THE COST OF EDUCATION - A SYNTHETIC APPROACH*

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There is perennial interest in the quality of education relative to its cost. For example, several Supreme Courts have ruled that funding education on the basis of a real property tax is unconstitutional because it makes the quality of a child's education dependent upon the wealth of his parents and neighbors. California, Michigan, Texas, and other states have focused on this problem, though the U.S. Supreme Court overturned the Texas decision (Rodriquez et. al. vs. San Antonio). These cases illustrate continuing interest in educational quality and cost. At the school level, the relation between quality and cost is also well known. Most, if not all, school administrators continually face the problem of providing education with rapidly increasing costs. In Nevada, for example, education costs have been increasing at a rate of 13.5 percent per year [7].

Several approaches to the problem of providing quality education at minimum cost have been demonstrated. White and Tweeten [12] have defined optimal school size in terms of minimum unit costs. Riew [5] and Osborne [4] have conducted similar studies. Sadler [6] used a linear programming approach to define least cost of education where spatial factors and educational quality have been integrated.

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* Contribution of the Nevada Agricultural Experiment Station, Journal Series No. 325.

No matter which approach is used, the estimation of cost of providing education is an integral part of the analysis. Economists have traditionally employed two methods to estimate cost functions: statistical [2] and synthetic [1].[1/] The statistical approach typically involves estimating the parameters of a regression model. A major limitation of this method is its reliance on past data with limited control over external items such as educational quality [2, 11]. The synthetic approach requires an explicit definition of the inputs required to provide a specific level or quality of education. These inputs are valued and summed to provide estimates of total costs. Through such a technique the analyst has more control over items entering the cost calculations.

While statistical cost functions may be useful, the methods used to derive them are well known. In contrast, methodology regarding synthetic cost functions for education are less well known. Accordingly, the purpose of this paper is to describe the construction of a synthetic cost function for providing education in a rural area of Nevada.

Procedure: Synthetic Cost Function

Three county school districts (Lincoln, White Pine, and Eureka) located in East Central Nevada were selected for study. While the selection was contingent upon on-going research in that region, the methodology described appears applicable to any one school district, or set of districts. The cost of education was viewed as containing four major components:

1. Instruction costs: teacher salaries, principal salaries, counselor salaries, clerical salaries, and teaching supplies.

2. Maintenance and operation costs: salaries for custodians and maintenance personnel, janitorial supplies, utility costs, etc.

3. Personnel Benefits: retirement contributions and insurance expenses.

4. Transportation costs: driver salaries, vehicle replacement costs, maintenance costs, gas, oil, etc.

A synthetic cost function was developed for the total of the first three categories to approximate operating budgets for different school sizes and program sizes (curricular offerings).

1/ Lesher and Mapp [3], discuss these methods as well as the survivorship technique.

Several assumptions were made regarding the formulation of a synthetic cost function. First, district administrative costs were assumed to be fixed and only arbitrarily allocable to specific schools. They are ignored in cost calculations. These costs include expenses classified as Administration Expenditures in the School Finance Accounting Manual [9], and consist primarily of expenses associated with the salary of the district superintendent and salary costs for supporting staff. These costs currently represent about two percent of a district's total operating budget [10].

Second, teachers were assumed to teach no more than five classes per day on the average. Teachers for the five high schools in the study region taught an average of between four and five classes. Most high school teachers in Nevada are provided with at least one period per day which can be devoted to class preparation. Thus, in the formulation of a cost function, a maximum teaching load of five classes per teacher was assumed.

Third, the initial student-teacher ratio was assumed to be 20:1 or less. For the five schools under study, the student-teacher ratio varied from 7:1 at Eureka to 20:1 at Ely (based on current enrollment). In the urban school districts of Nevada, student-teacher ratios exceed 20:1, but in most rural districts ratios are less than 20:1 [7].

Analysis of data for the fiscal years 1970 through 1974 [7, 10] indicated that about 96 percent of total operating expenditures (excluding administrative costs) are included in the categories of instruction, personnel benefits, maintenance and operations, and transportation costs (only the first three categories are considered in this paper). In addition to transportation, other costs not considered in the derivation of the synthetic cost function include adult education, food programs, and capital expenditures for equipment or structures.

