COST/PRODUCTIVITY RELATIONSHIPS IN CENTRAL AMERICAN NATIONAL UNIVERSITIES

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY
WILFERD W. WORTMAN

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This is to certify that the

thesis entitled

COST/PRODUCTIVITY RELATIONSHIPS
IN CENTRAL AMERICAN NATIONAL UNIVERSITIES

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ABSTRACT

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By Wilferd W. Wortman

The purpose of this study is to examine relationships between the investment of fiscal and human resources and socially useful output in Central American universities. The general thesis to be examined is this: The productivity of resources invested by the national universities can and should be increased. Due to the limited resources available to higher education in partially developed nations and the critical importance of education to development, increased productivity is essential.

Most partially developed nations have serious shortages of skilled manpower and a surplus of unskilled manpower. Higher education produces the trained manpower to fill the technical and administrative positions, it produces the teachers who prepare the population for subprofessional occupations and for further education, and it conducts research which helps to define and solve problems as they occur in the developmental process. Since there is an interaction and interdependence between economic development and educational development, a

portion of the study is devoted to the characteristics of the partially developed countries and their universities. These characteristics provide the environmental setting. They include widespread illiteracy, low per capita output, a predominantly agricultural economy, and political instability. Student achievement in the universities is slow and costly. The kind of trained manpower produced is not that which is most needed for further development.

In order to study input-output, and the variable factors which influence this relationship, it is necessary to measure productivity. A formula is developed which relates input of resources, student instruction hours, to the output of successful students. A successful student is one who passes the required examination for a course. A success ratio, successful students to enrollment, is applied to the input of instruction hours. Measurement is in terms of cost per productive instruction hour and cost per productive contact hour. Previous unit cost measurements in higher education have neglected productivity, concentrating on cost of input. The productive unit cost measure is used in determining relationships of class size, level of instruction, type of instruction, and subject matter to productivity. It includes all variables, such as enrollment, different costs and hours, and productivity in arriving at unit cost by class size, level or type of instruction. This measure of productivity does not pretend to measure

all the benefits of education. It does not automatically solve all the problems connected with attempts to increase productivity in higher education. It should, however, indicate where further study is needed and where changes might be desirable.

The formula is applied to data for individual courses from five Central American universities for the 1962-63 academic year. The influence on productivity of the variables of class size, level of instruction, and type of instruction is determined by university and for selected faculties in each university.

The data analysis indicates that the range of class sizes is not economical. Resources are spread over many small high cost units whose productive unit costs could be lowered. The two productive cost measures used together provide a means to select more economical class sizes. Analysis by level of instruction shows level one cost per productive instruction hour to be as high or higher than the cost on higher levels. The analysis by type of instruction shows that for different faculties one method is more productive than another resulting in lower productive unit costs. Considering all faculties and all universities no one method stands out as superior to the others.

COST/PRODUCTIVITY RELATIONSHIPS IN CENTRAL AMERICAN NATIONAL UNIVERSITIES

By

Wilferd W. Wortman

A THESIS

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ACKNOWLEDGMENTS

This study has been an interesting investigation of the problem of measuring cost-productivity relationships in higher education.

I wish to express sincere thanks to my doctoral committee chairman, Dr. Karl T. Hereford, for his generous help and guidance. I also extend my thanks to the committee members, Dr. T. Clinton Cobb, Dr. Stanley Hecker and Dr. Walter Johnson for their helpful comments and interest during the preparation of my thesis. I wish to acknowledge those members of the faculty and staff of Michigan State University whose interest and cooperation made the completion of my doctoral program possible.

This thesis is dedicated to my family: To my wife and daughter Cindy for their patience during years of continuing education. To my mother and father whose devotion to higher education for their children was an undying inspiration.

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CHAPTER I

THE ROLE OF HIGHER EDUCATION IN THE ECONOMIC DEVELOPMENT OF PARTIALLY DEVELOPED NATIONS

The purpose of this study is to examine relationships between the investment of fiscal and human resources and socially useful output in Central American universities. It is particularly useful to examine these relationships in partially developed nations where the resources available for education are limited and characteristically underutilized.

Statement of the Problem

The general thesis to be examined is this: The investment made by the national universities in partially developed nations tends to exceed the socially useful output produced by the universities. Hence, universities in such countries themselves tend to be uneconomic entities, despite their critical importance to development in their nations.

The thesis is tested against data constructed for each course offered by five Central American national universities during the 1962-63 academic year, the last year in which complete data were available. Two specific steps are taken in the examination. First, a new measure of university productivity is developed and applied systematically to the data thus enabling comparisons of investment and productivity to

be made between faculties, departments, levels of instruction and universities. Heretofore, conventional measures of university investment have achieved only limited utility because they lacked an adequate measure of university productivity. This ostensibly is overcome by the methodology developed by this study. Second, background information is presented that confirms the relevance of higher education to development in partially developed nations, and the present status of such education. The environment within which education functions is an important consideration. Therefore, the general characteristics of the partially developed nations and of their institutions of higher education are presented so as to show the interaction and inter-dependence of the environment and education.

A desired outcome of the study is that the methodology here presented may, if implemented, permit Central American and universities of other partially developed nations to determine better means to utilize their limited educational resources and to improve upon the socially useful output of their primary educational institutions.

Higher education is important to the economic development of a nation. Whether a nation is developed or underdeveloped, higher education is crucial to its progress.

Higher education produces the trained manpower to fill the technical and administrative positions which increase in number and complexity as the nation develops. Higher education produces the teachers who prepare the population for subprofessional occupations and for further education. It conducts research which is in itself necessary for development. Research helps to define and solve problems as they occur in the developmental process.

Higher education in the partially developed nations of Central America is post-secondary just as it is in the United States. Most post-secondary institutions of the United States are considered to be higher education, such as junior colleges, and private and public liberal arts colleges. In Central America, however, the term refers principally to the national universities. There are private schools, institutes, and universities and a few teacher's colleges in Central America which perform some of the functions of higher education; only the universities, however, are so regarded in terminology.

The partially developed nations are plagued with both critical shortages of trained manpower and burdensome surpluses of untrained manpower. Human resource development has lagged behind the development of other resources, and yet it is probably the most important resource for economic progress as well as for social, political, and cultural progress.

> If a country is unable to develop its human resources, it cannot develop much else, whether it be modern political and social structure, a sense of national unity, or higher standards of material welfare. Countries are underdeveloped because most of their people are underdeveloped, having had no opportunity of expanding their potential capacities in the service of the society.[1]

It might equally be said that their people are underdeveloped because the countries are underdeveloped due to a lack of effective demand for goods and services. The development of a country and of its human resources go hand-in-hand.

A goal common to partially developed nations is universal primary education. Yet few such nations have the physical facilities or qualified teachers to accommodate the population in the eligible age group. This is particularly true of the rural areas. Physical facilities are often not within reach of the children and qualified teachers prefer to remain in the towns and cities.[2] "Of the primary school attenders in the average partially developed country, it is possible that less than half achieve a state of literacy which is retained more than a few years".[3] An efficiency measure based upon the

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[1]Frederick Harbison, Charles Myers, Education, Manpower, and Economic Growth, (New York: McGraw-Hill Book Company, 1964) p. 13.

[2]Karl T. Hereford, Et Al, Plan of Public Expenditure for Education in Central America, (IIME: East Lansing, Michigan, 1964) p. 7.

[3]Harbison, p. 79.

ratio of attendance in the fourth grade to attendance in the first grade reveals the following for some countries in Latin America.

> In Colombia, enrollment in the fourth grade is only 18 percent of that in the first; in Guatemala it is only 19 percent. In Peru and Bolivia the percentages are 45 and 48 percent respectively, and by comparison with the Latin American average of 25 percent, they are relatively high.[4]

The present study is concerned indirectly with the development of human resources and specifically with making a contribution to the subject of measuring and, ultimately, increasing productivity of higher education in partially developed nations.

Higher education in partially developed nations is underproductive and uneconomic. It is underproductive in the sense that the quantity and quality of useful output is not commensurate with the input of resources. It is underproductive when resources are expanded on a large number of students but relatively few become sufficiently qualified in their specialization to graduate. A high drop-out rate suggest a high cost operation. Part-time professors and part-time students contribute to underproductivity and are characteristic of education in partially developed nations. Low university salaries

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[4] Ibid.

and the demand for educated people make it necessary and possible for university professors to hold two or more positions. They, of course, cannot give their best to each. Part-time study, when spread over long periods of time, probably does not contribute to student scholarly success. There may be other contributing factors to underproductivity which this study may discover through cost and productivity analysis. With reference to underproductivity, the following comment is made in the Final Evaluative Report, Program Interuniversitario:

> The educational system at present is a consumer of economic output, rather than a producer of economic capability. Between one-fourth and one-fifth of the Central American governmental budgets is spent on public education. The amounts spent per student are quite low, as compared to U.S. figures. However, the drop-out rate is so high that the amounts spent per graduate in Central America approach those of the U.S. figures. At the university level, the predominance of extremely expensive part-time study--and the very small numbers of part-time students who actually graduate--raises the cost of a graduate to excessive levels.[5]

Higher education is uneconomic in the sense that it does not produce the kind of trained manpower needed for development of the economy.

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[5] Final Evaluative Report, Program Interuniversitario, (Instituto do investigaciones y mejoramiento educativo, 1965) p. 9.

> Only one university graduate in ten is an engineer, but four are lawyers. For all practical purposes, the universities do not produce school teachers, agriculturists, and business administrators, not to speak of nurses, sanitary engineers, doctors of veterinary medicine and other specialists.[6]

There are two reasons for this. One, the societal incentives do not favor the training of scientists, engineers, or business administrators. Two, the cost of training in law and humanities is lower than that for technical education. Therefore, a larger number of students--especially part-time students--can be accommodated in these faculties at a lower total cost.

In most of the partially developed countries, with the exception of China, the high-prestige occupations are not those most needed for development. Landlords, lawyers, doctors, government officials, and military leaders enjoy both high status and political power. Access to their ranks does not depend on demonstrated competence but usually on family and political connections. The status of professional engineers and scientists is usually inferior since in most cases they are employed by the elites. The status of technicians, agricultural assistants, nurses, school teachers, and other subprofessional groups is even lower, for in most cases they have little or no opportunity ever to rise even into the

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[6] Ibid., p. 10.

professional ranks. Professional managers in private enterprises, as distinguished from owners or family managers, are not very high either on the status ladder.[7]

> A social structure of this kind obviously is an obstacle to growth along modern lines; and it must be drastically changed if the newly articulated goals of the partially developed countries are to be achieved. In China, of course, the required changes have been made in a completely ruthless and arbitrary manner. There, the scientist, the engineer, the technician, and the factory worker are glorified; and the other 'intellectuals' who are not members of Communist ruling elites are roundly castigated.[8]

The kind of education which a country needs is closely related to its level of development. It is not likely, however, to get the needed education until the need turns into demand, effective demand. After the Civil War in the United States, for example, the development of science and industry created a demand for a broader program in higher education. Existing universities responded, and new institutions were established to meet the demand of business and industry in the last quarter of the nineteenth century. Perhaps the demand was necessary before the production was feasible. On this point, Leibenstein says:

> It is as a consumption good, and one that attaches to itself an honorific and prestige value, that education often manifests itself in backward economies. ...The growth of skills depends on the creation of a demand for skills. There will, of course, be a supply of

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[7]Harbison, p. 92.

[8]Ibid.

> of some skills always available since some of the education and training obtained as a consumption good will be transferable and utilizable as production skill, but to expand the pool of skills there is the prior necessity of creating an observable demand and anticipated rewards for such skills. The demand must come first.[9]

Overview of study--The need for reform of higher education. This study is not concerned with social, economic, or political reform, but with the reform of higher education as one aspect of total development. Since higher education is a primary source of needed trained and professional manpower, and yet is itself underproductive and uneconomic, it must be reformed. As implied above, the uneconomic nature of higher education in terms of kind of manpower trained, is somewhat a function of the social and economic environment. In this study concentration is on "higher education productivity" and its measurement. Emphasis is on "measurement" because further development of higher education productivity cannot be planned or managed without an accurate and sensitive measure of university effectiveness and efficiency.

"All societies which have learned how to grow have solved the problem of increased productivity in agriculture and the extractive industries, and the problem of social overhead capital."[10] Social overhead capital consists of public

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[9]Harvey Leibenstein, Economic Backwardness and Economic Growth, (New York: John Wiley and Sons, 1957) p. 140.

[10]Walt W. Rostow, The Stages of Economic Growth, A Non-Communist Manifesto, (Cambridge University Press, 1960) p. 21.

utilities, transportation and communication, law enforcement, and education. Before economic growth becomes the normal condition, per capita output must be increased. In order to increase per capita output, human resources must be developed. "At present rates of population growth and school production, the populace is on its way to becoming more rather than less illiterate, hence is becoming less economically able with the passing of each year."[11]

Overview--The objective of reform. The objective is a viable, functional, economically relevant higher education in partially developed nations. Higher education must increase its output of socially and economically useful graduates and it must do so at substantially reduced cost. It must become more productive in terms of quantity of output and in terms of cost per unit of output. To get at this objective it is not only necessary to develop and use means of measuring cost and of productivity, but also to determine the relationships between cost and productivity. In this study such measures are developed and applied experimentally to data obtained from national universities in five partially developed nations of Central America. Four measures of unit costs are defined:

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[11] Final Evaluative Report, Programa Interuniversitario, p. 9.

the cost per instruction hour, the cost per productive instruction hour, the cost per student contact hour and the cost per productive student contact hour.

Overview--The aims of the study. Specifically, the study is aimed at these basic questions: (1) What are the unit costs by class size? (2) What are the unit costs by type of instruction? (3) What are the unit costs by faculty (subject matter)? (4) What are the unit costs by level of instruction? (5))Are the factors of class size, type of instruction, level of instruction, or faculty, interrelated in their effect on cost?

CHAPTER II

CHARACTERISTICS OF PARTIALLY DEVELOPED NATIONS AND OF UNIVERSITIES IN CENTRAL AMERICA

The definition of a partially developed nation. Institutions of higher education in Central America, as elsewhere, interact with their environment. To fully understand the need for reform and its potential, it is necessary to have some knowledge of the characteristics, and of the background and development, of the institutions and of the countries which they serve.

A partially developed nation is one which has not yet learned how to grow economically. Economic growth is taking place when per capita output is increasing. GNP is increasing relative to population. To be sure, some nations have higher growth rates than others, and some are more developed than others. However, the turning point, the 'take-off' as Rostow calls it, is when economic growth becomes a normal condition. It is preceeded by a stage in which social values, institutional arrangements, and economic techniques impose a ceiling on per capita output.

Partially developed nations have certain characteristics in common, although groups of nations in different parts of the world also have their unique differences. Each nation may have its individual characteristics based on history,

geography, natural resources, its culture, and the period of world history during which it experienced partially developed status. For example, in the case of the United States, an entire culture was transplanted from countries in Europe, especially Great Britian, which were already on the way to becoming developed nations. The attitudes favoring the old traditional social, political, and economic structure were not transplanted. To the extent that they were copied, the environment of abundant land, other natural resources, and the psychology of the frontier discouraged their maintenance. By contrast, the conquest of South America by the Spanish took place over a century earlier, during a time when the traditional society was the only model available. The Spanish, and in Brazil the Portuguese, imposed an alien culture on the native population during the sixteenth century. The attitudes and the social and economic values of an old world traditional society were transplanted. The resulting economic structure was meaningful only to the conquerors. The Indians were not completely removed from participation in civic and economic affairs as in the United States, but neither were they assimilated into a comprehensible economic system. They remained outsiders in their own land. Even after political independence was achieved in the early part of the nineteenth century, European economic philosophy was still alien and incomprehensible to the indigenous population. The native born Spanish simply replaced the former European masters. In the

United States a political framework was developed within which individuals could understand and justify their actions. In Latin America a noncomprehensible system was accompanied by considerable political and economic confusion which, in some countries, has persisted to the present.

As the study of the problem of economic development has progressed, the relative importance of various factors has changed. During the first quarter of this century it was thought that natural resources played a key role in development and held the center of the stage. Then capital was considered the most important factor. Now there is increasing stress placed on entrepreneurial ability and investment in people as productive agents. Actually, just as there is a combination of factors which are responsible for a partially developed nation so there is a combination of factors which are responsible for growth and progress.

