge were exceedingly comfortable in this sense in the eighteenth and well into the nineteenth centuries (Rae 1965, p. 20).

In Smith's day, University of Glasgow professors were paid on a commission basis. The professor was paid a fixed annual retainer financed out of university endowment, and seniority eventually gave entitlement to a university house, part of which could be rented to students to supplement income. The greater part of income arose out of fees paid directly to teachers by students (see Scott 1937). This system survived there through the beginning of this century. It survived even longer in Germany, though of course full professors were exempted from the scheme.

Students that we all are, or have been, the business wisdom of collecting one's fees "up front" is readily appreciated. The classicist Gilbert Murray (Smith and Toynbee 1960) taught in Glasgow at the turn of the century and described the system along the following lines. Three guineas were collected from each student appearing in class on the first few days of the term. After all accounts were settled, the gold was placed in a special leather sack and carried, along with a cudgel or stout walking stick, to the bank for safe deposit. Murray reports that certain professors brought precision scales to class, to minimize revenue slippage due to coin clipping and light money, though there is no indication that Smith ever engaged in such sharp practice.<sup>1</sup> Neither Smith, Murray, nor Smith's

<sup>1</sup> Smith proposed some unusual terms for his leave of absence to accompany the duke of Buccleugh abroad. He promised to return all student fees if he was obliged to leave before the course was finished and offered to pay his replacement

biographers provide any detail on how these fees were determined. Apparently, they were set as a matter of university policy, much like tuition is determined today—with an eye toward what the traffic would bear. The fee was the same for all professors, and those attracting more students earned more money. In this system tuition was distributed among faculty members in proportion to their value as perceived by students.

Porting gold, with or without cudgel, would present certain problems in Glasgow today, never mind in New Haven, Hyde Park, or Cambridge, Massachusetts. Were it necessary, we undoubtedly would see a somewhat different type of teacher than now follows the trade. But the invention of credit cards, automated teller machines, certified checks, and collection agencies eliminates the need for it. Surely teachers would devote more effort toward influencing the size and composition of their classes with this scheme instead of the present one, where, following the system that Smith despised, salary is only loosely connected to course enrollments. It is said that the threat of customer withdrawal tends to keep the mind more sharply focused on one's immediate task. Books and other scholarly writing might serve as loss leaders for drumming up business. Indeed, Smith's great reputation as a teacher and scholar attracted students to his lectures from all over the world. Perhaps his books materialized, in part, out of the need to build an audience at his lectures.

There are only a few instances in which the individual financial connection between students and teachers of the fee system has been observed in modern times. Most of the examples we see are confined to vocational education. Mark Twain's (1951) superb economic treatise on Mississippi riverboat pilots describes an educational system that has few counterparts now, though it was relevant for medical education 150 years ago. There still may remain a few antiquarian lawyers who learned their trades by apprenticeship in a law firm without ever enrolling in law school, and in the heyday of the smokestack industry, many midwestern firms earned stellar reputations for training high-quality engineers outside the auspices of formal engineering schools.

Elements of the system remain in musical instruction. I still recall my first piano teacher halfheartedly trudging to my house once a week, irrespective of rain and snow, and receiving payment on the spot—a practice that is as rare nowadays as housecalls by a physician. A serious student who has prospects and who wants to make a career of it will take instruction from an acknowledged master, but the odds are that even this is done through the intermediary of a prestigious music school.

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out of his own pocket. The second offer was refused, but Smith almost had to resort to force before his students would take back their fees (see Rae 1965, pp. 165–71).

Few other examples come to mind. Tutoring is an uninteresting one because it accounts for a minuscule proportion of teaching. The modern lecture circuit comes close, yet my own audience participation in the successful road shows of Buckley, Kunstler, Mailer, and Vidal suggests a large measure of entertainment per unit of education in these. "Genuine" teaching and learning is a far more sustained and effort-intensive activity, and very few of these lectures, including none at all, will suffice for a lifetime. Mostly they are produced to hustle books, not books hustling students.

