DOCUMENT RESUME

ED 039 730 | 56 | EM 008 063

AUTHOR Johnson, F. Craig; Dietrich, John E.
TITLE Cost Analysis of Instructional Technology.
INSTITUTION Academy for Educational Development, Inc., Washington, D.C.
SPONS AGENCY Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO BR-8-0571
PUB DATE [70]
NOTE 19p.; This is one of the support papers for "To Improve Learning; a Report to the President and the Congress of the United States by the Commission on Instructional Technology", ED 034 905

EDRS PRICE EDRS Price MF-$0.25 HC-$1.05
DESCRIPTORS *Cost Effectiveness, Educational Finance, *Instructional Technology, Program Budgeting, Resource Allocations

ABSTRACT

Although some serious limitations in the cost analysis technique do exist, the need for cost data in decision making is so great that every effort should be made to obtain accurate estimates. This paper discusses the several issues which arise when an attempt is made to make quality, trade-off, or scope decisions based on cost data. Three methods of cost analysis of instructional technology are presented. One method assigns costs from academic budget funds, a second from direct instructional salary costs, and a third from direct and indirect costs. To illustrate how several cost analysis methods can be applied to a single use of instructional technology, the three-year operation of closed ciruit television at Michigan State University is described. A short list of references is appended. (JY)

COST ANALYSIS OF INSTRUCTIONAL TECHNOLOGY

by F. Craig Johnson and
John E. Dietrich*

At present, cost data on educational technology is almost nonexistent. The lack of these data severely impedes the academic decision-making process. Regardless of costing procedures used (several are suggested below), ways must be found to place costs of educational technology in perspective. Present inadequate cost data are frequently so subjective that they are nothing more than pious hopes. The time is here to come to grips with the reality of cost analysis in the academic decision-making process.

Cost benefit analysis is typically used to help make a choice among alternatives when confronted with several products or plans which yield similar results. Seldom in higher education is this the case. Similar results are rarely found or even stated as desirable objectives. Rather than facing alternate paths, fiscal planning is a process of justifying past action with little concern for uniform results. Based on the decade of experience with cost analysis at Michigan State University in the Office of Institutional Research and special studies done by Professor Gardner M. Jones of the Department of Accounting and Financial Administration, we have come to several realizations which bear directly on cost analysis of instructional technology. (Jones, 1965.)

Problems of Cost Analysis

Costs are seldom linear. When we plot quarter-by-quarter expenses relative to a course against enrollments, we find some expenses directly proportional, some scattered, and others independent of enrollment. Other expenses are fixed over narrow ranges of volume but variable over wide ranges of volume.

* F. Craig Johnson is professor and research associate, Division of Instructional Research and Service, Florida State University. John E. Dietrich is assistant provost at Michigan State University.

Cost records are not adequate. Because costs are not linear, we find we need, for planning purposes, to make studies of individual expense categories separately. We do not, nor do other universities, maintain historical records of expense categories in sufficient detail over long enough periods to construct meaningful expense output relationships.

Not all relevant costs appear in the accounts The notion of "opportunity costs" is important in considering how resources are used. If a faculty member's time is used for research, the opportunity for him to teach is lost. The loss of his time for one purpose is valued by the lost opportunity to use his time in another way.

Data on teaching loads are unreliable. We collect data on teaching, research, service, and administration time spent by faculty. The methods for distributing the time are as varied as the definitions of a "full load." In most cases, the department chairman or his secretary fills out the forms for the faculty. Sir Josiah Stamp's famous story serves as an appropriate caution here. (Stamp, 1929.)

> The individual source of the statistics may easily be the weakest link. Harold Cox tells the story of his life as a young man in India. He quoted some statistics to a Judge, an Englishman, and a very good fellow. His friend said, 'Cox, when you are a bit older, you will not quote Indian statistics with that assurance. The Government is very keen on amassing statistics--they collect them, add them, raise them to the nth power, take the cube root and prepare wonderful diagrams. But what you must never forget is that every one of those figures comes in the first instance from the chowty dar (village watchman) who just puts down what he damn pleases.'

Gardner Jones (Jones, 1965), after many years of trying to make cost analyses of instructional technology at Michigan State, concludes:

> Evaluation of instructional costs in a large modern university is a baffling exercise in splitting joint costs and measuring intangible, invisible joint products, in a type of establishment where established accounting procedures and employee personalities are not geared to cost accounting.