The characteristics of a partially developed nation. Perhaps the most obvious characteristic of partially developed nations is the relationship between population and output. Per capita output is usually miserably low. People live in the misery of semi-starvation and under-employment. The Malthusian doctrine appears to be verified. Output relative to population is where all the factors come to focus and make the difference between developed and underdeveloped nations. It is also obvious that either the rate of population increase must decline or the rate of investment must

increase in order that per capita output may increase. Social and religious attitudes sometimes impede the former and economic realities impede the latter. There has been much talk about birth control and increasing output per acre, and even of farming the sea. But as mentioned earlier, there is also the investment in man as a productive agent approach. The way to raise output per man is through providing him equipment and education. The present study is concerned with education and the problems relating thereto. Rostow suggests some of the problems related to providing equipment:

> To get the rate of investment up some men in the society must be able to manipulate and apply modern science and useful cost-reducing inventions. Some other men in the society must be prepared to undergo the strain and risks of leadership in bringing the flow of available inventions productively into the capital stock. Some other men in the society must be prepared to lend their money on long term, at high risk, to back the innovating entrepreneurs--not in money-lending, playing the exchanges, foreign trade or real estate--but in modern industry. And the population at large must be prepared to accept training for--and then to operate--an economic system whose methods are subject to regular change, and one which also increasingly confines the individual in large, disciplined organizations allocating to him specialized narrow, recurrent tasks.[12]

Social values and attitudes are often obstacles to growth and improvement. Albert Hirschman suggests that both the ego-focused image of change and the group-focused image are inimical to development. In the former, change may be conceived

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[12]Rostow, p. 20.

as possible for the individual while it is not visualized at all for the group. At first impression this sort of attitude might appear to be favorable for growth as each individual strives to improve his lot. But it runs counter to the ability to bring and hold together an able staff in a partially developed nation, and to handle successfully a host of other managerial chores. Hirschman says:

> Success is conceived not as a result of the systematic application of effort and creative energy, combined perhaps with a 'little bit of luck', but as due either to sheer luck or to the outwitting of others through careful scheming. The immense popularity of lotteries in the Latin American countries and the desperate intensity of the political struggle testify to the strength of the belief in, and desire for, change through sheer luck or through scheming, respectively.[13]

The group-focused image expects all change to bring collective benefits. While many community development projects are compatible with this image, it is incompatible with any large-scale transformation and modernization of an economy. Economic progress does not come about evenly on all fronts and benefit all sectors of the economy equally. The group feeling is so strong in some societies that a successful man is often overburdened with free loading relatives.

The partially developed society is predominantly agriculture. Land ownership is concentrated in the hands of a relatively few and is inefficiently farmed in small plots. The result is considerable underemployment in rural areas.

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[13]Albert O. Hirschman, The Strategy of Economic Development, (New Haven: Yale University Press, 1958) p. 16.

Development in the rural areas depends on land reform so that agricultural mechanization is feasible. The efficient utilization of machinery and agricultural science also depend on education. In addition, the release of manpower which mechanization makes possible, requires that urban opportunities become available to the released workers and that they have sufficient education to exploit the opportunities.

In the United States the exodus from the rural areas has been in progress for almost a century. It started when New England farmers found that they could not compete with the agricultural expansion into the Midwest which was accompanied by increased mechanization soon after the Civil War. At the present time only about 7 percent of the American working force is in agriculture.

Savings are small but there is usually a potential for greater domestic savings as is evidenced by luxury consumption of the rich, and by considerable amounts of time devoted to leisure by both rich and poor. The savings which are possible are not channeled in the most productive uses. They go into land purchase, foreign balances, or public buildings and churches instead of productive real capital formation. Insufficient savings and their inefficient use are as much a phenomenon, or result, of underdevelopment as a cause.

Effective competition is generally lacking. The spread between the prices received by farmers and retail prices is

great. Middleman profiteering is the rule. Financial institutions contribute to such profiteering by lending generously to such businessmen. The time involved is shorter and the risk is less than in more productive enterprises. Small scale, low volume, high unit-profit is the prevalent attitude toward business ventures. "While a 10 to 15 percent return on investment is typical in the United States, a 20 to 40 percent return is expected in Latin America."[14] This expectation tends to retard development in that today's opportunities are passed up in waiting for better ones tomorrow. The lack of effective price competition makes such profits and expectations possible.

Political instability and weakness often accompany partial development. "Many partially developed nations, including some in Latin America, have regimes composed of diverse mixtures of middleclass, military, and dynastic elements which have been subject to frequent changes as a result of topside seizures of power, sporadic revolutions, and general elections."[15] This condition usually has to be remedied before other necessary improvements are possible. Safety of property and sanctity of contracts are necessary pre-requisites for productive private enterprise to become established in long term, high volume, low unit profit projects. A strong stable central government can help provide social overhead capital

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[14]Wendell C. Gordon, The Political Economy of Latin America, (New York: Columbia University Press, 1965) p. 59.

[15]Harbison, p. 75.

which consists of education, law-enforcement, and public utilities; so necessary for development.

Of all the factors responsible for a transition from a traditional society to take-off, Rostow believes that political stability is the most crucial.

> In many recent cases, although the period of transitions saw major changes in both the economy itself and in the balance of social values, a decisive feature was often political. Politically, the building of an effective centralized nation state--on the basis of coalitions touched with a new nationalism, in opposition to the traditional landed regional interests, the colonial power, or both, was a decisive aspect of the pre-conditions period; and it was, almost universally, a necessary condition for take-off.[16]

Government may also provide the means to acquire real capital if the resources are available although savings are not. The government may create the necessary legal-tender.

> What matters is the real wherewithal to provide real capital. If the country has the labor, the technology, and the raw materials necessary for the production or providing of the capital, there is no intelligent reason why it should be deterred from producing the capital merely because of lack of prior, voluntary, personal, monetary saving. Of course the country may effectively be deterred from producing the capital by institutional inhibitions, or by unwillingness to reallocate resources, and by scarcity of the resources in an absolute sense.[17]

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[16]Rostow, p. 7.

[17]Gordon, p. 223.

In any economic system however, real capital investment must be matched by real saving. The effective real saving to match the real capital creation would have to come from the reallocation of some resources which would otherwise produce consumer goods or otherwise remain idle. It is the idle resources, undeveloped natural and human resources, which are most plentiful in a partially developed country. The effective use of this technique requires a strong and responsible government. Otherwise it could get out of hand and become disastrous. It could result in inflation and undermine progress already achieved. The commercial banking system could also create the legal tender, or bank credit as it would be called, to provide the necessary funds. However, in a partially developed nation banks may not be able to, or wish to extend the necessary credit; or enterprisers may not take the initiative to use the credit which is available.

The last but not least important characteristic of a partially developed nation is the illiteracy of its people. In very short supply are scientific, professional, and technical personnel of all kinds. The most critical shortages are in the sub-professional categories of engineering and agricultural technicians, nurses and medical assistants, secondary school teachers, industrial supervisors, and senior craftsmen.[18]

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[18]Harbison, p. 79.

Characteristics of the Central American National University. Universities in Latin America were founded early in the history of higher education and soon after the discovery of the New World. The University of Santo Tomas de Aquino in Santo Domingo was the first in 1538.

> Throughout the colonial period the Spaniards were trying to set up American copies of Salamanca, with the four traditional faculties of theology, law, arts, and medicine. The arts faculty, furthermore, taught the seven liberal arts of the trivium (grammar, rhetoric, and logic) and the quadrivium (arithmetic, geometry, music, and astronomy) in strict adherence to the medieval tradition.[19]

As was true of most universities of the time and through the eighteenth century, the main purpose was the training of clergymen. Second in importance was training in law, medicine, and the arts. The civil functionaries were trained in law. Medical training was considered necessary and important but the lack of trained physicians in the colonies and the distrust of science by church authorities were deterrents to its growth. After the revolutions against Spain, early in the nineteenth century, the faculties of theology were reduced in importance, The faculties of law and medicine began to rank higher.

The following brief historical accounts of two Central American universities are typical:

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[19]Harold Benjamin, Higher Education in the American Republics, (New York: McGraw-Hill Book Co., 1965) p. 12.

> The National and Autonomous University of San Carlos of Guatemala (1676) is the parent institution of Central American universities, and during the colonial period it educated many important leaders of the Central American states. Until 1944 the University was directly subordinated to the President of the Republic through the Ministry of Education. In this Napoleonic model, it was merely the capstone of a national school system. In 1944, the revolutionary junta which had just taken over the government gave the University autonomy, re-establishing its historic name and its control over its own income.[20]

> The University of Costa Rica was founded in 1843. Although it was started by liberal and democratic groups, it held to the old colonial tradition in its organization and methods during most of the nineteenth century. ...In 1888 Congress abolished the University because it had not set up the required faculties, because current conditions in the country did not favor a scientific research center, and because the School of Law could give all the instruction the student wanted. The University was re-established in 1890. ...In 1941 it had eight faculties and in 1961 twelve faculties.[21]

The type of organization, control, and method of finance, also have their roots in the past. "All universities in the world today are descendants of the twelfth-century universities of Paris and Bologna. In Paris, the universitas was the corporation of masters; in Bologna, it was the corporation of students."[22] These two types have been modified; as in the United States, the corporation of masters has given way in

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[20] Ibid., p. 28.

[21] Ibid., p. 27.

[22] Ibid., p. 47

matters of general policy to lay boards representing the university's constituency. In Latin America, the corporation of students, in varying degrees, shares control with the faculty and professional associations of the country.

Control of the Central American university is vested in a combination of the university assembly, the university council, and the rector. The assembly is sometimes the supreme authority of the institution, the council is concerned with administration and supervision, and the rector is the executive officer of the assembly and the council.

In the case of the University of San Carlos of Guatemala, the council is composed of the rector, the deans, a representative of each professional association of the country, and a student delegate from each faculty. The electoral board, performing the function of an assembly, consists of the rector, five professors and five students from each faculty, and five professionals from each professional association.

The government of the University of El Salvador is similar to that of San Carlos. The assembly membership is smaller, consisting of two professors from each faculty, two representatives of the professional association of each faculty, and two students from each faculty.

> The National Autonomous University of Honduras has what is called the system of university "co-government". This provides a representation of students on all university bodies equal to the combined

> representation of professors and professional representatives.[23]

The universities of Central America have constitutional guarantees, in varying forms, for their financial and administrative autonomy. The financial provision varies from 2 percent of the general national budget for the University of San Carlos of Guatemala to 10 percent for the University of Honduras. The University of Costa Rica gets 10 percent of the annual budget of the Ministry of Public Education.

> The University of San Carlos of Guatemala, by decrees of 1944, had its ancient autonomy confirmed and was assigned its own sources of income for its financial autonomy. The Constitution provides that not less than 2 percent of the general national budget shall be given to the University for its operation, development, and expansion.
>
> The Constitution of Costa Rica guarantees the autonomy of the University and provides that the state shall give the University of Costa Rica the authority to handle its own finances. The Constitution provides further that the University shall receive each year a sum not less than 10 percent of the annual budget of the Ministry of Public Education.[24]

This autonomy has both desirable and undesirable consequences. Freedom from undue outside interference in the internal affairs of the university is desirable but the lack of accountability to a public body may encourage inefficiency and indifference to the needs of the community. There is frequently a

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[23] Ibid., p. 113.

[24] Ibid., p. 118, 119.

lack of cooperation between universities in Central America and the government ministries responsible for education. This situation coupled with many part-time professors contributes to a lack of interest in, and direction for needed reforms.

The financial provision imbedded in the constitutions lacks flexibility and substitutes an arbitrary formula for legislative judgement. Whether the provision is too much or too little seems to be immaterial. The wording which provides that 'a sum not less than' is probably the saving feature.

The lay boards in the United States are sometimes criticized because the members are not sufficiently well acquainted with education. In some cases this may be a valid criticism. Faculties strive for more participation in administration and many would no doubt welcome complete autonomy. The experience in Central America suggests, however, that a public institution should probably be subject to some public control. The Final Evaluative Report has the following comment:

> The Central American national university is comprised of an aggregate of semi-autonomous schools. It lacks a strong, effective central administration; moreover, its governing board is responsive to no outside control (except fiscal controls) and is held accountable by no public body for its behavior.[25]

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[25] Final Evaluative Report, p. 11.

Benjamin lists three objectives of higher education in Spanish America as being: (1) the preparation of students for the learned professions, (2) scientific research, and (3) service to the universities' areas. In the recent past too much emphasis has been put on professional training as compared to technical training for sub-professional work. Research and service go hand in hand. The research should relate to the particular society and conditions within it. Central American universities have not taken enough responsibility for this type of effort and thus are not providing leadership for social improvement.

Production in terms of kinds of graduates is largely unrelated to the needs of the economy but progress is being made in offering more diversified programs. Among the five universities, eighteen different programs are now available, although some, such as Fine Arts, Microbiology, and Social Services are available only at the University of Costa Rica, and Geology is available only at the University of El Salvador.

A positive note has been added with the establishment of the Central American University Council. The Council has formed a Technical Commission for Regional Planning. It has taken steps to integrate the educational resources of the region and avoid unnecessary duplication. It has also recommended that each university establish a program of general studies. This should contribute to useful educational output while the specific needs or demand of the economy are still undetermined.

Student enrollment and achievement. Student enrollment in the five Central American universities averages about 1.3 per 1,000 of general population. The University of Costa Rica is an exception with about 3.3 per 1,000 population. Costa Rica is also an exception among the Central American countries in the composition of its population. Its population is 97 percent white as compared with the other countries whose populations are mostly Mestizo and Indian. The white population is of Spanish descent. The Indian is the native Central American and Mestizo refers to the population resulting from inter-marriage. The following table shows the composition of population by country according to various census data available as reported in the Encyclopedia Britannica.[26]

	White	Mestizo	Indian
Costa Rica	97.7%	---	---
El Salvador	8.0%	92.0%	---
Guatemala	5.0%	36.0%	54.0%
Honduras	---	90.0%	7.0%
Nicaragua	20.0%	80.0%	---

Graduates of the universities in ratio to student enrollment are very low by comparison to universities in the United States. In 1960, for example, the University of Costa Rica had one graduate per 22 students enrolled. The ratio varied a great deal among faculties, all the way from 1 out of 5 in Dentistry, and 1 out of 6 in Education, to 1 out of 90 in

[26] Encyclopedia Britannica, (Chicago: Wm. Benton, 1966) Vol. 5, p. 134.

Economics and 1 out of 100 in Social Service, in the same year the ratio at the University of El Salvador was one graduate per 36 enrolled. This information is based on enrollments and graduates for 1960.[27] It indicates a high dropout rate for some faculties.

The time spent in achieving the successful completion of courses and graduation is also greater than normally required in North American universities. The Index of Academic Achievement is a measure of the rate of academic progress developed by Friedman and Hereford in a case study of the University of San Carlos of Guatemala. It is an expression of the number of calendar years spent by a student in order to complete one year of course work. An index of 1.0 means that the student completed a years work in one year. An index of 2.0 means it took two years to complete one year of work.

> If one adopts the definition that the only "successful" full-time student is the student who completes his courses in no more than the number of years scheduled in his carrera, there were only 466 successful full-time students among the 5,036 who re-enrolled in 1963; 9.25 percent of the total.[28]

Fifty-nine point seventy-one percent of the total had an index of 2.0 or below and 40.29 percent from 2.0 to 10.00. The index varies a great deal among faculties. For Veterinary

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[27] Benjamin, p. 124.

[28] IIME Staff Report, A Case Study: Academic Progress of University Students, University of San Carlos of Guatemala, 1963, (Published by Michigan State University and IIME) p. 47.

Medicine it was 1.11, for Law 2.16, Accounting and Auditing 2.74, and Business Administration 3.25.

It is apparent that productivity in higher education can and should be improved. Additional funds and more resources devoted to higher education would be helpful but that is not feasible in the immediate future. A better utilization of available resources may be feasible. Unproductive efforts should be remedied or dropped. The limited resources should be concentrated on the most productive efforts. In order to do this the relationship between resources invested and the results obtained must be determined. The key to this is an appropriate new measure of productivity.

CHAPTER III

DEFINING AND APPLYING COST ANALYSIS IN HIGHER EDUCATION

Input and output defined. In this chapter a formula is developed which relates productivity of institutions of higher education to the cost of input. The most obvious measurement of input is the enrolled student. This, however, does not take into account part-time students, therefore a more accurate measure is contact hours with students. Let (H) equal classroom and/or laboratory contact hours per student and (E) equal student enrollment per class or lab, then H X E, student contact hours times enrollment, incorporates both units into a simple formula. Let (C) equal cost, then input cost is equal to $\frac{C}{H \times E}$.

Productivity or output may consist of many things and may mean different things to different people. The most useful concept of output for the present study is the "successful student". A successful student is one who passes the required examination for a course. A sufficient number of courses successfully passed is one requirement for graduation. The formula developed herein is concerned only with the passing of a particular course or courses. The course is the least

common denominator among different schools, faculties, departments and levels of instruction. It is a flexible unit which makes various comparisons possible within a college and among colleges. Let (A) represent output of successful students and (A^1) students who are successful at the first opportunity. In Central American universities students may have more than one opportunity to pass course examinations. Let (C) equal cost so that C/A equals cost per successful student, or one rough measure of university productivity.

Neither C/A nor C/ H X E gives a fully satisfactory measure of 'productive' input. The latter is an input cost only which does not take into account output. As noted later in this chapter this type of measurement has been used for over fifty years with variations of the input unit. This unit may be the student, the full-time-student equivalent, the student-contact-hour, the student-credit-hour, or the term-credit-hour.

Developing the formula. The present study of Central American universities is concerned with a measure of that portion of all input which realizes a useful output, namely, a successful student. This proportion may be expressed as A/E or the proportion of all enrolled students who become in fact successful students.

This input cost, cost per contact hour or C/ H X E may be modified to include an output measure, the success ratio

of A/E. Hence, (H X E) (A/E) becomes a measure of productive input. Specifically, it is the productive proportion of all contact hours that the university invests in a given period. One may observe that this measure reduces arithmetically to H X A, or contact hours with successful students. Cost per productive input or productive contact hour becomes C/H X A. This remains, conceptually, an input measure times a success ratio. If cost represented total instructional cost and included overhead such as general administration, library facilities, and operation and maintenance of the physical plant, then cost would be a function of the total enrollment and would reflect total inputs. Even with the cost figure limited as it is in this study to faculty salary, the formula is a useful measure of productive contact hours.