The fact is that education is transacted much like other goods and services in the economy, through organizations that carry the brand name of a firm, or, more likely, a political entity, rather than through a more decentralized system of individual teacher-student contracts. To obtain an education is to obtain a collection of things, and this entails certain coordination problems, both in the sequencing of material in the normal progression of learning a subject and in diversification among subjects. Any one teacher's knowledge represents a small proportion of the total—and, in these days of extreme specialization, perhaps a vanishingly small proportion. Equally important, students (and teachers) learn from each other. Minimizing transport costs of students studying several courses at once, promoting intellectual and social interactions among students and teachers, and rationally utilizing fixed resources such as libraries and classrooms imply a centralized school as the efficient type of enterprise for providing educational services.

These scale factors by themselves would produce the equivalent of a Les Halles College, a Shopping Mall University, or the Diamond Exchange on Sixth Avenue. In this scenario, a developer provides the physical capital, renting stalls and classrooms to individual teacher-entrepreneurs, who turn their profit by selling their time to student shoppers. In his definitive history of medieval universities, Hastings Rashdall (1895) described the origins of colleges in exactly this way. The Latin Quarter of Paris is a remnant of those origins. The modern developer would have to be cognizant of certain market constraints. For instance, the rent charged to a chemistry teacher would depend on the number and quality of other chemistry teachers occupying the mall; and teachers might have to work under certain restrictions, such as one that prohibits offering cooking lessons on those premises. The type of customers attracted to this school would be affected by the quality and composition of its teacher-entrepreneurs, just as customers at K-Mart and Bloomingdales differ in certain respects. A shopping-mall school would develop a reputation and "brand name" because of economies of information for student-consumers: it is easier to keep track of the reputation and qualities of schools rather than of the individual teachers and students that constitute them. Perhaps this is why every university

that can legitimately do so advertises the number of Nobel Prize winners among its current and former faculty and student body. The actual names of these people are seldom mentioned. Accounting totals are more prominent because many of the names are long forgotten, if they were ever known to the general public in the first place.

That different schools cater to different types of students and occupy well-defined market segments and niches suggests a certain plausibility for the department-store model of schools. Where it fails is in the mechanisms used to match students and teachers to schools. Nonprice criteria play a more important role in determining these allocations in schools than in stores. True, many schools engage in price discrimination, using scholarships and other devices to attract the desired mix and composition of students; but a student's ability, interests, and social characteristics are just as important as the willingness or ability to pay for admission. I once worked at a school where a large proportion of the students came from Long Island. The number of high-quality applicants from there was so large that the admissions officers implicitly handicapped them by 30 SAT points to maintain diversity among the student body. Similarly, teachers are not free to rent places on the faculty of a specific school at an impersonal, market-determined price. Instead, they must be invited to join by the school's administrators and faculty. Many who desire an invitation are never asked, and many who are asked decline to join. Groucho Marx never would have made it in academe.

These clublike aspects of academic life are a symptom of strong interactions among students and teachers in educational production. Such interactions are ubiquitous and important in team production. Securing a chair in an orchestra, a position on a professional baseball team, or a partnership in a Wall Street law or investment-banking firm is not open to everyone for these reasons. It is the close-quarter interactions and complementarities among and between students and teachers that result in stratification of both among schools. Stratification is efficient, and even reasonably fair, when competition among schools for students and teachers is strong enough for all participants to be properly matched.

The problem of allocating students and teachers to schools is largely independent of the method by which teachers are paid. The method of pay has much more to do with how resources are allocated *within* schools and the extent to which transfer pricing mechanisms are used to accomplish this. A method whereby students compensate teachers directly on a per-course basis amounts to a transfer pricing scheme that, to use a loaded word, privatizes certain transactions that are specific to the organization, whereas payment by annual salary works in a more collective, political, and centralized mode, within the school. The problems

of how decisions are made and how resources are allocated within organizations hardly are unique to educational institutions. An organization is an interactive mechanism whose component parts must be coordinated and whose decisions must be decentralized to some extent. There are many ways in which this is accomplished. Still, it follows from a point of elementary logic that complete decentralization is not possible. For if it were, there is no reason for the organization to exist in the first place, and it might as well be divided into its separate components, as Ronald Coase (1937) pointed out long ago.