On the four main cost categories noted above, instruction costs were the largest. For 1970-1974, salaries comprised 93 to 94 percent of all costs in this category [7, 10]. Thus, salaries were assumed to equal 93 percent of total instruction costs in the development of a synthetic cost function (i.e., total instruction costs were estimated by dividing total instruction salary costs by 0.93). For these same years (1970-1974) maintenance and operation costs made up about 17 percent of instruction costs [7, 9]; and, this figure was used to estimate total maintenance and operation cost. Retirement benefit increases have steadily raised the relative amount of expenditures in the personnel benefits category, but currently this category equals about 11 percent of expenditures in the instruction category; and, this percentage was used to estimate total personnel benefits.

Salaries for teachers, principals, counselors, and clerical workers were estimated from district records. Teachers were assumed to receive an average salary of $11,200; principals were assumed to receive an

average salary of $18,000; counselors were assumed to receive an average salary of $12,000; and, clerical workers were assumed to receive an average salary of $6,000. In smaller schools (less than 300 students), it was recognized that fulltime principals, counselors, and clerical assistants were not justified. Accordingly, salaries for principals and counselors were prorated according to the number of students. Clerks were prorated according to the number of teachers.[2/]

Currently, the State of Nevada requires the completion of at least 19 credits of high school course work for graduation. Nine and one-half of the credits are specified by law. The remaining nine and one-half credits are selected from courses implemented by the school district. One credit is defined by the State Department of Education as "... 120 hours of instruction or its equivalent per year" [8]. For this study, one unit or credit is defined as 120 hours of differentiated class instruction per year. Thus, the identical course taught more than once would not count as two units, but the same course taught at differing degrees of difficulty (tracking) would. In this study, the minimal curricular offering is set at 24 units. This is a very restricted type of program since all students receive virtually the same educational training and there is little flexibility to develop individual needs and interests. Such a program is typical in smaller rural Nevada high schools.

Synthetic Cost Calculations

Proceeding from the previous assumptions it is possible to estimate the operating cost for an educational program of a given diversity and a specified number of students. Given a 24 unit curriculum and a student enrollment of 50, the operating cost for this program would be calculated in the following manner.

First, the number of classes resulting from required courses must be determined. Since there are less than 20 students in any particular grade, it would not be necessary to double up on required classes, which are assumed to total 10 credits. Given a maximum teaching load of 5 courses per teacher, 10 credits will require 2 teachers. Fourteen additional credits are assumed to be electives and 3 additional teachers will be required, bringing the number of required teachers to 5. Although not of consequence in this example, the student-teacher ratio cannot be allowed to exceed 20:1. If this had been the case, additional teachers would be assumed until the ratio is reduced to the 20:1 limit. Continuing with the example, clerical help and counseling services are prorated as follows: 5/6 X $6,000 = $5,000 for clerical salaries; and, $40 X 50 students = $2,000 for counseling services. The principal's

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2/ It was assumed that each clerk could service six teachers; and, principals and counselors were fully employed with 300 students. These ratios reflect conditions in rural Nevada.

cost is prorated at \$60 X 50 students or \$3,000. Teacher salaries total \$56,000 (11,200 X 5) and total salary costs in the instruction category equal \$66,000. Since salary costs represent 93 percent of total instruction costs, total instruction costs equal \$70,968 (\$66,000 ÷ 0.93). Maintenance and operation costs equal 17 percent of instruction costs or \$12,065. Personnel benefits equal 11 percent of instruction costs or \$7,806.

An itemization of the calculated operating costs for this program follows:

INSTRUCTION SALARIES	\$66,000	
INSTRUCTION EXPENSES	4,968	
TOTAL INSTRUCTION COSTS		\$70,968
MAINTENANCE & OPERATION		12,065
PERSONNEL BENEFITS		7,806
TOTAL OPERATING COSTS		\$90,839

$$\text{Cost Per Student} = \frac{\text{Total Cost}}{\text{Number of Students}} = \$1{,}817 \text{ per student}$$

Per student costs for other school and program sizes can be calculated in a similar fashion. For example, per student costs have been calculated for 24 unit, 48 unit, 72 unit, and 84 unit programs. Results are shown graphically in Figure 1. Note that this is a "smoothed" functional presentation of the derived cost curve. Each cost curve is actually discontinuous because of the discrete nature of the data. The major source of discontinuity is the student-teacher ratio which is assumed to be 20:1. A simplified flow chart describing the step-by-step operations used to compile the cost function is presented in Figure 2.