An alternative approach may be used where the success ratio is applied in a similar formula to instruction hours alone. Then (H) equals total course instruction hours and (A/E) equals the productive ratio or success ratio. H(A/E) is equal to that proportion of all university investment in instruction hours that proves to be productive of successful students. Cost per productive instruction hour may be expressed by the simple formula: C/H(A/E).

The symbols and definitions used throughout this study are summarized as follows:

C = Cost (Expenditure on faculty salary)

H = Total hours of instruction in classroom and/or laboratory

E = Total enrollment

A = Total successful students

H X E = Contact hour with students. A rough measure of institutional input

A/E = Proportion of successful students to enrollment (Productivity)

(H X E) (A/E) = Productive contact hour or productive input

H(A/E) = Productive instruction hour

An economic definition. The purpose of the formula is to relate input of factors of production or resources, in this case contact hours with students, to the output of successful students; and to express this relationship in economic terms. Cost per student, cost per contact hour, cost per productive contact hour, or cost per productive instruction hour, express an economic relationship. In order to discover ways to increase economically useful output at reduced cost, it is necessary to study unit costs and their relationships.

It is not possible to measure all the benefits of education in economic terms but that should not preclude measuring that which can be measured. Alice Rivlin, writing in Economics of Higher Education, has a pertinent observation on this point.

> Just because we cannot measure all of the cultural and spiritual benefits of education is no excuse to ignore what we can measure and preclude all objective thinking about costs and benefits in education. All resources used in education are measurable in physical units and their monetary equivalents. Since these resources are limited it makes sense to think about their efficient use in achieving the measurable benefits of education as long as they are not taken too seriously and the immeasurable benefits are not forgotten.[29]

Unit cost analysis in the United States has a long history but very little progress has been made in relating costs to benefits. Educators in partially developed nations are not in as favorable a position as United States educators relative to available resources. They must think objectively about the costs and benefits if they wish to make the most efficient use of scarce resources. Before considering the case of partially developed nations further it might be well to look at unit cost measurement in the United States.

Unit cost measurement in higher education in the United States. In early United States studies where costs were emphasized, the cost varied by (1) the student, (2) student-credit-hour, (3) student-contact-hour, (4) student recitation hour by subject matter, (5) student by level of instruction, primary-secondary-higher education, (6) types of institution,

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[29]Alice M. Rivlin, "Research in the Economics of Higher Education: Progress and Problems," Economics of Higher Education, U. S. Department of Health, Education, and Welfare, Office of Education, 1963, No. 5, p. 359.

and (7) size of enrollment. These variances, however, not revealing of institutional output, have limited utility in partially developed nations. The literature surveyed covers a fifty-four year period from 1912 to 1966. Much of the cost literature is repetitive and deals only with input cost. In 1935 the National Committee on Standard Reports for Institutions of Higher Education brought unit cost measurement up to date and formalized the procedure. Very little interest in cost analysis was evident during the 1940's but a renewed interest developed in the 1950's. Only in the present decade however, has this interest turned toward output and productivity measurement. The following selection of educational surveys show some of the various units of measurement and bases which have been used in arriving at unit costs.

In a study of Massachusetts state normal schools for the academic year of 1912-13, the United States Bureau of Education determined costs per student under six categories; salaries, supplies, furnishings, utilities, repairs and improvements, and grounds.[30]

The State Board of Public Affairs, in a December 1914 report, of a cooperative survey of the conditions and needs of Wisconsin's normal schools, used the cost of instruction per student recitation hour by subject matter.[31]

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[30]United States Bureau of Education, Bulletin, 1916, No. 12, p. 76.

[31]Conditions and Needs of Wisconsin's Normal Schools, Report of Cooperative Survey, State Board of Public Affairs, December, 1914.

The report of the Survey Commission of the University of Minnesota for 1920-21 showed student credit hour cost by department, college, and by course in some colleges. The Commission included the following comment concerning the magnitude of the problems forty-five years ago. "The problems which American democracy faces at the present time are the most gigantic and overwhelming, the most numerous, complex, and intricate, the most baffling and elusive that any generation has ever faced."[32]

An Indiana legislative resolution of 1921 called for an educational survey. Among other things it was to investigate and determine the cost per student of those attending the schools of the state, including primary, secondary, and advanced institutions of learning. It is interesting to note an observation made in the report concerning cost analysis.

> Objection is often raised at any attempt to determine the cost per student at a university on the ground that this is an attempt to evaluate an item whose value cannot be measured in dollars and cents, but such a statement is comparable to objection to segregating medical bills in a family budget on the theory that such expenditures measure the value of good health.[33]

Cost per student, according to size of enrollment of junior colleges, was reported in 1924 by Leonard Koos. The

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[32]Report of the Survey Commission, University of Minnesota, 1920-21, Vol. XXV No. 7, April 20, 1922.

[33]Financial and Statistical Studies of Indiana University, Purdue University and Indiana State Normal School, A Preliminiary Report to the Indiana Education Survey Commission, p. 3.

cost per student hour was compared among junior colleges of different sizes and among four-year colleges and universities.

A Missouri study, 1939, also stressed cost per student according to size of enrollment. It showed the relative expensiveness of small schools. With the same curricular offerings, the cost per student was much more for the small school than the larger school.[35]

In 1935 Russell and Reeves correlated expenditures per student and selected criteria of excellence. They found a positive correlation between expenditures per student and (a) the rating given faculty, (b) the rating given personnel service, and (c) the rating given administration.[36]

Cost analysis procedure as recommended by the National Committee on Standard Reports for Institutions of Higher Education in 1935 is the standard work on unit costs. The following is a summary of the recommended procedure.

Adequate and accurate records are, of course, a prerequisite. Furthermore, if costs are to be compared among

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[34]Leonard V. Koos, The Junior College, University of Minnesota, 1924.

[35]Report to the State Survey Commission on Publicly Supported Higher Education in the State of Missouri, Institute of Educational Research, Teachers College, Columbia University, November, 1929.

[36]John D. Russell, Floyd W. Reeves, The Evaluation of Higher Institutions, Vol. 7 Finance, The University of Chicago Press, 1935, p. 101.

institutions, they must be computed according to identical procedures and from standardized reports. Three main factors are involved. They are (1) the base, (2) the time period, and (3) the unit employed. The base may be the entire institution, the major divisions, departments or curriculums, the instructional level, or courses offered. The financial and enrollment data apply to a definite time period such as the quarter, the semester, or the academic year. The unit employed may be the student enrolled, the full-time-student equivalent, the student-clock-hour, the student-credit-hour, or the term-credit-hours.

Expenditures are divided between non-instructional and instructional purposes. The latter consist of two main categories, teaching costs and overhead costs. Teaching costs are computed on the expenditures that apply specifically to the classroom and laboratory instruction of students. They are: teaching salary costs, cost of supplies, materials, and equipment replacements. The portions of the salaries of faculty members that represent time devoted to activities that are not strictly classroom teaching, such as research and committee assignments, are excluded. However, to the extent that research and committee assignments are deemed to be related to and contribute to the teaching function they may be so included. Otherwise, they are properly included under non-instructional expenditures. Overhead costs include: (1) general administrative expenses of the institution, divisions,

and departments; (2) library facilities; and (3) the operation and maintenance of the physical plant.

The expenditure of the president's office and of the business office should be allocated between non-instructional and instructional functions on the basis of the estimate of the president and the chief business officer. Other administrative office expenditures such as the registrar, placement, student health, entrance examinations, commencements, convocations, general publications and printing should be charged directly to the instructional function. After the total institutional administrative expenditures have been allocated to instruction, they are then allocated to the divisions and thence to the departments. They may be allocated on the basis of two factors, equal weight being given to each, namely, budgetary expenditures and student-credit-hours. Total administrative expenditures divided by total student-credit-hours provides a pro-rating factor based on student-credit-hours offered in each division and department.

In most cases, the total expenditures for library facilities can be charged directly to instructional functions. The expenditures are allocated to divisions and departments on the basis of student use of facilities. If it is impossible to determine use by objective studies, then an allocation may be based on departmental expenditures for books or on student-credit-hours offered by departments.

Costs for operation and maintenance of the physical plant are allocated on a basis of square-foot-hours of space used for non-instructional and instructional purposes, each department being charged for actual square-foot-hours of space used.

With costs so assigned to each division or department the total costs divided by the total student-credit-hours or contact hours offered provides the division or departmental cost per credit or contact hour.

With teaching costs and overhead costs distributed to the various departments, the selection of a base and determination of its unit costs may proceed. The selection of the base suggests the unit to be employed. For example, the full-time-student equivalent might be a satisfactory unit if the institution as a whole is the base, but it would not be satisfactory for a department since some departments offer more credit hours per student than do other departments. For general use the student-credit-hour or the student-clock-hour are most satisfactory since they indicate the amount of classroom contact time with the faculty.

Costs for the instruction of students in the various curricula are based on the costs determined for each department. The number of credit hours or contact hours taken in each department. The number of credit hours or contact hours taken in each department times the departmental cost per credit or contact hour is the cost by department. Total costs

for the curriculum so arrived at divided by the total contact hours in the curriculum provides the cost per contact hour for that curriculum.

Costs for various student achievement levels may be obtained by multiplying departmental credit or contact hour costs by the number of hours taken in each department. Total costs for an achievement level divided by the total contact hours on the level provides the cost per contact hour for that level of achievement.[37]

The procedure outlined above represents an efficient allocation of costs among departments, levels of achievement, or curricula, but it does not relate cost to institutional productivity. A formula for relating cost to productivity has not been developed which could be applied to the needs of institutions in partially developed nations. The idea, however, has been suggested in previous studies. For example, in 1931 the California Taxpayer's Association reported on a survey of the University of California which included the following comment: "The enrollment hour may be said to measure the condition at the beginning of the semester, while the unit granted measures results obtained at the end of the semester."[38]

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[37]The National Committee on Standard Reports for Institutions of Higher Education, Financial Reports for Colleges and Universities, (The University of Chicago Press, 1935).

[38]California Taxpayer's Association, Report on University of California, (775 Subway Terminal Bldg., Los Angeles, California, 1931) p. 33.

The procedure recommended by the National Committee on Standard Reports was used as a model in an analysis of the unit costs of instruction of nine universities conducted by the United States Office of Education in 1937. The study was reported in the U.S. Office of Education Bulletin 21 by John H. McNeely, a specialist in Higher Education.

In more recent literature the procedure is still referred to as a standard. John Dale Russell and James Doi in "Analysis of Institutional Expenditures", College and University Business, October, 1955, make reference to it.

The literature of the 1960's puts more emphasis on measuring productivity with a view toward increasing it than on the distribution of costs in arriving at unit costs. Several contributions to a seminar on the economics of higher education are of interest. Kenneth Deitch, a student at Harvard College, developed a resource substitution chart in which hypothetical marginal returns were assigned to resource variables in an effort to show a method by which the most efficient allocation of resources could be made. In concluding remarks he said:

> It should be eminently apparent by now that the measurement of benefits is the most problematical issue in this entire analysis. My own general impression is that research will yield meaningful results which, if they are less than perfect, will still be a better solution than the alternative of making no effort to measure benefits systematically whatsoever. It seems to me then that educational institutions could profit from pursuing this line of inquiry in a systematic fashion.[39]

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[39]Seymour Harris (Ed.), Higher Education in the U.S., Harvard University Press, Cambridge, Mass., 1960, p. 198.

Alvin Eurich, Vice-President for The Fund for the Advancement of Education, suggested better utilization of educational plant and human resources, particularly faculty. He advocated reduction of courses made available and the use of teaching devices. He observed that: "The profession of teaching is the only profession in American society that has been untouched by the revolution that has transformed agriculture, industry, and all the other professions during the past fifty years."[40]

John M. Evans, Fiscal Vice-President, University of Connecticut, and John W. Hicks, Assistant to the President, Purdue University, observe that: "Cost figures best serve as indicators of where thought and consideration may be needed. In themselves, they can be no specific guide to action."[41] In their analysis they used cost per student enrolled as the unit of measurement and individual courses as the base.

Tyndall and Barnes state in the Winter 1962 issue of The Journal of Experimental Education that the Student Credit Hour is the best available index of 'output' of the teaching function.[42]

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[40] Ibid., p. 187.

[41] John M. Evans, John W. Hicks, "An Approach to Higher Educational Cost Analysis," Studies in Higher Education No. 91, Purdue University Division of Educational Reference, p. 25.

[42] Gordon Tyndall, Grant A. Barnes, "Unit Costs of Instruction in Higher Education," Journal of Experimental Education, Vol. XXXI, No. 2, Winter 1962, p. 115.

Another example of recent though on output and productivity is from Charles S. Benson:

> From the economist's point of view, only as school systems go beyond the measurement of productivity to study the contributions of specific inputs (various types of human services and various types of physical goods) to educational ends, i.e., to explore the interrelations between inputs and outputs, can productivity advance in education be assured.[43]

Harry Williams, Assistant Director for Economic Studies, Institute for Defense Analyses, suggests an 'iterative analytical process' which may be regarded as: "An attempt to equalize the value of the last increment of any resource expended in any direction in which resources are used."[44] This suggested process is in connection with program budgeting and is intended to focus attention on alternatives in the use of resources and comparison of the increment or payoff in terms of student class hours or research hours. "The latter are indicators of outputs and can be compared with inputs which consist of resources such as personnel, space, and equipment."[45] It would appear that this would amount to a measure of input cost such as C/H X E.

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[43]Charles S. Benson, The Economics of Public Education, (Boston, Houghton-Mifflin Co., 1961), p. 336.

[44]Harry Williams, Planning for Effective Resource Allocation in Universities, Commission on Administrative Affairs of The American Council on Education, Washington, D.C., 1966, p. 4.

[45]Ibid., p. 55.

An operational definition. It is possible to define cost and productivity of education in terms which can be measured in partially developed nations, Cost is limited to an expenditure on faculty salary because other data are scarce and undependable. Adequate and accurate records, as mentioned above, for all the teaching and overhead costs are just not available. Even if additional cost information were readily available it probably would not lend itself to making comparisons among institutions of several different countries. Such comparisons would depend upon identical procedures and standardized reports. Even in the United States accurate and standardized cost information is not readily available. The additional cost information is really not necessary to investigate the relationships in which we are interested. Faculty salaries constitute the bulk of instructional cost and probably have more bearing on educational outputs than other costs. A 1956-57 survey of higher education in Michigan by John D. Russell and associates revealed that expenditures for the four functions associated with instruction amounted to 58 percent for classroom instruction, 15.9 percent for administration, 15 percent for plant operation and maintenance, and 4 percent for libraries.[46] In an article reported in the

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[46]John Dale Russell, Higher Education in Michigan, 1958, p. 80.

In an article reported in the Journal of Experimental Education, Tyndall and Barnes indicate that the most important single cost identified with instruction is the salary of the teacher.

> Allocations of general administration, library, maintenance and operation of plant, can be made but for purposes of attention directing and problem solving it is not necessary. The more complete figure is usually less useful than on which eliminates indirect costs.[47]

Productivity is measured by the output of successful students. This may not be a measure of all the benefits of education but it is a measure of an output economically useful to society. Professor James Buchanan, a recognized scholar in public finance, says:

> An 'efficient' allocation of any scarce resource is defined as one that maximizes the useful return or output from any given total input. This elementary definition is completely general, and it may be applied to an oil furnace, a gasoline engine, a nuclear power plant, a church organization, the operation ofaa firm, or the housewife's trip to the supermarket. In each of these cases, some meaning may be attached to the term, 'useful output', be this, BTU's horsepower delivered, kilowatt hours, souls saved, the present value of a profits stream, or family utility.[48]

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[47]Gordon Tyndall, Grant A. Barnes, p. 115.

[48]James M. Buchanan, The Public Finances, (Homewood, Illinois: Richard Irwin, 1965), p. 222.

Just as horsepower delivered and kilowatt hours are useful outputs, so successful students are socially useful outputs.

L. E. Hull, Assistant Director of the Bureau of Institutional Research at Indiana University lists a number of undesirable characteristics of unit-costs as they are now used.

1) All cost-study data are quantitative, not qualitative. They can't say anything about the quality of teaching, they equate all contributions to a cost figure.
2) Quantitative measures are not accurate. It is difficult to measure the time spent by the staff on various functions.
3) They may imply that cost and efficiency are the most important aspects of the educational climate, neglecting the climate itself.
4) Instructional costs may be distorted due to having all costs charged to classes or courses as the unit.
5) Cost study data may lead to faulty interpretations, misuses, may attempt to compare units, courses, curricula that are not comparable in nature.
6) Cost studies may lead to abuses from excessive zeal in reducing costs, whereas basic differences of departments and faculty must be taken into account.

What has been said here is that there are dangers in cost studies as they are currently constructed and used. It should be stated in conclusion, however, that the positive benefits of cost studies far

> outweign their disadvantages. The need is for more refinement in their construction, more understanding of their nature, and more intelligence in their use.[49]

The refinement suggested in this study is in the unit of measurement used. The most useful unit is defined as productive input, that input which produces desired and economically useful output, namely a successful student. This may be expressed as: (H X E) (A/E) where A/E is the proportion of students who are successful. The unit cost becomes: C/(H X E) (A/E) = C/H X A = cost per productive input or productive contact hour. The success ratio, A/E may also be applied to instruction hours (H) so that the cost per productive instruction hour is expressed as C/H (A/E).