The Survival Principle asserts that the salary system was the “fittest” because the fee system withered away. It is not so easy to identify overwhelming reasons why this should have been the case, though it is notable that piece-rated systems of compensation are far less important in the general labor market than they used to be. Let me offer some speculations for teachers. An efficient internal pricing mechanism has to mimic a competitive market system; and a market solution to the problem of efficiently matching teachers and students almost surely requires price differences among teachers and also among students. As we have it from Rashdall concerning the great University at Bologna in the Middle Ages: “The teacher was absolutely dependent for support upon his *collecta*, i.e., the fees paid to him by his pupils. The ordinary practice was for a professor to employ a couple of scholars to negotiate with the other students as to how much each was to pay; but at times a large body of students would make their own terms with the professor, and divide the cost among themselves. The amount of the honoraria was not even approximately fixed by custom, and at times we find learned professors of the highest reputation haggled with their scholars over these payments in a highly sophist-like and undignified manner” (1895, p. 208). We might imagine that, as medieval professors discovered the virtue, for them, of guilds, licensure, and other monopolistic practices to limit competition, they also found it desirable to avoid the hassles of bill collecting, attracting a student clientele, and course scheduling by turning these duties over to a more centralized agency of nonteaching personnel and that this, in turn, promoted uniform pricing practices within schools. To the present day we find that trade unions compress relative wage differences among their members. The “company union” at Glasgow required such extraordinary teachers as Smith and Murray to charge the same price as everyone else.

In addition to assigning specific students to specific teachers, an efficient internal pricing system has to respond to internal shifts in demand for various subjects and to changing external market conditions. These details require finely tuned adjustments that are difficult to calculate in the small numbers setting within a school while avoiding bargaining problems and invidious comparisons and inequities that

unsettle the collective spirit of the organization. Prices that are too low demoralize teachers, and prices that are too high demoralize students. These theoretical considerations aside, the fact is that the rise of the salary system followed on the entry of the papacy into the education business and on the provision of “free” education to students.<sup>2</sup> What is the incentive for a student who pays only a small fraction of the money expenses of education to express his preference for a specific teacher in direct monetary terms unless compelled to do so?

Everyone can see the weakness of these arguments: they do not provide a sharp contrast to a salary system. Underpaid teachers have a tendency to shirk and work to the rules whether they are piece rated or salaried, and overpaid teachers require larger tuition payments that reduce student enrollments. If students do not express their preferences directly in fees, there are no barriers to a school doing it for them. An obvious way is by capitation payments to teachers, calculating annual salaries in proportion to personal course enrollments. And if fees give incentives for teachers to increase course enrollments by adulterating course content, salaries provide incentives to reduce enrollments by making courses excessively difficult and boring. On recognizing the market discipline of competition, we are led to the conclusion that a salary system and a fee system are approximately equivalent on these accounts. In Smith’s time, Oxford and Cambridge had little competition from other colleges in England, and a social club can do all kinds of damage when it is the only club in town. It is probably the absence of effective competition and the oversight it implies that accounted for the sorry intellectual climate of Oxford and Cambridge in Smith’s era.<sup>3</sup> After all, they became the premier institutions in the world in spite of their salary systems. What happened to Glasgow?

There is an economic factor that tips the balance in favor of salaries in modern schools. An education represents a complicated bundling and

<sup>2</sup> Fees raised dilemmas for some canonists ignorant of the concept of human capital: “Ideally, they all say, the true philosopher, ‘exemplo Socratis,’ should reject money, for ‘knowledge is a gift of God, and therefore cannot be sold’” (Post 1932, p. 189). In the opinion of some, masters could not demand fees, but they could accept payments offered voluntarily by wealthy students! Nor were salaries confined to church schools. Large stipends were used to attract famous professors to the city-state universities that competed with Bologna, and Bologna had to respond in kind to keep them. Salaries did not supplant fees in these secular universities. They supplemented them.