Looking at Figure 1, we see that with a program size of 24 or 48 units, an enrollment of approximately 400 students is required for reasonably low cost of operation at point A. A program size of 72 units requires an enrollment of 500 students to achieve this same cost per student at point B, whereas an 84 unit program requires a school size of 600 students as shown at point C.

Conclusion

The purpose of this paper has been to illustrate the construction of a synthetic cost function for providing educational services in a rural area of Nevada. Specific assumptions and values of parameters (e.g., teacher and principal salaries) used in the development of the cost function were described. The authors suggest that the main uses of a synthetic cost function involve justification for budgets and for planning purposes. We feel that the synthetic approach to cost functions are most appropriate since they provide the cost analyst with maximum

FIGURE 1. PER STUDENT OPERATING COSTS FOR PROGRAMS OF 24, 48, 72, AND 84 UNITS.

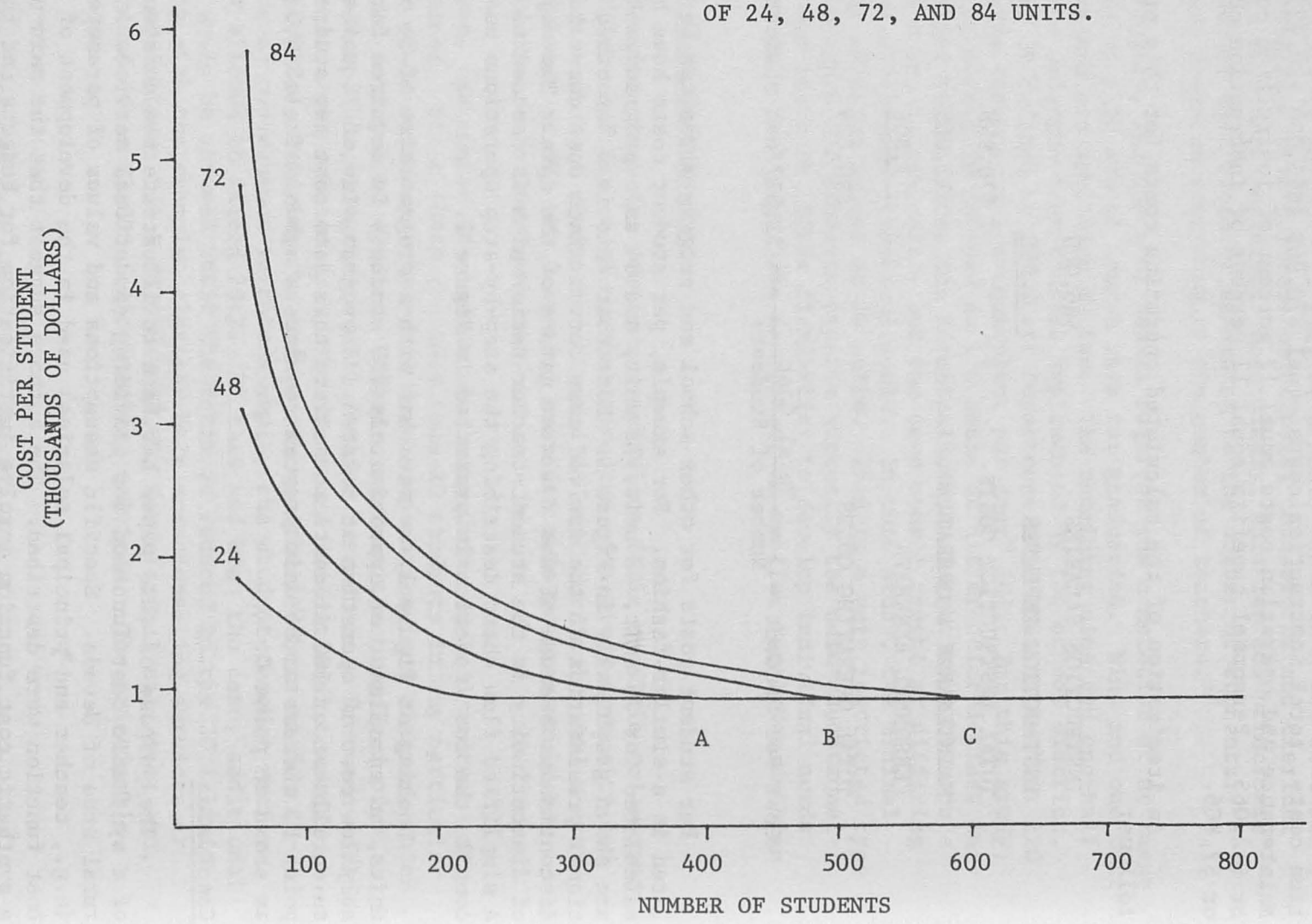
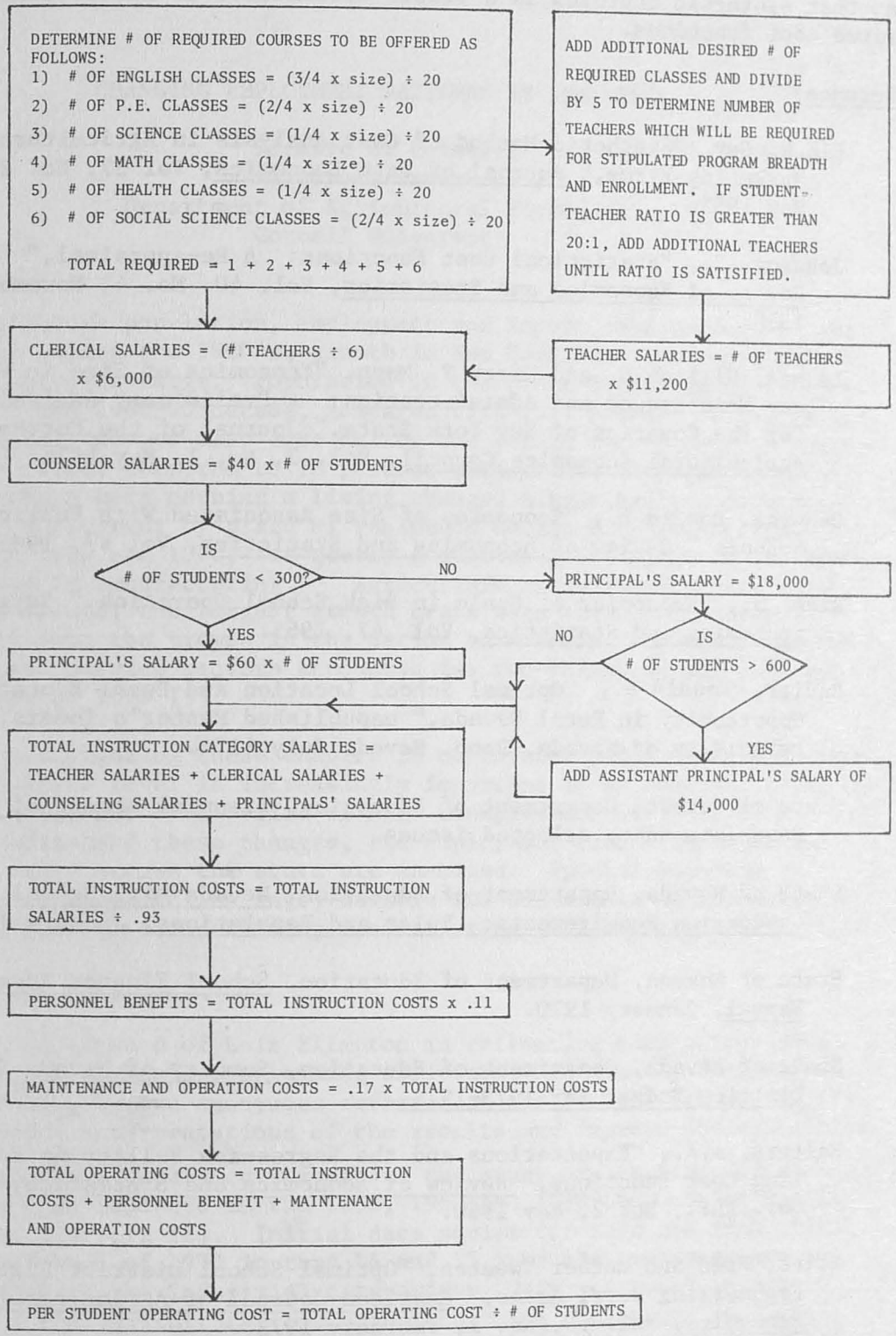


Figure 2

Flow Chart For Cost Computations



control over the items which enter the cost computations. Statistical approaches do not provide this type of control since analysts are less able to influence the compilation of cost statistics. Thus, we suggest that that synthetic approach is a viable alternative to statistically derived cost functions.

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