Applying the formula. The formula may be applied analytically to explore effects, if any, of different administrative conditions within the university upon costs of various divisions in the university. A determination of the cost per productive instruction hour among courses will direct attention to those areas where appropriate questions may be raised concerning the differences in productivity. The study is particularly concerned with discovering the relationships, if any, between:

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[49] L. E. Hull, "Pitfalls in the Use of Unit-Cost Studies," Journal of Higher Education, Vol. XXXII No. 7, October, 1961, p. 376.

1) Class size and cost per productive instruction hour and cost per productive contact hour for each university and for selected faculties within each university.
2) Level of instruction and cost per productive instruction hour and cost per productive contact hour for each university and for selected faculties within each university.
3) Type of instruction and cost per productive instruction hour and cost per productive contact hour for each university and for selected faculties within each university.

Procedure for arriving at cost and productivity figures for each class size, level of instruction, and type of instruction: Cost per instruction hour, for example, was determined for each class in a given class size, this unit cost for each class was totaled for all classes and divided by the number of classes, hence the cost per instruction hour for a given class size is the mean of all such costs for individual classes. Productivity, A/E, was determined for each class in a given class size, on a given level of instruction, or for a particular type of instruction. The productivity for all classes in a category was totaled and divided by the number of classes, hence the productivity arrived at is a mean for all classes in a given category of class size, level of instruction, or type of instruction. The figure for each measure, cost

per productive instruction hour, cost per productive contact hour, or cost per contact hour, was arrived at in a similar manner.

Instrumentation. The present study is concerned with data on the national universities of Central America for the academic year of 1962-63. These data were collected during 1963-64, the last of which were not available until July 1964. The reason for this is that examinations are offered at least three different times. The first time, at the end of the course, normally November 1-15, again two months later, January and February, and eight months later, June and July. Students may also take examinations at a subsequent date up to eighteen months. Hence, a course offered in 1962 technically is not completed until the last student who so chooses is examined. Course data, therefore, may not be completed until eighteen months or so following the termination of instruction.

The inventory used to gather the data was developed by the IIME staff and a copy of the instrument is found in Appendix D of this study. Data found on the completed inventory allows one to appraise the institution by looking at the several variables, such as class size, instructional hours, instructional cost, number of matriculates, number of successful students and combining the variables to show, for example, cost productivity relationships as well as others.

Procedure in the collection of data. Teams of IIME staff members went to each of the five Central American national universities and stayed from seven to ten weeks during which time they consulted all primary sources and documents available in offices of University Registrars and Faculty Secretaries. When the data was not sufficient to allow complete information to be obtained on a course, the staff conducted personal interviews with the various faculty members in order to ensure the accuracy and completeness of the data sought. These data were then listed by course, department, university, year, etc. These listings of data concerning course information were then verified faculty by faculty in each university for accuracy and completeness by the IIME staff. These inventories, mentioned above, were coded for punch cards and transferred to IBM cards for analysis.

Currency factor. In each of the five countries of the national universities a different national currency is used. Each currency may be converted into another currency at the official exchange rate. The cost figures used herein are in United States dollars, having been converted at the following rates. One U.S. dollar is equal to:

6.625 Colones in Costa Rica

1.000 Quetzales in Guatemala

1.998 Limpiras in Honduras

7.14 Cordobas in Nicaragua

2.5 Colones in El Salvador

There is a disparity in salaries among the countries which makes inter-university cost comparisons unreliable unless this is taken into account in the interpretation of results. Real cost, the cost in terms of what the local currency or the United States dollar will buy in goods and services in each country will also vary as the price level varies in each country. Even though each currency is converted into U.S. dollars it doesn't mean that a dollar will buy equal quantities of goods and services in each and every country.

CHAPTER IV

CLASS SIZE AND COST/PRODUCTIVITY

Cost/productivity relationships. In this and following chapter the relationships between class size, level of instruction, type of instruction and cost/productivity are examined for each university and for selected faculties within each university. It is possible, within certain limitations, such as resources available, enrollments, and subject matter, to change class size and type of instruction. It is desirable to make those changes which are possible and which will increase productivity relative to cost. In order to determine which changes may improve the cost/productivity ratio it is necessary to study the data available on present performance.

Cost/productivity measurement. In the data analysis which follows four measurements are used. They are: cost per instruction hour, cost per student contact hour, both measures of input cost, and cost per productive instruction hour and cost per productive student contact hour, both of which are measures of productive input or institutional output. It is desirable to use the input and output measures together for comparison to see how they vary with each other as class size changes. The more productive the class size the closer the output cost should be to the input cost.

Where C/H X E is input cost and C/H X A is productive input cost, the nearer A, successful students, is to E, enrollment, the closer the two cost figures will be. Cost per instruction hour and cost per productive instruction hour do not reflect differences in enrollment or class size as the student contact hour measures do. Productivity difference is the major reason for cost per productive instruction hour to vary. Cost per productive instruction hour C/H(A/E) will be greater than cost per instruction hour C/H but will approach the latter as productivity increases.

Hypothesis. It is to be expected that productivity would be greater in small classes but that the productive unit cost would be comparatively high. On the other hand, since the cost is spread over more students, it is to be expected that the productive unit cost would be comparatively lower in large classes although productivity is less.

Data analysis-class size by university. The data, reproduced in Tables I through V, show that productivity is greater in the small classes relative to the productivity in the larger classes. Therefore, the smaller classes tend to show a lower cost per productive instruction hour than larger classes. There is, however, some variation since cost per instruction hour and cost per productive instruction hour are functions of the different hours, costs, and success ratios in the different class sizes.

The lowest cost per productive instruction hour at universities A and D is in the class size 0-9. At university C it is in class size 30-49, and at universities B and E it is in class size 10-19.

The larger classes show a lower cost per productive contact hour. This measure is a function not only of hours, costs, and the success ratios but also of enrollment. The enrollment factor overtakes the decreasing productivity factor in producing the lower productive student contact hour cost in the larger classes. Again there is some variation,, the largest class does not consistently produce the lowest unit cost since the blend of hours, costs, and productivity varies among class sizes.

At university A, class size 150 plus; produces the lowest cost per productive contact hour. Size 80-109 and1110-149 also have a low cost figure. At university B size 80-109 has the lowest cost per productive contact hour. At university C it is the lowest in size 150 plus. At university D it is lowest in size 110-149 and at university E it is lowest in class size 80-109.

In terms of output per dollar spent, the larger classes are the most economical. But in terms of output per student enrolled, the smaller classes are the most productive. The question arises as to which resource to conserve, dollars or students. The dollars represent productive resources used to

convert students, which represent a raw material resource, into a socially useful output.

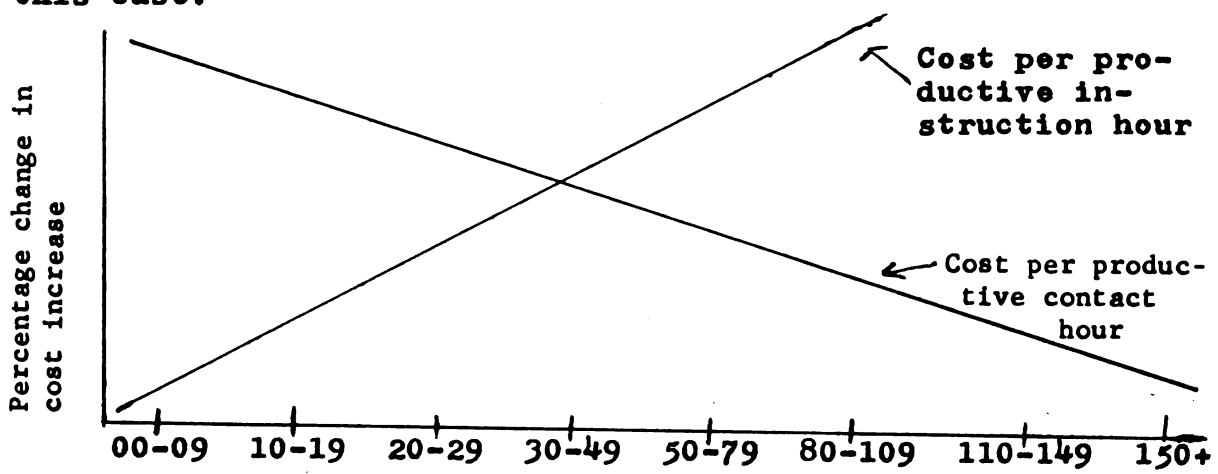
Another question is that of compromise between the conservation of one resource or the other. At university A class size 20-29 appears to offer a good compromise where cost per productive instruction hour is third from the lowest which is in size 0-9 and cost per productive contact hour is one-fourth of the cost in class size 0-9. At university B class size 80-109 has the third from the lowest cost per productive instruction hour and the lowest cost per productive contact hour. At university C class size 30-49 has the lowest cost per productive instruction hour with a great reduction in cost per productive contact hour from the smaller class sizes. At university D class size 30-49 appears to offer a good compromise. At university E class size 20-29 offers the third from the lowest cost per productive instruction hour and a seventy percent reduction in cost per productive contact hour.

Confronted with the fact of limited resources available for education it appears that the Central American universities should seriously question the offering of class sizes of 0-9 and 10-19 students. In these classes the cost per productive contact hour is from two to four to five, and even ten times as high as it is in class sizes mentioned above as compromise class sizes. For example, at university A the cost

per productive contact hour is sixty-eight cents for class size 20-29 as compared to two dollars and seventy cents for class size 0-9. Class size 10-19 is less than half as much at one dollar and five cents. At university B the cost per productive contact hour in class size 80-109 is nine cents as compared to one dollar and sixty-nine cents in class size 0-9. At university C cost per productive contact hour in class size 30-49 is fifty-nine cents compared to eight dollars and twenty-five cents in size 0-9. And in the latter size cost per productive instruction hour is thirty-one dollars and sixty-nine cents compared to twenty-one dollars and seventy-nine cents in the 30-49 class size.

The cost figures for productive contact hours show a continuous decline as class size increases with a few minor exceptions. The cost figures for productive instruction hours are more erratic, generally increasing as class size increases but with some ups and downs between the lowest and highest figures. Nevertheless, it would be possible to construct a ratio chart showing cost on the vertical axis and class size on the horizontal axis with the cost per productive contact hour declining as class size increased and cost per productive instruction hour increasing as class size increased. The intersection of these two curves at a given class size would represent one possible compromise between the extremes of either cost measure. It would not necessarily be the best

compromise. If a compromise is desirable, it should be determined according to the goals, the resources available, and other circumstances of the institution. Such a ratio chart could serve as a guide to decision making. The following diagram is an example of how a ratio chart might be used in this case.



The following Table summarizes by university the cost/productivity relationship to class size according to the lowest cost per productive contact hour, the lowest cost per productive instruction hour, and the highest productivity per enrolled student.

CLASS SIZE COST/PRODUCTIVITY RELATIONSHIPS
BY UNIVERSITY

University	Lowest Cost Productive Contact Hour Class Size	Lowest Cost Productive Instruction Hour Class Size	Highest Productivity Class Size
A	150 plus	0-9	0-9
B	80-109	10-19	10-19
C	150 plus	30-49	10-19
D	110-149	0-9	0-9
E	80-109	10-19	0-9

Data analysis-class size by selected faculty. The previous analysis by university showed that the smaller classes produced lower cost per productive instruction hour and the larger classes produced lower cost per productive contact hour. The following analysis should show what influence, if any, the type of subject matter has on the cost and productivity of different class sizes. The following tables show, by faculty, which class sizes produce the lowest cost per productive contact hour, the lowest cost per productive instruction hour, and the highest productivity per enrolled student.

The lowest productive instruction hour cost occurs in the smaller first three class sizes for economics, 0-9, 10-19, and 20-29 students per class. Maximum productivity per student enrolled corresponds in four out of five cases. Highest

ECONOMICS

University	Lowest Cost Productive Contact Hour Class Size	Lowest Cost Productive Instruction Hour Class Size	Highest Productivity Class Size
A	150 plus	0-9	30-49
B	50-79	10-19	10-19
C	150- & over	20-29	20-29
D	50-79	20-29	20-29
E	80-109	0-9	0-9

productivity and lowest cost per productive instruction hour usually are in the same class size. This is not always true due to variations in cost and hours among class size. The lowest cost per productive contact hour occurs in class sizes of 50-79 students and up.

EDUCATION

University	Lowest Cost Productive Contact Hour Class Size	Lowest Cost Productive Instruction Hour Class Size	Highest Productivity Class Size
A	80-109*	20-29	20-29
B	10-19*	0-9	0-9
C	50-79*	50-79	20-29
D	DATA NOT AVAILABLE		
E	30-49*	10-19	0-9

*Largest class listed.

With the exception of university C the pattern runs as expected. The exception is due to a big difference in hours between size 50-79 and 20-29, with more hours in the former.

LAW

University	Lowest Cost Productive Contact Hour Class Size	Lowest Cost Productive Instruction Hour Class Size	Highest Productivity Class Size
A	30-49	30-49	10-19
B	50-79	50-79	30-49
C	150 & over	50-79	80-109
D	110-149	30-49	30-49
E	50-79	30-49	30-49

At university B class size 30-49 has a total cost nearly 50 percent above that of size 50-79 while hours are about the same. It's productive instruction hour cost is greater than in size 50-79 even though it's productivity is higher per student enrolled. This suggests further investigation into total costs by class size. The divergence of the two cost measures by class size is not so pronounced in the law faculty. This suggests that large classes are as productive as they are economical.

This faculty is a good example of the merit of compromise between low productive instruction hour cost and low productive contact hour cost. Productivity drops sharply after the

ENGINEERING

University	Lowest Cost Productive Contact Hour Class Size	Lowest Cost Productive Instruction Hour Class Size	Highest Productivity Class Size
A	30-49	10-19	10-19
B	80-109	20-29	10-19
C	110-149	0-9	0-9

30-49 class size sending cost per productive instruction hour up, but cost per productive contact hour drops very little. The latter lower cost past size 30-49 does not merit the productivity loss. In class sizes below 20-29 the increase in productive contact hour cost is great relative to the increase in productivity and consequent decrease in productive instruction hour cost.

PHARMACY

University	Lowest Cost Productive Contact Hour Class Size	Lowest Cost Productive Instruction Hour Class Size	Highest Productivity Class Size
A	20-29*	20-29	20-29
B	DATA NOT AVAILABLE		
C	30-49**	0-9	0-9
D	20-29**	0-9	30-49
E	20-29	0-9	0-9

*Largest size class.
**Lower cost sizes are disregarded due to only one or two classes in size.

Large classes are not the rule in the pharmacy faculty but the pattern of the small class low productive instruction hour cost and the larger class with low productive contact hour cost is still evident.

DENTISTRY

University	Lowest Cost Productive Contact Hour Class Size	Lowest Cost Productive Instruction Hour Class Size	Highest Productivity Class Size
A	10-19	0-9	0-9
B	30-49	30-49	10-19
C	30-49	0-9	0-9
D	10-19	0-9	0-9
E	30-49	20-29	10-19

The largest class size in the faculty of dentistry is 50-79 at university C. The pattern of least cost productive hours is also evident in this faculty.

MEDICINE

University	Lowest Cost Productive Contact Hour Class Size	Lowest Cost Productive Instruction Hour Class Size	Highest Productivity Class Size
A	0-9	0-9	0-9
B	50-79	50-79	20-29
C	80-109	20-29	20-29
D	30-49	0-9	0-9
E	30-49	20-29	20-29

Some interesting contrasts show up in the faculty of medicine. University B has some rather large classes compared to university A and productivity is as high in the large classes as in the small. University C shows a high productivity in class size 80-109, 80 percent, but size 110-149 is disregarded due to there being only two classes in the category. Class size 20-29 has a productivity of 100 percent. University D shows high productivity in class size 30-49, 84 percent, as compared to size 0-9 with 89 percent. The 30-49 size also has the second lowest cost per productive instruction hour. The faculty of medicine demonstrates that productivity can be high in large classes which is in contrast to the pattern set by other faculties except for law which also shows high productivity in the larger classes.

Summary. The data analysis by university shows with great consistency among the universities that the lowest cost per productive contact hour occurs in the very large classes while the lowest cost per productive instruction hour occurs in the very small classes. The analysis by selected faculties generally supports this pattern but with some exceptions and especially in the faculties of law and medicine as noted above.

The data supports the hypothesis that productivity is higher in small classes than in large but that the productive contact hour cost is high in small classes as compared to large classes. It is clear that small classes are costly

in dollars (productive resources), but that large classes are also costly in terms of the loss of potential output (successful students). The analysis suggests that with the aid of the productive cost measures developed herein that intelligent compromises can be made between the extremes of under utilization of resources in small classes and the loss of potential output in large classes.

The cost and productivity tables for class size by selected faculties are in Appendix A.

Table I

UNIVERSITY A

Class Size	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{C}{H \times \frac{C}{H \times E}}$
0- 09	183	5.8	5.0	905.3	91.7	11.24	14.33	.83	2.41	2.70	126.3	125.
10- 19	211	14.2	11.2	1031.3	100.8	10.91	14.42	.80	.79	1.05	131.5	131.
20- 29	161	24.3	17.0	1027.4	103.2	11.64	16.41	.70	.49	.68	147.2	147.
30- 49	181	38.5	25.4	649.3	78.3	9.02	25.97	.65	.24	.73	156.6	155.
50- 79	168	59.1	31.0	713.3	78.7	9.58	31.11	.57	.16	.57	192.1	191.
80-109	22	96.6	70.1	863.7	91.8	11.29	20.64	.72	.12	.22	137.1	138.
110-149	6	122.2	51.5	860.3	136.0	6.56	18.14	.42	.05	.15	238.7	241.
150+	1	221.0	41.0	1806.0	432.0	4.180	22.53	.19	.02	.10	526.3	561.