<sup>3</sup> Ironically, it was government intervention that reformed Oxford and Cambridge and made them into great universities once again. The sorry state of these institutions was caused by an ingrown system of self-government. Royal commission inquiries and acts of Parliament in the nineteenth and twentieth centuries provided the oversight function that a board of trustees performs in a modern American university (see Darlington 1958).



certification problem and is seldom closely tied to a specific teacher compared with the collectivity of a school's faculty, student body, and administration. The reputation of a school rests far more on this collectivity than on the specific identities of its individual members for this reason. It is the price of the whole package that matters most for a bundled good, and pricing out each component is of far less consequence so long as the sum remains unchanged. A buyer of a pair of shoes cares about the price of the pair and is indifferent to how that price is allocated between the right shoe and the left. Paying the salesman a different amount for each shoe might adversely affect the quality of the overall fit.

Though almost all teachers are paid annual salaries, we may use the idea of per-class fees to make a backdoor or "as if" calculation. How much would a teacher have to charge a student on a per-class basis to justify the teacher's salary? The calculations will shed some interesting light on the value and costs of education.

To set ideas, let us begin with a high school teacher in a metropolitan school district earning the 1985 average of \$30,000 per year (salary plus fringes). This is an academic year, lasting 9 months. Ignoring school holidays, teacher conferences, and the like, it is a 36-week year, or \$833 per week. A 5-day workweek figures to \$167 per day. A typical teacher meets five classes per day, so the \$167 translates to \$33 per class. Average class size has varied in the 25–30-student range in the past 2 decades. Right now it is closer to 25 than to 30, so the equivalent number is about \$1.30 per student per class. Interpret this as follows: if the teacher collected a \$1.30 toll from each student at the beginning of each class, a grand total of \$30,000 would be accumulated from all students taught over the academic year. Alternatively, a student could be charged \$238 tuition at the beginning of the school year for 1 annual 50-minute classroom hour. I assume that the teacher could willingly attract 25 students per class for five classes per day, 5 days a week, and 36 weeks per year.

The \$1.30 is too small not only because there are fewer actual classes than this but also because the calculation ignores complementary resources. Ascertaining capital expenses in the education industry is difficult because the accounting system used by schools is not adequate to the task. They are, after all, either nonprofit or state institutions. Besides, capital is heavily subsidized in education, both directly through state provision and tax-subsidized gifts and indirectly through exemption from property and income taxes by virtue of nonprofit status. An educated guess can be made as follows. A classroom suitable for 25 students requires about 300 square feet of space. The annual rental for residential property (site plus structure) averages \$10 per square foot per year. Assuming an 8-hour-day usage of this space, so it sits idle two-

thirds of the time classes are in session, implies a rental charge of \$375 per hour for a single class over the academic year, or an additional \$15 added to that class's annual tuition per student. Double this to include furnishings and extra wear and tear (students are not exactly model tenants). Then the annual tuition per student per annual class amounts to \$268, or about \$1.50 per lecture.

A buck-and-a-half isn't bad. We know that education is very labor intensive. The labor intensity implied here is .87 and is larger than actual fact because I have not made allowances for public and private utilities, insurance, books, pencils, chalk, administrative overhead, teaching machines, laboratories, and the like. These things would add perhaps another 35 cents or so to the per-lecture bill for a student, bringing the total to \$1.85. This number compares favorably to many consumption items, even on a 50-minute-hour basis. For example, baby-sitters charge much more, even though capital, food, and telephone usage are provided by the buyer. Of course, baby-sitters' hourly rates per child would be smaller if they could handle 25 children at a time rather than one child or two. A class is a media event, something like theater-in-the-round with audience participation. The hourly charge in a theater is much larger than this. Even a first-run commercial film seen in a theater costs \$3.00 or \$4.00 per hour, which is usually less than \$1.85 on a per-actor basis, but then the typical movie audience per performance is larger than the 25 customers per performance in teaching.

It is admittedly unusual to compare education to movies, plays, baby-sitters, and the like. We know that education is an investment, so a more appropriate comparison is to items of capital like blast furnaces, skyscrapers, and, even better from an analytical perspective, cattle feedlots and vineyards. A great deal of research has established that the rate of return to educational investment is near the vicinity of 10%. Then the teacher and allied expense of 1 classroom hour has to raise a student's annual income by a mere 19 cents to make it an economically viable proposition. One class for the entire academic year has to raise it by only \$34 to make it a good investment, and since there are usually two courses per year, that amounts to \$17 additional annual income per course, or less than \$170 in capital value. A complete economic value accounting of this hour would have to recognize the earnings opportunities forgone from attending class and that the teacher and related expense of schooling is only one aspect of its total cost, both to the student and to society. Nonetheless, for parents to be willing to pay \$170 out-of-pocket money for a typical semester course makes primary and secondary education seem like a pretty good deal, even on a baby-sitting basis.

Let us try out the same ideas for a college teacher. A teacher in a regular 4-year college who had a full-time teaching schedule would meet four classes each term, two terms per year. However, these classes would

meet only 3 days per week. The full-time college teacher meets classes about 12 50-minute hours per week rather than the 25 hours that a primary or secondary school teacher does, or only about half as much. A college teacher who earns \$30,000 and who sees 25 students per class has to charge twice as much per student to cover labor costs alone, or about \$2.60 per lecture. A college year is shorter than a primary school year. It consists of 2 16-week-semester terms, for 32 rather than 36 weeks, or eight-ninths less time. Consequently, the labor charge has to be \$2.93 per lecture. Capital is more expensive for college than for high school education, if for no other reason than that the students are larger, so add \$1.00 per lecture rather than 50 cents. The total implicit per-lecture charge for this teacher is \$3.93 per head.

There is one more step in the calculation because college teachers earn more than high school or elementary school teachers. The annual compensation of a full-time teacher in a 4-year college averages \$40,000, including fringe benefits. Recalculation with this figure yields a teacher charge of \$3.90 per lecture for an average class size of 25 students. Adding the \$1.00 for other expenses brings the total to about \$5.00 in round numbers, a figure that is 2.7 times larger than for primary and secondary school teachers.

These numbers are merely averages. It is plain that the implicit toll per class necessary to support a given teacher's compensation depends on the salary level, on the number of students per class, and on the number of courses taught by the teacher. All these things show substantial variation, and this variation is much larger at the college level than at the primary and secondary levels. For instance, the mean compensation in an elite 4-year liberal arts college is close to \$50,000, and average class size is smaller than 25, perhaps as small as 15 students per class. Furthermore, a teacher employed in such a school would teach no more than six courses per year rather than eight. This comes down to something like \$11 per class for the teacher's time alone, never mind materials or administrative and capital expenses, which create a figure that is beginning to get up there. On the other hand, we hear of introductory courses in major universities that enroll 800 students per lecture. Even allowing for the numerous graduate assistants required to manage such a course, the implicit per-lecture tolls per student are a pittance.

College teachers earn more than high school and elementary school teachers because it is costlier to obtain the Ph.D. certificate necessary for college teaching than it is to obtain the B.A. or M.A. certificate required for elementary and high school teaching. The additional time, effort, and expense must be offset by greater earnings prospects, or else not enough people would choose college teaching careers. The added cost easily accounts for the 33% difference in annual earnings (\$40,000

compared to \$30,000) between types of teachers. In contrast, the implicit toll per student per classroom hour is larger by 270% or more in college teaching. Evidently, students are willing to pay much more for a unit of a college teacher's time than for a unit of a primary school teacher's time. Why is this so?

I think the answer lies in the fact that the technology of learning follows a hierarchical design. Education begins by learning basic reading, writing, and arithmetic skills and affective or social skills—how to get along with others and how to operate in groups. Education in elementary school, and earlier in the home, installs the language and primitive skills on which all subsequent learning builds. Learning branches out into more specialized and abstract knowledge as the student progresses through the system. Providing these primitives requires more direct instruction and supervision—in short, more contact time with a teacher. As the student travels higher in the educational scheme of things, time spent in class and time spent in self-study out of class increasingly complement each other, and there is a sense in which class time is higher-quality time at the margin for higher levels of education compared to lower levels. Attending a college class is of little value to an unprepared student. Why should the teacher teach what the student can just as well learn himself?