N = the number of classes in each size.
The other symbols are identified on page 26 of Chapter III.
The figures are the average (mean) for the classes in each size.

Table II

UNIVERSITY B

Class Size	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{C}{H \times A}$
											$\frac{C}{H}$	$\frac{C}{H \times E}$
0- 09	288	5.7	5.3	458.4	96.2	6.38	7.48	.92	1.46	1.69	119.0	118.7
10- 19	267	13.3	12.4	555.7	84.6	6.70	7.25	.94	.50	.55	119.0	118.7
20- 29	74	24.9	20.9	626.4	73.5	9.24	11.90	.84	.36	.47	120.4	120.1
30- 49	139	38.1	31.1	1776.2	110.9	9.95	12.13	.82	.26	.31	129.8	130.1
50- 79	105	61.1	47.7	748.3	106.1	5.95	7.94	.78	.10	.13	129.8	130.7
80-109	2	90.0	72.0	120.0	20.0	6.000	7.75	.79	.07	.09	125.0	125.7
110-149	1	123.0	33.0	337.0	96.0	3.510	13.09	.27	..03	.11	370.3	378.5
150+	1	151.0	40.0	337.0	96.0	3.510	13.26	.26	.02	.09	384.6	378.2

Table III

UNIVERSITY C

Class Size	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{C}{H \times A \over C \over H \times E}$
0- 09	221	4.8	3.4	711.9	60.7	17.12	31.69	.73	5.55	8.25	147.0	146.9
10- 19	165	13.5	10.0	119.0	108.6	13.6	26.3	.74	1.07	2.01	142.8	143.1
20- 29	109	24.2	17.8	1363.3	114.0	12.3	24.08	.73	.52	1.01	138.8	138.2
30- 49	85	37.9	21.4	1113.5	109.7	11.00	21.79	.56	.29	.59	178.5	177.5
50- 79	90	62.0	39.8	1236.0	116.1	12.48	35.37	.49	.21	.58	208.3	208.7
80-109	47	90.3	50.8	1636.7	157.3	11.88	35.39	.56	.13	.39	178.5	178.5
110-149	42	124.0	47.8	1162.6	107.2	13.56	45.32	.40	.11	.36	256.4	259.7
150+	39	220.2	67.5	1002.5	93.6	12.04	49.02	.31	.06	.24	333.3	337.5

Table IV

UNIVERSITY D

Class Size	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times E}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{C}{H \times A}$
											$\frac{C}{H}$	$\frac{C}{H \times E}$
0- 09	148	6.1	5.8	495.6	94.4	5.64	6.61	.95	1.06	1.19	107.5	106.9
10- 19	63	12.6	10.2	499.5	76.5	6.87	10.87	.82	.55	.84	123.4	123.5
20- 29	58	24.5	19.6	1018.6	151.3	8.73	14.57	.79	.35	.61	125.0	125.1
30- 49	92	38.0	28.9	884.6	108.1	8.88	14.69	.76	.24	.40	131.5	131.4
50- 79	34	59.6	45.6	810.8	91.4	9.68	13.90	.75	.17	.24	135.1	135.1
80-109	12	101.4	40.6	1342.3	154.2	10.54	67.03	.42	.11	.64	250.0	248.8
110-149	1	137.0	74.0	959.0	85.0	11.28	20.88	.54	.08	.15	185.1	185.3
150+	8	230.8	113.8	7165.1	317.5	25.06	53.90	.48	.11	.25	204.0	204.1

Table V

UNIVERSITY E

Class Size	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times E}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{\frac{H \times E}{\frac{C}{H}}}$	$\frac{C}{\frac{H \times A}{\frac{C}{H \times E}}}$
0- 09	53	6.9	6.4	415.8	91.1	5.28	5.76	.94	.87	.93	106.4	106.5
10- 19	118	14.1	11.9	556.8	128.6	4.24	5.11	.86	.31	.37	119.1	118.7
20- 29	79	24.0	21.0	443.3	79.5	5.56	6.79	.88	.23	.28	113.7	114.2
30- 49	83	40.3	31.0	649.1	124.3	5.11	7.37	.77	.13	.19	131.6	131.2
50- 79	19	63.9	37.2	559.1	111.9	5.51	10.19	.58	.09	.16	172.3	171.7
80-109	4	89.0	50.5	540.8	77.5	6.00	12.67	.57	.07	.14	175.4	176.9
110-149	DATA NOT AVAILABLE											
150+	DATA NOT AVAILABLE											

CHAPTER V

LEVEL OF INSTRUCTION AND COST/PRODUCTIVITY

Hypothesis. In this chapter the relationship between the level of instruction and productive unit cost is examined. It is generally assumed that the cost of instruction increases as the level of instruction increases. Input cost may be higher at higher levels of instruction since more highly trained personnel is usually used at the higher levels, and classes tend to be smaller. On the other hand, productivity should also be higher as many of the weaker students are eliminated in the lower level courses. Increased cost at higher levels may, therefore, be offset by increased productivity, the relationship of successful students to enrollment. If such offset does not occur productive unit costs may be higher at higher levels, but if the cost per productive contact hour and productive instruction hour increase at a lower rate than simple input cost, C/H X E and C/H, then it can be concluded that the relationship between productivity and enrollment is working toward more effective resource use as the level of instruction increases.

To examine this possibility the data were distributed by university and by selected faculties within each university. The data by university are reproduced in Tables VI through X.

This provides an opportunity for analysis of the relationship of level of instruction to cost/productivity and affords comparison among universities. Levels one through four are undergraduate levels. Some programs require five or six years and therefore in some faculties levels five and six are also undergraduate. Levels beyond level four may be either undergraduate or graduate to and including level six, but beyond six they are all post graduate.

Data analysis-level by university. At university A productivity, the relationship of successful students to enrollment, increases steadily from level one to level six. It is fifty-seven percent on level one and increases to ninety-three percent on level six. As a consequence of increased productivity, cost per productive instruction hour decreases from twenty-seven dollars and thirty cents on level one to eight dollars and nineteen cents on level six. While productivity is the major factor in determining cost per productive instruction hour, the variation of cost and hours among the levels of instruction also contribute to any changes in the productive instruction hour cost.

Cost per productive contact hour tends to increase as level of instruction increases. The variation of cost and hours, as well as productivity, among the levels of instruction contribute to changes in this cost measure. However, it is most responsive to enrollment changes. Since enrollment declines as level increases cost per productive contact hour

increases. Increased productivity is not sufficient to offset the effect of enrollment decline on cost per productive contact hour.

The data does not support the hypothesis that cost increases as level of instruction increases. Therefore, while productivity increases, cost per productive instruction hour declines and cost per productive contact hour tends to increase.

At university B productivity increases from seventy-nine percent on level one to eighty-nine percent on level six. It is seventy-two percent on level seven. Cost per productive instruction hour is irregular as level of instruction increases. No definite trend is established. Cost per productive contact hour is erratic, increasing and decreasing from level to level. Level six has the highest cost by all measures which depart significantly from the costs on other levels.

At university C productivity increases steadily from thirty-five percent on level one to ninety-seven percent on level eight. There is a sharp drop to sixty-six percent on level nine. Cost per productive instruction hour declines from forty-two dollars on level one to eighteen dollars on level eight. There is a large increase on level nine to forty-seven dollars. This can be explained in part by the drop in productivity to which this cost measure responds. A substantial decrease in hours also occurs on level nine which means the cost is spread over fewer hours.

Cost per productive contact hour increases as level of instruction increases which reflects the decrease in enrollment. A dramatic increase in enrollment on level seven drops cost per productive contact hour to twenty-five cents from a dollar and eighty-one cents on level six.

The data for university C does not support the hypothesis that cost increases as level of instruction increases. While productivity increases, cost per productive instruction hour declines and as enrollment declines cost per productive contact hour increases, as level of instruction increases.

At university D productivity is irregular as level of instruction increases. It fluctuates within a narrow range, from a low of seventy-five percent to a high of eighty-eight percent. Cost per productive instruction hour tends to follow productivity, varying inversely as productivity varies from level to level. Cost per productive contact hour generally tends to increase as level of instruction increases, but it varies from level to level as enrollment varies.

At university E productivity increases steadily from sixty-six percent on level one to ninety-seven percent on level seven. Cost per productive instruction hour, reflecting the increase in productivity, declines from seven dollars and forty-seven cents on level one to five dollars and sixty-two cents on level seven. Cost per productive contact hour increases from twenty-one cents on level one to fifty-three

cents on level five, reflecting declining enrollment. There is an increase in enrollment on level six and the cost per productive contact hour drops to twenty-three cents.

The following table shows the change in the three measures from level one to levels five and six by university.

	UNIVERSITY				
Productivity-A/E	**A**	**B**	**C**	**D**	**E**
Level one -	.57	.79	.35	.79	.66
Level five -	.82	.91	.79	.88	.92
Level six -	.93	.89	.82	.79	.99
Cost per productive instruction hour					
Level one -	$27.30	$ 9.14	$42.13	$19.88	$7.47
Level five -	10.27	9.55	14.59	12.79	5.77
Level six -	8.19	15.47	18.31	14.21	5.95
Cost per productive contact hour					
Level one -	$ .82	$ .38	$ .51	$ .56	$ .21
Level five -	1.19	.91	1.32	1.19	.53
Level six -	.75	2.04	1.81	.68	.23

Summary. Three universities, A, C, and E conform to a pattern of steady productivity increase as the level of instruction increases, Reflecting productivity, cost per productive instruction hour declines. As the level of instruction

increases, enrollment generally decreases and therefore cost per productive contact hour increases.

The data for universities B and D is not consistent with the above pattern. Productivity and enrollment changes are irregular from level to level producing erratic changes in the two productive cost measures as level of instruction increases.

Costs and hours for all universities tend to be erratic showing no regular pattern as level increases. These changes in costs and hours from level to level contribute to the irregular pattern of universities B and D.

Most important, the data does not show a cost increase as level of instruction increases. Instead, the cost per productive instruction hour declines as level increases. The relative high cost of a productive instruction hour on level one indicates that productive resources are not being used as effectively on level one as on other levels. The data analysis by university suggests that the allocation of resources and accompanying costs among the various levels should be examined in greater detail than is possible in this study.

Data analysis-level by selected faculty. The foregoing analysis by university has modified the original hypothesis. Cost does not increase as the level of instruction increases. Each faculty will now be examined to see how it conforms to or departs from the expected pattern. Productivity, the relationship of successful students to enrollment, is expected to

increase as level increases. Cost per productive instruction hour is, as a result, expected to decline. And cost per productive contact hour is expected to increase as level increases and enrollment declines. Increased productivity is not expected to cancel the effect of enrollment decline on the latter cost.

The following tables by faculty show the performance at each university in respect to the above measures. The performance is coded for clarity of presentation. The productivity or cost is shown as increasing or decreasing if this is the trend. It is indicated to be erratic if a trend is not established or if there are several reversals (directional changes) from level to level.

I = Increasing as level of instruction increases

D = Decreasing as level of instruction increases

E = Erratic as level of instruction increases

	$\frac{C}{H \times A}$	$\frac{C}{H\ (A/E)}$	A/E
	Cost Per Productive Contact Hour (Expected to Increase)	Cost Per Productive Instruction Hour (Expected to Decrease)	Productivity Per Enrolled Student (Expected to (Increase)
ECONOMICS			
University A	E	D	I
B	E	E	I
C	E	D	I
D	I	D	I
E	I	E	I

		$\frac{C}{H \times A}$ Cost Per Productive Contact Hour (Expected to Increase)	$\frac{C}{H\ (A/E)}$ Cost Per Productive Instruction Hour (Expected to Decrease)	A/E Productivity Per Enrolled Student (Expected to Increase)
EDUCATION				
University	A	I	I	E
	B	I	D	E
	C		DATA NOT AVAILABLE	
	D		DATA NOT AVAILABLE	
	E	I	E	I
LAW				
University	A	E	E	I
	B	E	E	I
	C	E	D	I
	D	E	D	I
	E	E	E	I
ENGINEERING				
University	A	E	D	I
	B	I	D	I
	C	I	D	I

	$\frac{C}{H \times A}$	$\frac{C}{H\ (A/E)}$	A/E
	Cost Per Productive Contact Hour (Expected to Increase)	Cost Per Productive Instruction Hour (Expected to Decrease)	Productivity Per Enrolled Student (Expected to Increase)
PHARMACY			
University A	I	E	E
B		DATA NOT AVAILABLE	
C	E	D	I
D	E	E	E
E	I	D	I
DENTISTRY			
University A	E	E	I
B	E	E	I
C	I	E	E
D	I	E	E
E	I	D	I
MEDICINE			
University A	I	D	I
B	E	E	E
C	E	E	I
D	I	E	I
E	I	E	I

Where the above tables show an E, for erratic behavior a and departure from the expected pattern, the reason for such departure in the cost measures is an unexpected change in productivity, in enrollment, or changes in cost and hours from level to level. In some cases it is a combination of two or more of these variable factors.

In the faculties and at the universities where erratic behavior is indicated is where university administrative personnel should investigate the reasons for such behavior. The faculties of law, dentistry, and medicine, and to some extent pharmacy, were those with the greatest divergence from the pattern. Fluctuating costs and hours among the different levels is probably greater in these faculties and accounts for much of the divergence. Most of the erratic behavior in the law faculty is due to cost changes on different levels. Hours of instruction do not vary from level to level at universities A, B, and D. In contrast, the hours vary a great deal from level to level at universities C and E.

As might be expected the analysis by selected faculty shows greater variance from the expected pattern than did the analysis by university where individual faculties were part of the group.

Summary. Total cost by level of instruction does not increase as level increases. The unit cost measures reflect changes in productivity and enrollment. Productivity tends

to increase as level increases so cost per productive instruction hour, sensitive to productivity, tends to decline. Enrollment and class size tend to decrease as level increases so cost per productive contact hour, sensitive to class size, tends to increase.

Variations in cost and hours from level to level are not consistent, therefore the trend in unit costs due to productivity and enrollment are not always consistent with the above mentioned tendencies.

Cost and productivity tables for level of instruction by faculty are in Appendix B.

Table VI

UNIVERSITY A

Level of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times E}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{C}{H \times A}$
							$\frac{H}{E}$				$\frac{C}{H}$	$\frac{C}{H \times E}$
1	309	42.3	24.1	877.7	75.8	11.44	27.30	.57	.38	.82	179.27	180.155
2	199	33.6	21.1	755.9	87.7	11.74	27.63	.67	.93	1.11	175.51	176.862
3	135	24.2	17.3	920.7	104.1	9.31	13.04	.78	.97	1.27	142.90	142.222
4	124	17.0	13.7	1192.5	105.9	11.00	13.33	.85	1.31	1.56	123.4	124.0
5	103	15.9	13.4	713.6	105.0	7.67	10.37	.82	.97	1.19	123.4	124.1
6	28	15.5	13.9	779.6	106.3	7.67	8.19	.93	.72	.75	111.1	111.4
7-8				NONE LISTED								
9	35	21.3	14.3	680.7	99.5	7.98	12.16	.72	1.19	1.86	166.6	167.8

Table VII

UNIVERSITY B

Level of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times \frac{H}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{C}{H \times \frac{A}{C}}$
1	226	34.9	25.0	717.1	84.9	6.38	9.14	.79	.30	.38	142.9	143.3
2	242	20.1	17.9	460.1	71.3	6.22	7.00	.92	.84	.93	112.3	112.2
3	143	20.4	18.2	1348.7	104.5	9.02	10.08	.90	.73	.81	113.6	114.2
4	121	19.1	16.9	710.1	82.6	7.31	7.52	.93	.60	.66	123.5	123.3
5	104	17.6	16.5	940.4	91.9	8.26	9.55	.91	.79	.91	125.0	124.8
6	61	15.0	12.7	1112.6	122.9	12.51	15.47	.89	1.59	2.04	149.3	150.0
7	21	19.2	41.6	1075.5	419.7	2.79	6.86	.72	.29	.12	192.4	193.9
8	NONE LISTED											
9	8	11.3	12.5	304.0	92.0	3.28	3.64	.81	.70	.55	120.4	120.2

Table VIII

UNIVERSITY C

Level of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times E}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{C}{H \times A}$
											$\frac{C}{H}$	$\frac{C}{H \times E}$
1	119	108.3	32.3	897.9	102.2	9.50	42.13	.35	.15	.51	333.4	335.8
2	98	62.0	29.6	1065.4	109.2	10.15	26.24	.55	.27	.69	212.7	211.4
3	85	44.9	24.5	1534.1	143.2	13.00	24.01	.62	.53	.90	181.8	183.6
4	82	28.1	19.1	1600.7	155.3	10.57	18.07	.68	.68	1.17	153.8	153.0
5	88	20.0	15.0	1397.0	132.1	10.39	14.59	.79	.99	1.32	138.8	138.3
6	67	20.1	14.5	1453.0	132.0	11.60	18.31	.82	1.29	1.81	144.9	144.6
7	28	46.2	44.3	600.0	90.9	9.64	9.85	.98	.243	.245	104.2	104.2
8	4	90.0	87.8	1200.0	124.0	17.5	18.10	.97	.19	.20	102.0	102.5
9	227	13.0	7.4	641.1	34.3	21.6	47.15	.66	5.23	8.22	188.6	188.2