It is by now obvious, if it was not before, that the most important constraint in the economics of the education industry is the student-teacher ratio. It is the media aspect of teaching that enables a teacher to serve many students at once and allows the ratio to exceed one. Think of a medium as a communications and information channel. Once the channel has been set up, signals can be transmitted to several users simultaneously, up to capacity. A metaphor of teaching might be constructed along these lines, with teachers as transmitters, students as receivers, and classrooms as channels. Examinations and grades serve to certify the extent to which the signal has been received and processed.

The various media differ in their carrying capacities and the extent to which they allow two-way communication. There is an inverse trade-off between the two in teaching because communication becomes increasingly unidirectional as the scale of the media is enlarged. For example, I cannot ask Smith to clarify for me what seems to be a crazy argument in the *Wealth of Nations* (1937) asserting that public education should prevent the growth of cowardice in the population. Actually, I used to know a philosopher who periodically consulted a medium to discuss fine points with the Reverend Berkeley, but that does not seem very cost effective for your run-of-the-mill student. Asking questions of a live teacher generally is thought to be more efficacious.

Television and movies offer the greatest potential for scale economies of all the media. It is certain that the education industry would look

much different and the rewards to teachers would be unusually distributed if these media were routinely used in teaching. We need only to examine the distribution of rewards in the mass-media business to support this point. Barbara Walters is reputed to earn somewhere in the vicinity of \$2 million per year. Her airtime appearances amount to no more than an hour per week, and, counting summer reruns, her class-equivalent meetings are perhaps 50 per year. That amounts to \$40,000 per air-time hour. A prime-time network program must attract 20 million viewers to be commercially viable (how's that for a student-teacher ratio?), so even though her per-appearance remuneration is huge, the per-viewer valuation of them is a trifle. It is 10 cents per viewer for an entire year's worth of programs, or two-tenths of a cent per hour, a truly paltry sum compared to the \$1.30 and up per hour valuation of school teachers. Individual students and their parents value a teacher's services more than 600 times as much as, arguably, the best personality on network news. To put it another way, we spend \$1.3 billion in teacher time alone for 50 hours of class time for 20 million students. This is 650 times more than if it were done through network television. Moreover, the 650:1 ratio is a lower bound because it does not make any allowance for the fact that teaching content does not depreciate nearly so fast as yesterday's news. The rerun potential for successive generations of students is much larger in teaching, as every teacher well knows. Since we spend 6.8% of the national income on education in this country, the national debt could be paid off very fast were education organized in this way.

Certainly many teachers would be put out of business if the large-scale visual media were extensively used in the education industry. They are not used very much. The major innovation in teaching, the low-cost book, occurred 4 centuries ago. Beyond that, teaching methods have changed remarkably little, in spite of vast changes in knowledge and in communications technology. No Luddite movement among teachers and school administrators is at work here. The fact is that large-scale media other than books are not effective for most types of teaching, and this imposes sharp constraints on a teacher's scale of operations. Effective teaching requires teacher-student interchange and becomes increasingly difficult as class size increases. In addition, large-scale production degrades the signal content of teaching. A teacher produces a uniform message, and that message becomes garbled as class size and student diversity increase. Teaching a large class compels one to broadcast to the median student, lending a certain mediocrity to the end product, which is a phenomenon that will be well known to television viewers. Judging from what one sees on television, it just does not seem possible to transmit most difficult and abstract ideas on a mass scale through the air waves, and that state of affairs is unlikely to change in the foreseeable future.