TABLE IX

UNIVERSITY D

Level of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times E}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{C}{H \times A \over C \over H \times E}$
1	96	48.9	28.5	1183.3	106.6	8.19	19.88	.79	.79	.56	172.3	173.6
2	113	23.4	17.9	635.3	103.6	7.06	11.58	.83	.55	.74	131.5	131.6
3	99	19.2	15.4	518.5	81.8	6.68	9.45	.86	.56	.73	123.4	124.2
4	42	27.1	20.0	865.9	109.9	8.30	16.05	.79	.65	1.00	135.1	135.5
5	41	22.9	18.4	1187.1	138.9	10.53	12.79	.88	1.02	1.09	124.9	124.3
6	17	26.5	21.3	1132.5	183.7	10.09	14.21	.79	.47	.68	125.0	124.5
7	6	14.0	11.3	1241.7	226.0	7.91	9.35	.86	.85	.94	123.4	123.9
8	2	6.0	4.5	1137.6	133.0	8.25	11.45	.750	1.38	1.91	133.3	133.3
9	NONE LISTED											

Table X

UNIVERSITY E

Level of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times E}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{C}{H \times A}$
							$\frac{H}{E}$				$\frac{C}{H}$	$\frac{C}{H \times E}$
1	68	42.1	25.3	418.7	98.4	4.39	7.47	.66	.14	.21	166.5	166.3
2	80	20.8	16.2	458.3	102.9	4.81	6.78	.83	.32	.40	128.2	128.7
3	81	21.5	19.0	538.8	102.6	5.08	6.09	.89	.36	.41	113.7	112.8
4	51	21.9	19.2	772.8	151.1	5.67	6.73	.85	.35	.42	113.6	114.1
5	51	17.6	16.0	562.5	110.1	5.28	5.77	.92	.49	.53	109.8	121.0
6	9	25.3	25.0	747.3	113.3	5.87	5.95	.99	.231	.234	100.9	101.0
7	10	25.5	24.8	424.2	78.0	5.45	5.62	.97	.213	.219	103.1	102.8
8	NONE LISTED											
9	6	19.4	12.25	259.0	114.0	2.41	1.82	.80	.09	.11	195.9	197.8

CHAPTER VI

TYPE OF INSTRUCTION AND COST/PRODUCTIVITY

This chapter deals with the relationship between the type or method of instruction and cost/productivity. Some methods of instruction are generally considered to be less effective than others. The lecture method, for example, has been generally criticized. K. H. Hoover says in an article on lecturing that:

> A mass of experimental, as well as applied, research indicates that lecturing and reciting are extremely poor methods of teaching for immature individuals... There is a great deal of evidence accumulating to suggest that the lecture-reciting formula is equally ineffective at all levels.

Hoover refers to a statement by Stroud in Psychology in Education that there is only "19.6% retention of factually learned material after three months by the lecture method."[50]

This study is concerned with the effectiveness of various methods of instruction and resulting cost, productivity under the conditions in which Central American universities operate. It is concerned with the results of analysis of the data peculier to the university in a partially developed nation. Therefore,

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[50]K. H. Hoover, "Lecturing," Clearing House, Vol. 34, Summer, 1959, p. 52. (Stroud may be overly precise in estimate but the point remains clear.)

although there are many studies about methods of instruction the review of such literature is not pertinent to the present study.

To examine the relationship of method of instruction to cost/productivity the data were distributed by university and by selected faculties. Three methods or types of instruction are employed by the Central American universities, with the exception of university C which also employs a fourth type. Type one is lecture or seminar, type two is a combination lecture-laboratory with a large lecture session and small lab sections, and type three is laboratory only. Type four used by university C is a clinical technique.

Productivity, A/E, and four cost measures are calculated for each type of instruction. The data are presented in Tables XI through XIII by university.

Hypothesis. The assumption is that the lecture-seminar method is least efficient but that there may be exceptions. The data are analyzed to determine which method produces the least cost per productive instruction hour and per productive contact hour. Since the most efficient method may depend a great deal on faculty (type of subject matter), the analysis by selected faculty is expected to produce better results than the analysis by university.

Data analysis by university. The following table shows by university which type of instruction produced the lowest

productive contact hour cost, the lowest productive instruction hour cost, and the highest productivity. Type of instruction is indicated by number.

University	Lowest Productive Contact Hour Cost	Lowest Productive Instruction Hour Cost	Highest Productivity
A	1	1	3
B	1	1	3
C	2	3	3
D	2	3	2
E	3	3	3

At university A type three instruction has the highest productivity. Low cost per productive instruction hour usually accompanies high productivity. Given the same cost and same number of hours of instruction the higher the productivity the lower the cost. In this case, type one instruction produces the lowest cost per productive instruction hour because cost is lower for type one than for the other types. Cost per productive contact hour is responsive to enrollment as well as productivity, cost and hours. Since enrollment is greater in type one, as well as cost being lower, it produces the lowest cost per productive contact hour.

At university B type three instruction produces the highest productivity. Type one produces the lowest cost per productive

instruction hour and productive contact hour for the same reasons as at university A. Cost is lowest for type one and enrollment is as high as for the other types.

At university C type three again produces the highest productivity. The combination of cost and hours is such that it also produces the lowest cost per productive instruction hour. Type two produces the lowest cost per productive contact hour, mainly due to the greater number of instruction hours with type two compared to the other types.

At university D type two instruction produces the highest productivity and the lowest cost per productive contact hour. Type three produces the lowest cost perproductive instruction hour.

At university E the combination of cost, hours of instruction, and productivity is such that type three produces the best results by all measures.

Summary. It should be observed that the types of instruction in this analysis include all sizes of classes and all faculties. Hence, the special adaptation of one type or another to class size or faculty is not taken into account. The value of this analysis to administration is in providing a general guide to efficient use of resources in terms of type of instruction. The analysis indicates that as a general rule type one instruction provides the greatest output per dollar spent at universities A and B. Type three is the most efficient at

university E. This again is generally true and there may be many exceptions when particular factors, such as subject matter, are taken into account. At universities C and D type two produces the lowest cost per productive contact hour and type three the lowest cost per productive instruction hour. As mentioned in chapter four emphasis on the former cost measures conserves dollars and resources while emphasis on the latter conserves students.

The assumption that type one, the lecture or seminar method, is the least efficient is not upheld by the data. Both type one and type three produce low productive unit costs. One cannot be said to be superior to the other. Type two instruction does not appear to be as productive as types one and three. However, it may have superiority in particular instances which do not show up in this aggregate analysis. An additional question raised by this analysis, but beyond the scope of this study, is why type one instruction is more efficient at universities A and B while types two and three are more efficient at universities C, D, and E.

For future analysis, university officials should start keeping detailed records on cost, hours of instruction, and productivity by type of instruction and according to class size and faculty.

Data analysis by selected faculties. In this analysis the cost and productivity measures are determined for each

type of instruction by faculty or subject matter. A point to consider is that while the same faculty is involved, the classes include different courses within the faculty which may have different costs, hours and enrollments. The following tables, one for each faculty, shows which type of instruction, indicated by number produces the lowest productive contact hour cost, the lowest productive instruction hour cost, and the highest productivity.

	Lowest Productive Contact Hour Cost	Lowest Productive Instruction Hour Cost	Highest Productivity
ECONOMICS			
University A	3	3	3
B*	1	1	1
C	2	1	1
D**	2	2	1
E*	1	1	1

*Only type one instruction was available at university B and E.

**Instruction type one produced the highest productivity, A/E, but not the lowest cost per productive instruction hour due to the extra large number of hours (H) for type 2 which resulted in a lower productive instruction hour cost. Usually low productive instruction hour cost accompanies high productivity.

The data indicate that for economics, type one instruction, lecture or seminar, is the most efficient in terms of

the measures used. However, since there was no alternative method used at universities B and E, no clear cut evidence of the superiority of type one instruction is there.

	Lowest Productive Contact Hour Cost	Lowest Productive Instruction Hour Cost	Highest Productivity
EDUCATION			
University A	1	1	3
B*	1	1	1
C	1	1	1
D	DATA NOT AVAILABLE		
E*	1	1	1

*Only type one and two instruction available.

For the faculty of education type one instruction offers either the only practical method or is clearly superior to the others used. Since type two was available and used at three universities and type three at two it seems probable that type one has advantages over the other two.

	Lowest Productive Contact Hour Cost	Lowest Productive Instruction Hour Cost	Highest Productivity
LAW			
University A	1	1	1
B	1	1	1
C	2	2	2
D	1	1	1
E	2	2	2

Only type one and two instruction was available and at universities A, B, and D only type one was available.

The faculty of law at most universities offered only type one instruction. Only universities C and E offered both type one and two instruction, and since type two was most productive at both, type two would appear to have an advantage over type one.

	Lowest Productive Contact Hour Cost	Lowest Productive Instruction Hour Cost	Highest Productivity
ENGINEERING			
University A	2	1	1
B	2	1	1
C	3	3	3

Engineering was offered at only three of the universities and all three types of instruction were employed at each. In this faculty type three seems to offer the most consistent productivity since it rates best on all three measures, at least at university C. Since the other two types also rate well at universities A and B no one type has a clear advantage.

	Lowest Productive Contact Hour Cost	Lowest Productive Instruction Hour Cost	Highest Productivity
PHARMACY			
University A	3	3	3
B	DATA NOT AVAILABLE		

Pharmacy (Con't)	Lowest Productive Contact Hour Cost	Lowest Productive Instruction Hour Cost	Highest Productivity
University C	2	3	3
D	2	2	3
E	3	3	3

All three types of instruction were offered in pharmacy at each university. Therefore, since type three produces the lowest cost more often it must tentatively be assumed that it has advantages over the other two types of instruction. Variation in hours and costs among types of instruction, levels of instruction, and class sizes has a bearing on how some of the measures compare to each other.

	Lowest Productive Contact Hour Cost	Lowest Productive Instruction Hour Cost	Highest Productivity
DENTISTRY			
University A	2	2	1
B	1	2	3
C	1	2	2
D	1	1	1
E	1	1	1

Dentistry is another faculty which makes use of all three types of instruction. Type one is most productive in all measures at two universities and shares with type two the lowest cost at two more, universities B and C.

	Lowest Productive Contact Hour Cost	Lowest Productive Instruction Hour Cost	Highest Productivity
MEDICINE			
University A	3	3	3
B	1	3	3
C	1	3	3
D	1	1	1
E	3	3	3

Type three appears to be most productive at least cost and since all three types are used in each of the five universities this would indicate some advantage to type three.

Summary. Compared with the analysis by university the analysis by selected faculty provides a more discriminating observation of types of instruction and their effectiveness. Cost and productivity vary by type of instruction and the productive unit cost brings these variables together in one measure of efficiency.

The analysis of the data indicates that type one is more efficient in the faculties of Education and Dentistry than other types. Type three is more efficient in the faculties of Pharmacy, Medicine, and Engineering. In the faculty of Law where two universities provided a comparison between type one and type two, type two was the most efficient at both schools. In the faculty of Economics one type is no more efficient than

another. As a matter of practical necessity each type probably has its place and usefulness among different courses within each faculty. Administrators, however, should give special attention to those types which offer lowest productive unit cost considering the faculty as a whole as in this analysis.

The hypothesis stated earlier in this chapter, that the lecture or seminar method is least efficient, was not supported by the data. Some methods or types of instruction are more efficient than others, depending upon the faculty in which they are used.

As a final note it should be observed that according to use type one was first, followed by types two and three. The following table shows the number of courses in which each type was used by university:

Type	University	A	B	C	D	E
I	----------	581	654	493	266	261
II	----------	242	169	235	95	74
III	----------	109	103	64	55	21

The cost and productivity tables for type of instruction by selected faculties are in Appendix C.

Table XI

UNIVERSITY A

Type of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
I	581	33.2	20.3	649.8	79.5	9.03	18.33	.68	.62	.94
II	242	23.4	13.7	1478.8	132.2	12.27	20.47	.69	1.03	1.45
III	109	27.6	26.9	700	64.5	14.07	32.11	.88	1.37	1.36

UNIVERSITY B

Type of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
I	654	23.5	19.6	427.1	71.3	6.05	7.37	.88	.56	.63
II	169	23.3	20.7	2365.6	197.9	10.44	13.83	.88	.94	1.14
III	103	17.7	14.6	562.9	76.7	10.64	10.96	.92	1.12	1.36

UNIVERSITY C

Type of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
I	493	40.7	19.6	756.0	58.8	15.73	35.09	.63	2.59	4.14
II	235	44.7	20.9	1826.0	185.3	10.48	25.54	.64	.58	.91
III	64	34.5	33.2	828.4	95.3	9.82	18.40	.68	.52	.93
IV	5	26.8	28.0	975.0	82.4	36.11	68.08	.63	12.94	5.09

UNIVERSITY D

Type of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
I	266	32.3	22.4	641.8	82.7	8.01	14.82	.82	.52	.71
II	95	26.5	18.4	1293.9	147.5	7.42	11.57	.85	.47	.62
III	55	13.8	11.0	1046.9	164.9	7.84	10.99	.83	1.03	1.26

UNIVERSITY E

Type of Instruction	N	E	A	C	H	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
I	261	25.4	19.4	391.1	82.6	4.99	6.63	.83	.32	.38
II	74	23.8	18.5	1027.2	199.3	5.23	6.58	.83	.33	.39
III	21	24.3	22.4	490.3	129.1	4.10	4.59	.90	.18	.21

CHAPTER VII

SUMMARY AND CONCLUSIONS

The Problem. Most partially developed nations lack an adequate supply of trained manpower but have an over abundance of untrained manpower. The nature of the problem and its environmental setting are important in seeking a solution, but education also has a major role to play.

Central American institutions of higher education have been unable to make their maximum contribution to the problem for at least two reasons. Resources available for education are limited and they have not been used in the most efficient manner. This study, in the preceding chapters, has examined the relationships between the investment of fiscal and human resources and the production of successful students in five major tested american institutions in an effort to discover means of improving efficiency. Cost and productivity were combined in two measures of productive unit cost. These measures, cost per productive instruction hour, and cost per productive contact hour, were applied to such variables as class size, method and level of instruction, to determine the influence of such variables on cost-productivity relationships.

Cost, productivity, and class size. The analysis of data in chapter four demonstrates that productivity cost measures

such as cost per student, cost per student contact hour, or cost per instruction hour. Cost per student contact hour shows, as is to be expected, that the umit cost is higher in small classes than in large classes. Adding the productivity factor makes a difference in the unit cost. The cost is still higher in small classes than in large classes but the productive contact hour cost measure differentiates among the class sizes in determining the lowest productive contact hour cost.

A physical productivity measure, such as A/E alone, is not sufficient in determining the most economically productive class size because costs and hours of instruction vary among classes.

Cost per instruction hour does not reflect class enrollment, it is simple input cost measure. The productive instruction hour does not reflect enrollment either but it does take into account productivity. It is a better guide to efficiency than a simple productivity measure such as A/E, because costs and hours of instruction vary. Usually, cost per productive instruction hour varies inversely with productivity. When productivity is high the hourly cost is lower than when productivity is low. In C/H(A/E), increasing productivity, A/E, lowers the hourly cost. However, there were instances in the data analysis where productive instruction hour cost was lower in a class size with lower productivity than in another class size with higher productivity. This was due to higher costs

in the latter. Class sizes 30-49 and 50-79 in education at university C is a case in point. In class size 30-49 productivity is 65 percent and cost per productive instruction hour is $33.28. In the 50-79 size the figures are 53 percent and $29.56 respectively.

Two productivity cost measures are better than one. The productive contact hour C/H X A gives weight to enrollment as well as productivity. The productive instruction hour C/H (A/E) gives exclusive weight to productivity. Hence, it is possible to get a lower unit cost in small classes than in large classes with the latter measure, given the same costs and hours of instruction.

The data analysis shows that by one measure, the productive contact hour cost, only large classes should be offered. But by the other, productive instruction hour cost, only small classes should be offered. The large classes conserve teaching resources while the small classes conserve students. From the standpoint of cost and limited teaching resources the large classes are most economical. However, even though the cost per productive contact hour is lowest for a given class size the productivity may be too low for practical consideration. Perhaps a large class size should not be encouraged where productivity, A/E, is below 75 percent. For example, in the engineering faculty at university C, class size 110-149 gives C/H X A as 39 cents and productivity at 26 percent while class

size 20-29 gives C/H X A as 55 cents and productivity as 75 percent. The increase in contact hour cost may be justified by the increased productivity. But a jump to 100 percent productivity for C/H X A of $1.19 in class size 0-9 produces only nine successful students as compared to eighteen in size 20-29. The increased productivity for such a small number of students does not justify the increased cost.

Administrative implications. Class size is a variable within administrative control. The present study provides information and tools of analysis which should be helpful in exercising such control.

Productive resources are presently being underutilized as is indicated by the high cost per productive contact hour in small classes relative to the potential lower cost in larger classes. The smaller costlier classes predominate. For all faculties and all universities there are 1,717 classes with less than twenty students as compared to 1,713 classes for all other sizes combined. The distribution of classes by size is as follows:

Class Size	No.	Class Size	No.
0- 9	893	50-79	416
10-19	824	80-109	87
20-29	481	110-149	50
30-49	630	150 plus	49

The universities should seriously consider eliminating both the very small classes, under twenty students, where possible, and the very large classes of eighty and above. There are exceptions in some faculties which should be taken into account, such as in law and medicine. While it is clear that small classes are costly in dollars (productive resources) large classes are also costly in terms of the loss of potential output (successful students). When students fail to achieve their potential due to large classes this is both a private cost and a social cost which are not reflected in university costs. The student and society lose the contribution of greater economic output which success would make possible. If large classes contribute to slow student achievement the extra time taken to acquire an education is also a loss to both the student and society. To some extent this social cost is reflected in a high cost per productive instruction hour for large classes.

With the aid of the productive unit cost measures developed in this study it is possible to make reasonable compromises between the extremes of under utilization of resources and the loss of potential output. One possible compromise is that class size where productive contact hour cost is equal to productive instruction hour cost. If adequate records were available the ideal class size could be determined for each faculty.

The carreras, programs of study, which enroll small numbers of students in the beginning contribute to more small classes

on subsequent levels than do those carreras which attract large enrollments. The low enrollment carreras should be discontinued, or if necessary for social and economic development of the country, ways should be found to increase their enrollment.

The data used in this study indicate a great variation in cost and hours of instruction among different class sizes within faculties. An analysis of the reasons for such variation could be a fruitful further step in increasing productivity.

Cost, productivity, and level of instruction. Three factors: cost, productivity, and enrollment and their effect on the four cost measures, are of interest as the level of instruction increased. Cost did not increase as level increased as was expected. In fact, cost declined as level increased as a general trend for all universities. At university A, for example, cost per productive instruction hour was twenty-seven dollars on levels one and two and thirteen dollars on levels three and four. It was ten dollars on level five and eight dollars on level six. At university C cost per productive instruction hour declined from forty-two dollars on level one to fourteen dollars on level five.

Universities B and E are exceptions to the general trend. At university B cost per productive instruction hour remained about the same as level increased and at university E it declined only slightly. In the latter case the decline was due to a steady increase in productivity.

Productivity increased as a general trend as level increased among all the universities. This caused cost per productive instruction hour to decline as a general trend as level increased.

Enrollment decreased as expected as level increased. The cost per productive contact hour therefore increased as the productivity increase did not offset the enrollment decline.

The average class size on level one, according to the data by university, appears to be in a range of from 35 to 48 with the exception of university C where it is over 100. This may account for the very low productivity on level one at university C which is 35 percent as compared to over 50 percent at the other universities.

Administrative implications. Level of instruction is not a variable within administrative control but some of the characteristics of certain levels may be modified.

The productive instruction hour cost on level one is higher than other levels in each university. This is the case because instruction hour cost is as high, or higher in some universities, on level one as on other levels and productivity is lower on level one than other levels. In order to equate costs on each level and thus use available resources as effectively as possible level one cost should be reduced or productivity increased.

Productivity on level one by university is as follows: University A-57 percent, B-79 percent, C-35 percent, D-79 percent, and E-66 percent. The productivity of 79 percent at university B and D, although the highest, could probably be increased. Certainly the productivity at universities A, C, and E should be raised. This may mean smaller classes, better student selection, or improved guidance and counseling. Smaller classes may be helpful at university C where average class size is 108 on level one. Greater productivity on level one should make it possible to increase the class size on higher levels. The costly small classes are on the upper levels.

A further step which could and should be taken is to determine the reason or reasons for the variation of cost and hours of instruction among the different levels.

Cost, productivity and type of instruction. The superiority of any one type of instruction over another was not demonstrated by the data analysis. However, some types are more efficient than others in particular faculties. Since the cost of providing instruction and productivity do vary by type the productive unit cost measure brings these variables together in one measure. The measures developed in this study then aid in allocating scarce resources to the most efficient methods. Since type of instruction is a variable within the control of administrative action it would be helpful if

adequate records were maintained. Information on cost, hours of instruction, and productivity of various methods by class size within faculties would provide the necessary data for further analysis.

Case study--university C. The following case study develops in greater detail the application of the productive cost measures and their significance for administrative action.

University C has a large number of small classes below twenty students. The two sizes of 0-9 and 10-19 number 386 as compared to 412 for all other class sizes. The next three class sizes, 20-29, 30-49, and 50-79 account for 284 and the classes of 80 and above number 128.

Productivity in the first two sizes, 0-9 and 10-19 is 73 and 74 percent respectively. Class size 20-29 has a productivity of 73 percent. Productivity in classes of 30 and above ranges from 56 percent down to 31 percent in size 150 or more.

The cost per productive instruction hour is lowest for class size 30-49 and cost per productive contact hour is fifty-nine cents, as compared to eight dollars and twenty-five cents for class size 0-9.

The following table summarizes the above verbal description.

No. of classes	size	$\frac{C}{H \times A}$	$\frac{C}{H\ (A/E)}$	$\frac{A}{E}$
386	0- 9	$8.25	$31.69	.73%
	10- 19	2.01	26.30	.74
194	20- 29	1.01	24.08	.73
	30- 49	.59	21.79	.56
218	50- 79	.58	35.37	.49
	80-109	.39	35.39	.56
	110-149	.36	45.32	.40
	150+	.24	49.02	.31

$\frac{C}{H \times A}$ = Cost per productive contact hour.

$\frac{C}{H\ (A/E)}$ = Cost per productive instruction hour.

A/E = Productivity.

Classes size 0-9 have an average enrollment of five students and represent the extreme in under utilization of resources with a high productive contact hour cost ($8.25). Classes size 150 or more represent the other extreme of excessive loss of potential output with a high productive instruction hour cost ($49.02). Class sizes of from twenty to fifty students represent the most effective use of resources. Cost per productive instruction hour reaches its lowest point within this range and cost per productive contact hour is neither excessively high or low. On a ratio chart as described in chapter four these two measures would be in closest proximity to each other within this range.

To increase efficiency the university should eliminate the very small classes, or at least drastically reduce their number. The very large classes, above fifty students, should be considered for possible elimination or curtailment. The largest number of classes are in the two most uneconomical or unproductive ranges as may be noted on the above table. Only 194 classes out of a total of 798 are in the most efficient range.

Cost and hours of instruction vary by class size from a low of $708.60 and 60 hours in size 0-9 to a high of $1,602.00 and 157 hours in size 80-109. These variations by class size should be explained, if indeed they are due to size of class.

Among the five universities in this study university C has the lowest productivity on level one, 35 percent. As a result, level one also has the highest cost per productive instruction hour except for level nine which is higher. It also has the largest average class size of any university on level one, an average enrollment of 108. Although it permits a relatively low cost per productive contact hour of fifty-one cents it probably also accounts for the low productivity. If this represents a deliberate economy it is a false economy which deals with only half of the problem and results in a loss of potential output. The loss of output on level one may very well contribute to the excessive number of small classes which prevail on higher levels.

Productivity by type of instruction is in a narrow range of 63 percent to 68 percent. Type three has the highest which contributes to the lowest cost per productive instruction hour for type three. Another contributing factor is the combination of instructional cost and hours which produces the lowest simple input cost per hour of instruction of any type. Type three also has a low cost per productive contact hour. It is ninety-three cents as compared to four dollars and fourteen cents for type one. The following table summarizes the pertinent information for each type:

Type	No. of classes	$\frac{C}{H}$	$\frac{C}{H\ (A/E)}$	A/E	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
I	493	$15.73	$35.09	63%	$2.59	$4.14
II	235	10.48	24.54	64	.58	.91
III	64	9.82	18.40	68	.52	.93

It should be noted that type three is used in only 64 classes out of a total of 798. Apparently it is suitable for a relatively few classes. If it can be effectively used on a wider scale it should be so employed.

Implications for North American universities. The productive unit cost measures developed in this study and the technique of application to data could be used in any college or university. There are at least three pre-requisites which would have to be met and which are only partially met at present.

First, adequate and standardized records of cost, hours of instruction, and productivity would be necessary. Such information should be by subject matter and if not by individual course, then by level of instruction within narrowly defined subject matter areas.

Second, productivity would have to be defined and measured by common standards. The definition could be that of a successful student, one who passed a course or one who completed a level of instruction with a minimum measure of success, such as a grade of C or a socalled two point average.

Third, measurement would have to be such as to insure comparable degrees of achievement. This would mean common examinations for all students taking a given course or within a level of instruction of a specific subject matter. Common examinations are already widely in use in many colleges for various basic courses enrolling a large number of students. Such a measure deals with information gained or techniques mastered. As noted in chapter three some of the intangible benefits of education are difficult to measure even under the best of circumstances.

The data on cost and productivity could then be used in the productive unit cost measures developed herein and applied to various class sizes and methods of instruction. These are the two variables which most readily lend themselves to administrative control.

Further research possibilities. This study reveals a great variation in cost and instruction hours by class size, level and method of instruction. In many cases the variation is not consistent. Further research should be undertaken to determine the reasons for such variation and especially the reasons for the inconsistency. Such research might suggest additional means by which to improve cost-productivity relationships and efficiency.

Following are some examples of cost and instruction hour variation by class size:

	Class Size	Average Cost	Average Hours
University A	20-29	$1,027.40	103.2
	30-49	649.30	78.3
University C	20-29	1,363.30	114.0
	30-49	1,113.50	109.7
University E	0- 9	415.80	91.1
	10-19	556.80	128.6
	20-29	443.30	79.5

At university A there is over a 30 percent drop in cost from class size 20-29 to 30-49 and only a 20 percent drop in hours. One would expect the cost and hours to be greater in the larger class size. The same kind of variation prevails at university C although it is not as large. At university E

cost and hours are higher for class size 10-19 than for size 0-9 which could be expected. But both cost and hours are lower in the next larger size class of 20-29 which is not consistent with the previous change where both increased as size increased.

The following are examples of cost and instruction hour variation for courses by level of instruction:

	Level	Average Course Cost	Average Hours
University A	4	$1,192.50	105.9
	5	713.60	105.0
University B	1	717.10	84.9
	2	460.10	71.3
University D	1	1,183.30	106.6
	2	635.30	103.6

In each of the above cases the cost per course declines by a significant amount from one level to the next higher level. The change in hours of instruction per course are about the same or as in the case of university B the decline in hours does not correspond to the decline in cost. As mentioned earlier, one would expect cost to increase as level increases if there is a change in cost.

Finally, in the methods of instruction, at university B, method one has an average cost per course of $427.10 and

average hours of instruction of 71.3 whereas method two has a cost of $2,365.60 and 197.9 hours. Such differences could very well be due to the kind of instruction and subject matter involved. It should however be investigated further.

The real need for further research in this particular problem area in the Central American universities is with variations in cost and hours by class size and level of instruction.

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APPENDICES

APPENDIX A

ECONOMICS

Class Size	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
0- 09	3.82	5.24	.79	1.73	1.83
10- 19	4.43	7.22	.63	.39	.64
20- 29	6.02	16.46	.41	.26	.68
30- 49	6.44	15.8	.84	.17	.36
50- 79	5.66	7.89	.74	.09	.13
80-109	6.11	14.70	.65	.06	.16
110-149	6.46	19.01	.41	.05	.15
150+	4.18	22.53	.19	.02	.10
University B					
0- 09	NONE LISTED				
10- 19	3.67	3.93	.95	.24	.26
20- 29	11.68	22.50	.62	.52	.99
30- 49	4.13	6.71	.67	.09	.15
50- 79	4.20	6.23	.73	.07	.11
80-109	NONE LISTED				
110-140	NONE LISTED				
150+	NONE LISTED				
University C					
0- 09	8.75	11.70	.79	1.39	1.87
10- 19	8.94	19.64	.64	.72	1.63
20- 29	8.80	10.58	.85	.35	.42
30- 49	8.06	13.60	.65	.24	.41
50- 79	8.11	14.18	.67	.13	.23
80-109	9.09	131.97	.21	.10	1.52
110-149	NONE LISTED				
150+	8.18	22.92	.51	.04	.11
University D					
0- 09	9.82	16.03	.73	1.30	2.11
10- 19	10.43	32.06	.37	.74	2.29
20- 29	11.19	11.62	.97	.43	.45
30- 49	9.01	13.08	.73	.26	.37
50- 79	8.79	11.73	.74	.14	.19
80-109	9.34	88.67	.32	.09	.82
110-149	NONE LISTED				
150+	NONE LISTED				

(Economics Con't)

Class Size	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University E					
0- 09	6.97	7.41	.97	.98	1.01
10- 19	10.54	13.21	.80	1.00	1.26
20- 29	8.42	10.76	.86	.34	.43
30- 49	8.10	12.42	.65	.19	.29
50- 79	8.8	14.43	.59	.13	.25
80-109	6.00	12.67	.57	.07	.14
110-149	NONE LISTED				
150+	NONE LISTED				

EDUCATION

Class Size	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
0- 09	9.4	12.1	.78	1.69	2.26
10- 19	8.13	9.49	.86	.53	.61
20- 29	5.36	6.10	.88	.23	.26
30- 49	5.17	8.43	.74	.14	.24
50- 79	4.70	6.19	.79	.08	.11
80-109	5.72	7.24	.79	.07	.09
110-149	NONE LISTED				
150+	NONE LISTED				
University B					
0- 09	4.70	4.79	.96	.78	.79
10- 19	4.80	6.00	.85	.41	.52
20- 29	NONE LISTED				
30- 49	NONE LISTED				
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University C					
0- 09	35.00	75.69	.63	10.93	19.58
10- 19	32.65	63.37	.57	2.45	4.99
20- 29	22.22	33.33	.67	1.06	1.59
30- 49	21.67	33.28	.65	.51	.77
50- 79	15.56	29.56	.53	.27	.52
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University D					
0- 09	4.29	4.64	.93	.87	.91
10- 19	4.12	4.43	.93	.33	.35
20- 29	4.29	4.66	.82	.17	.19
30- 49	3.7	4.47	.67	.10	.16
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				

LAW

Class Size	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
0- 09	NONE LISTED				
10- 19	5.72	6.40	.89	.30	.34
20- 29	6.25	7.41	.83	.24	.28
30- 49	4.95	5.89	.84	.11	.13
50- 79	7.47	13.54	.65	.13	.23
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University B					
0- 09	NONE LISTED				
10- 19	NONE LISTED				
20- 29	8.02	16.65	.48	.30	.62
30- 49	9.09	9.56	.95	.21	.22
50- 79	6.38	7.59	.86	.10	.12
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University C					
0- 09	10.59	39.71	.30	2.12	7.94
10- 19	10.59	105.88	.10	1.06	10.58
20- 29	NONE LISTED				
30- 49	8.00	26.13	.31	.16	.53
50- 79	12.69	22.65	.60	.18	.33
80-109	16.18	24.71	.72	.20	.30
110-149	14.74	35.95	.48	.12	.29
150+	13.62	41.47	.34	.06	.17
University D					
0- 09	NONE LISTED				
10- 19	NONE LISTED				
20- 29	NONE LISTED				
30- 49	10.8	12.37	.88	.26	.30
50- 79	10.52	12.65	.84	.17	.20
80-109	NONE LISTED				
110-149	11.28	20.88	.54	.08	.15
150+	11.6	36.83	.32	.07	.21
University E					
0- 09	NONE LISTED				
10- 19	NONE LISTED				
20- 29	14.55	26.41	.60	.59	1.06
30- 49	4.26	6.02	.86	.11	.17
50- 79	4.67	9.09	.56	.07	.14
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				

ENGINEERING

Class Size	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times E}$
University A					
0- 09	NONE LISTED				
10- 19	6.95	7.55	.94	.38	.41
20- 29	6.39	8.23	.83	.28	.36
30- 49	6.08	9.15	.70	.16	.24
50- 79	7.76	22.67	.35	.14	.39
80-109	12.72	40.36	.32	.14	.44
110-149	NONE LISTED				
150+	NONE LISTED				
University B					
0- 09	6.52	7.39	.93	1.23	1.39
10- 19	6.3	6.82	.94	.47	.51
20- 29	5.55	6.47	.87	.23	.27
30- 49	5.88	7.75	.80	.16	.21
50- 79	5.2	6.57	.83	.09	.11
80-109	6.0	7.75	.79	.07	.09
110-149	NONE LISTED				
150+	NONE LISTED				
University C					
0- 09	8.36	10.71	1.00	1.19	1.19
10- 19	10.57	13.94	.83	.79	1.02
20- 29	9.24	13.12	.75	.39	.55
30- 49	10.11	18.12	.62	.26	.46
50- 79	10.42	37.82	.40	.17	.61
80-109	9.22	37.37	.34	.10	.42
110-149	10.50	49.68	.26	.08	.39
150+	11.00	72.85	.16	.06	.42

PHARMACY

Class Size	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
0- 09	9.82	13.89	.72	1.48	2.11
10- 19	9.6	13.51	.81	.81	1.11
20- 29	5.99	7.44	.82	.28	.35
30- 49	NONE LISTED				
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University B					
0- 09	8.52	13.75	.72	1.77	2.62
10- 19	8.28	14.15	.68	.66	1.15
20- 29	8.86	27.73	.44	.37	1.15
30- 49	5.04	14.80	.37	.14	.40
50- 79	9.47	55.60	.18	.13	.73
80-109	7.66	14.77	.52	.07	.14
110-149	10.68	75.39	.18	.09	.61
150+	7.85	68.15	.11	.04	.33
University C					
0- 09	6.64	9.28	.94	1.05	1.40
10- 19	NONE LISTED				
20- 29	5.92	19.79	.68	.27	.91
30- 49	10.19	10.51	.97	.32	.33
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University D					
0- 09	3.9	3.97	1.00	.67	.67
10- 19	3.85	4.43	.90	.29	.33
20- 29	3.58	4.47	.80	.14	.18
30- 49	3.71	9.69	.39	.12	.32
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				