These inherent constraints on the student-teacher ratio expose education to Baumol-Bowen Syndrome, an affliction that is benign in *Homo sapiens* but almost fatal for certain labor-intensive industries. William Baumol and William Bowen (1966) isolated an early strain in studying the economics of the lively arts, in which labor-intensive production methods have remained essentially unchanged, whereas labor costs have increased along with rising standards of living in the rest of the economy. It is in this way that the \$58 Broadway theater ticket and the \$12,000 or more annual admission price to many private colleges and universities are connected. And though students enrolled in public schools and colleges pay very little in the way of explicit tuition charges, there is no evidence that the real costs to society of providing education in public schools are smaller than the costs in private schools.

The California state legislature is contemplating a \$5 billion budget for the University of California system next year. That system covers the nine state campuses offering significant graduate as well as undergraduate instruction, and enrolls 148,000 students overall. Dividing \$5 billion by 148,000 yields a remarkable \$33,800 per student. The shock value of this number immediately is offset by the fact that the calculation is all wrong conceptually because the \$5 billion includes major items of expense that are only trivially associated with teaching. In the University of California case it includes the management of two great national laboratories and five university-affiliated hospitals that between them cost about \$3 billion, the major part of which is financed from other sources. Netting this out and dividing the remainder by 148,000 yields a more plausible figure of \$13,800, comparable to full tuition charges in premier private research universities.

I chose this example because the numbers were handy and also to illustrate the difficulties of calculating implicit teacher fees as we move to the higher reaches of modern education, where a significant part of institutional resources are devoted to activities that are not directly associated with teaching. An excellent American university used to be in the noodle business, and many are involved in biotech ventures, industrial parks, real estate developments, and what have you. However, the primary "other activity" is the research efforts of the faculty, and in such universities teachers divide their time between teaching and research. The typical split is 50–50, with the teacher meeting two courses per semester rather than the four-course-per-semester standard in 4-year colleges. A teacher in a research university is only a half-time teacher. We could organize teaching and research differently, in separate institutions, and in fact we do to some extent. However, the informed judgment has it that teaching and research are complementary and enhance each other. In finding ways to express the ideas of the past better, it is inevitable that new ideas occasionally arise, that errors in the

old ones are uncovered, and that unresolved problems are clearly revealed. Similarly, there is value for some students in being exposed to knowledge at the leading edge, and this is best done by teachers who are actively involved in those developments. Our educational system is organized both to transfer knowledge from older generations to younger generations and to add to the social store of knowledge available to be transferred.

Bundling and joint cost allocation problems arise in allocating teaching hours to implicit lecture fees in this kind of organization because teaching and research are both jointly produced and jointly financed. At a research university, loading a professor's salary solely onto the teaching component is as wrong as allocating the cost of the University of California hospitals and national laboratories to University of California students. Now this would *not* be true in a genuine fee system and in the absence of outside subsidies to the research activities of faculty members. In a strictly private fee system, a teacher's incentives to engage in complementary research at his or her own time and expense arise from its anticipated effect on the future fees payable by students. I am hardly suggesting that personal financial gain is the only engine or even the primary engine of progress in these endeavors. All that is needed for the argument is that it is an important factor, and all doubt on that score is dispelled by the observed sensitivity to funding prospects of research activity in various subjects and fields.

There is no question that total investment in the creation of new knowledge would be much smaller if it were financed only through personal student fees compared with our existing institutional setup. In part this is due to the fact that research is heavily subsidized in universities today. But in greater part it arises from the technology of knowledge itself, from the fact that new knowledge is a common property resource once it has been discovered. Royalties in proportion to use do not redound to the originator, if indeed the originator can be identified, and new knowledge would be grossly underexploited by society if they did. The entire social order and structure of academic life is founded on the idea of quick and free dissemination of new ideas. A teacher who reveals original thoughts to students may be creating some fierce competition at a future time, and if the cost of research investments can be recovered only through direct student fees, the teacher might just as well use the ideas of others rather than invent new ones. Experience of the eighteenth and nineteenth centuries proves that academic invention would not be entirely suppressed in such a system. Its pace would be slower. A salary system loosens these constraints and promotes the free exchange of ideas that productive research demands. But does it promote the most efficient allocation of a professor's time between teaching, research, and leisure?

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