DENTISTRY

Class Size	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
0- 09	6.98	7.53	.99	1.14	1.27
10- 19	8.30	8.44	1.02	.69	.70
20- 29	NONE LISTED				
30- 49	NONE LISTED				
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University B					
0- 09	NONE LISTED				
10- 19	18.0	26.7	.93	1.13	1.67
20- 29	14.15	16.46	.88	.49	.57
30- 49	10.45	14.83	.79	.31	.41
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University C					
0- 09	6.06	6.06	1.00	3.03	3.03
10- 19	11.80	19.31	.81	.83	1.38
20- 29	14.11	27.81	.75	.66	1.28
30- 49	5.56	12.63	.45	.13	.29
50- 79	6.14	24.66	.37	.11	.45
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University D					
0- 09	8.41	8.57	.99	2.06	2.10
10- 19	8.67	16.97	.54	.67	1.31
20- 29	NONE LISTED				
30- 49	NONE LISTED				
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University E					
0- 09	NONE LISTED				
10- 19	4.09	5.30	.79	.29	.37
20- 29	3.59	4.71	.76	.17	.22
30- 49	3.04	6.88	.50	.07	.15
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				

MEDICINE

Class Size	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
0- 09	7.45	7.45	1.00	.83	.83
10- 19	14.76	15.87	.93	1.33	1.39
20- 29	19.49	21.66	.90	.97	1.09
30- 49	NONE LISTED				
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University B					
0- 09	13.20	29.68	.91	4.71	10.85
10- 19	13.48	26.53	.80	.85	1.58
20- 29	67.10	134.72	.96	2.40	4.81
30- 49	34.86	40.19	.88	.84	.96
50- 79	11.57	13.37	.87	.21	.24
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University C					
0- 09	NONE LISTED				
10- 19	NONE LISTED				
20- 29	7.50	7.50	1.00	.28	.28
30- 49	14.26	25.37	.54	.38	.69
50- 79	23.15	38.19	.72	.42	.71
80-109	12.74	17.23	.79	.14	.19
110-149	12.64	12.68	.99	.12	.12
150+	25.00	0.00	0.00	.15	0.00
University D					
0- 09	7.1	8.22	.88	1.30	1.49
10-119	15.0	31.25	.48	1.11	2.32
20- 29	9.99	11.66	.85	.39	.46
30- 49	7.22	9.74	.84	.21	.29
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				
University E					
0- 09	NONE LISTED				
10- 19	NONE LISTED				
20- 29	5.36	5.52	.97	.212	.219
30- 49	6.69	7.23	.93	.17	.19
50- 79	NONE LISTED				
80-109	NONE LISTED				
110-149	NONE LISTED				
150+	NONE LISTED				

APPENDIX B

APPENDIX B

ECONOMICS

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times E}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
1	NONE LISTED				
2	6.30	24.71	.42	.15	.52
3	4.86	8.49	.64	.08	.13
4	4.82	6.24	.81	.69	.84
5	4.89	6.27	.81	1.32	1.29
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University B					
1	4.09	8.21	.52	.08	.17
2	4.09	5.16	.80	.10	.13
3	8.04	9.32	.88	.38	.44
4	4.54	5.06	.91	.19	.21
5	4.83	5.20	.93	.10	.11
6	9.56	29.11	.37	.41	1.26
7	NONE LISTED				
8	NONE LISTED				
9	2.60	2.70	.97	.11	.11
University C					
1	8.44	54.59	.44	.06	.51
2	8.16	16.11	.59	.25	.54
3	8.11	11.71	.76	.83	1.08
4	8.78	11.82	.78	.40	.55
5	8.72	16.85	.67	.81	1.59
6	9.89	9.88	1.00	1.33	1.33
7	NONE LISTED				
8	NONE LISTED				
9	8.18	9.09	.90	.82	.91
University D					
1	9.42	97.74	.32	.09	.90
2	9.98	23.67	.52	.45	1.26
3	9.86	17.16	.64	.80	1.45
4	8.99	10.96	.87	.78	1.02
5	11.81	11.60	1.01	.48	.47
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				

(Economics Con't)

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University E					
1	6.16	13.33	.62	.09	.15
2	8.60	14.91	.59	.18	.31
3	10.88	15.75	.80	.64	.78
4	8.14	9.30	.88	.57	.66
5	5.73	5.73	1.00	.82	.82
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	5.45	.00	.00	.00	.00

EDUCATION

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
1	5.75	6.94	.84	.23	.27
2	5.53	6.38	.88	.21	.23
3	6.58	9.70	.69	.47	.65
4	10.43	14.98	.78	1.11	1.45
5	NONE LISTED				
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	3.42	6.56	.63	.14	.25
University B					
1	5.37	5.89	.92	.43	.47
2	5.59	5.37	1.07	.70	.69
3	4.01	4.66	.87	.45	.52
4	3.66	3.65	.88	.59	.58
5	3.67	6.22	.73	.37	.62
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University C					
1	NONE LISTED				
2	NONE LISTED				
3	NONE LISTED				
4	NONE LISTED				
5	NONE LISTED				
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	31.42	62.35	.60	4.86	9.01
University D					
1	4.83	7.48	.71	.22	.29
2	3.89	4.26	.93	.49	.52
3	4.87	5.22	.92	.67	.71
4	7.48	7.48	1.00	1.50	1.50
5	NONE LISTED				
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	1.35	1.82	.80	.09	.11

LAW

Level of Instruction	C/H	C/(H X A/E)	A/E	C/(H X E)	C/(H X A)
University A					
1	NONE LISTED				
2	9.37	21.62	.51	.15	.35
3	6.02	7.81	.78	.11	.13
4	6.80	10.30	.71	.14	.21
5	5.17	6.79	.78	.10	.13
6	6.16	7.24	.84	.25	.29
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University B					
1	6.19	8.08	.79	.12	.17
2	7.14	8.17	.88	.11	.12
3	5.54	5.87	.95	.095	.103
4	10.57	11.09	.95	.14	.15
5	7.05	7.92	.89	.10	.11
6	9.33	9.63	.97	.218	.220
7	3.73	6.86	.72	.07	.12
8	NONE LISTED				
9	NONE LISTED				
University C					
1	10.29	40.80	.27	.05	.20
2	12.48	42.56	.38	.16	.98
3	17.66	37.00	.48	.35	.84
4	15.38	28.74	.64	.47	1.77
5	19.69	31.10	.65	.18	.28
6	13.48	21.99	.65	.19	.30
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University D					
1	11.47	31.51	.39	.07	.19
2	9.91	12.41	.81	.15	.18
3	10.62	12.24	.87	.19	.22
4	10.56	12.41	.87	.16	.19
5	11.07	13.16	.84	.21	.25
6	10.90	12.58	.87	.29	.34
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				

(Law Con't)

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University E					
1	4.66	9.62	.51	.07	.14
2	12.01	23.18	.55	.45	.85
3	3.59	3.87	.93	.09	.096
4	3.70	4.08	.91	.08	.09
5	3.30	3.81	.90	.08	.09
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				

ENGINEERING

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
1	NONE LISTED				
2	7.89	21.32	.47	.12	.31
3	7.01	11.70	.71	.24	.34
4	6.02	7.58	.83	.26	.31
5	6.56	10.20	.72	.28	.43
6	6.59	7.28	.92	.32	.35
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University B					
1	5.87	8.02	.78	.17	.22
2	6.08	6.85	.90	.33	.36
3	6.00	6.88	.91	.68	.76
4	6.44	7.13	.92	.61	.67
5	6.09	6.90	.93	.85	.94
6	6.43	7.23	.93	1.49	1.74
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University C					
1	10.39	54.84	.27	.12	.57
2	9.84	24.15	.57	.16	.30
3	9.73	21.18	.52	.19	.38
4	10.61	21.82	.54	.32	.64
5	9.84	12.89	.79	.69	.87
6	10.71	13.62	.89	.87	1.07
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				

PHARMACY

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
1	NONE LISTED				
2	9.76	11.57	.89	.94	1.11
3	6.17	9.80	.68	.87	1.33
4	7.54	11.04	.75	1.16	1.81
5	12.69	18.11	.75	1.22	1.66
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University B					
1	9.45	61.37	.20	.09	.56
2	8.68	31.18	.34	.38	1.36
3	8.04	17.65	.48	.60	1.29
4	8.77	17.89	.55	.97	1.97
5	7.47	9.26	.83	1.20	1.46
6	8.86	10.69	.90	1.86	2.35
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University C					
1	7.10	11.91	1.05	.77	1.37
2	5.65	9.08	.72	.77	.99
3	NONE LISTED				
4	6.73	33.68	.73	.31	1.53
5	7.17	8.03	.92	.80	.89
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University D					
1	3.52	8.35	.46	.12	.28
2	4.12	5.49	.90	.27	.31
3	3.55	3.59	.99	.301	.305
4	3.97	5.51	.73	.27	.37
5	3.97	3.97	1.00	.67	.67
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	3.58	.00	.00	.12	.00

DENTISTRY

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
1	NONE LISTED				
2	5.13	5.26	.99	.45	.46
3	7.35	8.94	.94	1.48	1.86
4	5.70	5.68	1.01	.82	.81
5	8.06	8.58	1.07	.699	.696
6	8.92	9.12	.98	1.16	1.18
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University B					
1	12.01	23.80	.56	.29	.57
2	7.38	9.26	.87	.24	.30
3	14.97	17.44	.88	.52	.60
4	11.44	11.40	.91	.36	.36
5	27.70	52.71	.92	1.73	3.30
6	13.6	13.71	.94	.85	.86
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University C					
1	6.01	21.99	.38	.11	.41
2	13.27	18.45	.74	.62	.86
3	13.00	17.58	.82	.89	1.19
4	11.00	21.60	.73	.85	1.69
5	10.72	16.00	.85	.86	1.21
6	15.63	42.61	.76	.73	1.92
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University D					
1	NONE LISTED				
2	6.53	6.30	1.07	1.31	1.26
3	8.67	16.97	.54	.67	1.31
4	6.56	7.12	.93	1.64	1.78
5	10.11	10.11	1.00	2.53	2.53
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				

(Dentistry Con't)

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University E					
1	3.04	6.88	.50	.07	.15
2	3.69	4.54	.82	.19	.24
3	3.82	6.63	.59	.28	.48
4	3.88	5.15	.80	.23	.31
5	4.82	5.15	.92	.43	.46
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				

MEDICINE

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
1	24.29	26.99	.90	1.21	1.35
2	15.66	15.66	1.00	1.57	1.57
3	10.52	11.11	.95	.80	.84
4	15.99	17.48	.92	1.44	1.52
5	NONE LISTED				
6	NONE LISTED				
7	NONE LISTED				
8	NONE LISTED				
9	NONE LISTED				
University B					
1	15.67	24.19	.81	.59	.99
2	24.48	34.08	.84	13.01	14.19
3	55.95	67.69	.78	1.25	1.51
4	19.81	21.80	.91	.41	.44
5	29.78	34.36	.99	.87	1.01
6	22.57	27.21	.96	3.21	4.05
7	2.50	.00	.00	.36	.00
8	NONE LISTED				
9	NONE LISTED				
University C					
1	7.50	15.84	.51	.18	.40
2	11.67	15.93	.71	.13	.20
3	41.59	75.08	.65	.84	1.51
4	10.08	15.73	.72	.14	.20
5	21.98	22.72	.97	.36	.37
6	20.15	30.71	.63	.42	.60
7	9.64	9.85	.98	.243	.245
8	17.50	18.10	.97	.19	.20
9	NONE LISTED				
University D					
1	7.46	7.46	1.00	.23	.23
2	7.18	8.30	.88	.21	.24
3	6.92	7.86	.89	.23	.26
4	6.71	9.03	.83	.61	.72
5	16.48	17.86	.89	.62	.67
6	9.76	14.89	.76	.54	.83
7	7.91	9.35	.86	.85	.94
8	8.25	11.45	.75	1.38	1.91
9	NONE LISTED				

(Medicine Con't)

Level of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University E					
1	5.14	5.96	.87	.12	.15
2	3.82	4.15	.90	.15	.16
3	7.25	7.84	.95	.19	.21
4	7.77	8.21	.97	.18	.19
5	6.88	7.14	.95	.218	.22
6	5.87	5.95	.99	.231	.234
7	5.45	5.62	.97	.21	.22
8	NONE LISTED				
9	NONE LISTED				

APPENDIX C

APPENDIX C

ECONOMICS

Type of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
I	5.16	9.71	.75	.77	.91
II	5.44	17.68	.43	.47	.51
III	5.72	5.91	.97	.18	.18
University B					
I	5.39	8.83	.73	.19	.31
II	NONE LISTED				
III	NONE LISTED				
University C					
I	8.65	13.64	.74	.63	.96
II	8.16	43.48	.43	.20	.66
III	NONE LISTED				
University D					
I	9.93	30.93	.65	..57	1.13
II	4.29	11.18	.38	.07	.19
III	NONE LISTED				
University E					
I	7.89	11.29	.78	.46	.54
II	NONE LISTED				
III	NONE LISTED				

EDUCATION

Type of Instruction	$\frac{C}{H}$	$\frac{C}{H \times E}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
I	5.01	6.65	.78	.15	.20
II	7.54	9.42	.83	.72	.91
III	6.67	8.60	.88	.31	.38
University B					
I	4.55	5.12	.93	.51	.57
II	5.47	5.72	.96	.64	.66
III	NONE LISTED				
University C					
I	31.16	61.57	.61	5.19	9.54
II	NOT LISTED				
III	NOT LISTED				
IV	33.3	68.08	.50	2.44	5.09
University D					
	NOT AVAILABLE				
University E					
I	4.13	4.92	.87	.43	.46
II	4.70	5.81	.87	.62	.67
III	NONE LISTED				

LAW

Type of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
I	6.68	10.62	.73	.15	.23
II	NONE LISTED				
III	NONE LISTED				
University B					
I	6.73	8.00	.86	.12	.14
II	NONE LISTED				
III	NONE LISTED				
University C					
I	14.31	37.46	.45	.21	.75
II	6.95	13.21	.60	.07	.11
III	NONE LISTED				
University D					
I	10.71	14.59	.80	.19	.23
II	NONE LISTED				
III	NONE LISTED				
University E					
I	5.31	8.72	.76	.15	.24
II	4.70	5.34	.88	.09	.11
III	NONE LISTED				

ENGINEERING

Type of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
I	6.73	10.18	.80	.27	.36
II	6.89	14.59	.61	.17	.30
III	NOT LISTED				
University B					
I	6.08	7.05	.89	.63	.71
II	5.39	7.30	.79	.27	.33
III	6.62	7.74	.90	.57	.65
University C					
I	10.68	27.65	.59	.46	.72
II	9.76	39.56	.40	.20	.57
III	9.90	14.81	.69	.24	.34

PHARMACY

Type of Instruction	$\frac{C}{H}$	$\frac{C}{H \times E}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
I	9.38	13.15	.79	.96	1.29
II	10.76	15.12	.70	1.43	2.10
III	6.11	8.40	.83	.64	.91
University B					
	NOT AVAILABLE				
University C					
I	10.35	26.20	.60	1.12	1.80
II	7.06	19.78	.56	.75	1.32
III	7.71	15.62	.60	.80	1.49
University D					
I	8.00	37.08	.87	.68	2.02
II	6.12	9.65	.82	.64	.93
III	6.24	10.22	.89	1.22	1.91
University E					
I	3.67	5.06	.82	.33	.39
II	4.25	6.05	.82	.32	.40
III	3.58	3.58	1.00	.30	.30

DENTISTRY

Type of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
I	7.22	7.87	1.00	1.03	1.20
II	4.62	4.72	1.01	.67	.69
III	12.105	12.099	.98	1.31	1.33
University B					
I	16.2	12.93	.87	.36	.41
II	10.8	16.62	.77	.33	.48
III	16.3	21.93	.89	.85	1.16
University C					
I	9.40	20.23	.65	.47	.83
II	12.0	18.84	.74	.67	1.00
III	15.00	52.29	.70	1.05	2.82
University D					
I	7.69	7.69	1.00	1.85	1.85
II	NONE LISTED				
III	8.62	11.61	.83	1.61	1.86
University E					
I	3.64	4.95	.76	.23	.30
II	4.08	5.97	.73	.26	.34
III	3.60	5.03	.75	.25	.36

MEDICINE

Type of Instruction	$\frac{C}{H}$	$\frac{C}{H \times \frac{A}{E}}$	$\frac{A}{E}$	$\frac{C}{H \times E}$	$\frac{C}{H \times A}$
University A					
I	15.12	17.00	.89	1.36	1.47
II	16.38	17.25	.96	1.27	1.32
III	3.68	3.68	1.00	.37	.37
University B					
I	29.5	37.06	.89	1.63	2.02
II	19.30	34.53	.86	2.00	3.43
III	20.57	22.58	.93	5.10	5.59
University C					
I	12.30	18.86	.66	.20	.35
II	16.04	24.49	.84	.32	.48
III	12.56	12.75	.99	.368	.371
IV	.00	.00	1.00	.00	.00
University D					
I	7.98	9.48	.87	.52	.59
II	11.96	13.42	.86	.55	.67
III	8.46	12.49	.79	.55	.79
University E					
I	4.94	5.24	.95	.16	.17
II	8.65	9.24	.94	.26	.27
III	4.48	4.63	.97	.165	.169