Uses of Cost Analysis in Decision Making

These serious limitations in the cost analysis technique do not diminish in any way the need for cost data even at the highest levels of decision making in our Federal Government. On June 2, 1965, for example, in hearings before the Education Subcommittee of the United States Senate Committee of Labor and Public Welfare, cost data on instructional technology were presented in support of Senate Bill S. 600. Those testifying for Michigan State were impressed and concerned by the Senators' eager acceptance of cost data. (Schuller, 1965.) State legislators and university trustees often feel more comfortable with cost data than with the less familiar problems of the esoteric research and teaching topics faculty often discuss. Within the universities, the availability of adequate cost data for instruction and particularly educational technology is of paramount importance in making academic administrative decisions.

Michigan State University has made some attempts to collect adequate cost data and to use it as a base for making cost decisions. In our experience, several issues arise as we try to make quality, trade-off, or scope decisions based on cost data.

Cost Decisions. Unless there are radical differences in cost, academic administrators seldom make decisions on cost alone. Obviously, the cheapest instructional model (for example the correspondence course) is not the prime criterion for acceptability.

If CCTV, for example, were radically more expensive, a clear-cut cost decision could be made to eliminate it. On the other hand, if CCTV costs indicated extreme savings while gaining general quality acceptance, a cost decision could be made to expand its use. Usually, however, these academic decisions involve additional factors.

Cost-Quality Decisions. The costs of CCTV seem to be reasonably similar to traditional modes of instruction unless the number of students involved in each course exceeds 500. If a pure cost decision were made, CCTV might be eliminated for all courses whose enrollments numbered less than 500. The cost-quality problem is not so simple. Some of the most significant uses of television may well be the highest cost uses; e.g., magnification of surgical procedures or the introduction of materials not otherwise available in the ordinary classroom. Decisions now become more subject to cost-quality decisions as to what method at what cost will produce the "best" educational result.

To cite an additional example, initial cost figures for multi-media laboratories, if they include the cost of material preparation, are clearly more expensive than traditional instruction unless very large numbers of students are affected. A pure cost decision would reduce or eliminate multi-media laboratories. However, in the case of the SLATE laboratories (Structured Learning And Training Environment) at Michigan State University, there appears to be some increase in learning and a vast improvement in student attitude (11% of the students approve of the traditional laboratories; 93% approve of the SLATE laboratories). In this instance a cost-quality decision has led to the further expansion of the multi-media laboratories. (Davis, 1968.)

Cost-Quality-Trade-Off Decisions. If the administrator assumes reasonably comparable costs and reasonably comparable learning and attitudinal responses, how then can a decision be made? Frequently, these decisions are reached in terms of trade-offs. For example, specialized problems of time, movement and space at Michigan State demand the continuation of closed circuit television. Without a CCTV network, Michigan State would have less adequate use of student stations, less adequate use of afternoon and evening class hours, more long distance student movement about the campus, higher student density on the central campus, more repetition of lectures by senior faculty, and in addition would have to build additional auditoria. These factors then must be traded off against any differential in costs. However, without knowing the comparative costs of CCTV, a trade-off decision becomes almost impossible.

Cost-Trade-Off-Scope Decisions. There is fear and insecurity on university campuses about the possibility that the "machines" may take over higher education. There is some basic logic to this fear. Indeed, in some large beginning courses or small departments that rely heavily on lecture presentations, it would be possible, for example, for CCTV to replace the entire faculty. Thus, the university administrator is faced with cost-trade-off-scope decisions.

Again using CCTV as an example, there is a point at which a given "originations facility" reaches capacity. Any further expansion implies the complete duplication of the entire system of both machines and crews. Despite the fact that CCTV may have proved its economy and quality, the academic decision is now one of trade-off and scope.

At Michigan State we "believe" (a subjective judgment) that students should be given as many different kinds of instructional situations as is feasible. For example, it may be decided to limit CCTV to its present capacity regardless of cost factors, even though other instructional models may be more expensive. A trade-off is chosen to "protect" the students' education.

The application of this principle may well affect all kinds of educational technology. Despite the fact that comparative cost no longer is a consideration, no rational, though subjective, decision can be made without realistic cost figures as a base point. The following sections present the several attempts Michigan State University has made to establish some base points for instructional technology.

Cost Analysis of Instructional Technology

There are three ways to analyze instructional technology costs using student credit hours as the measure of productivity. The first assigns costs from academic budget funds, the second from direct instructional salary costs and the third from direct and indirect costs.

SCH/Academic Budget Expenditures. The simplest way to measure cost of instructional technology is to divide the cost of the technology by the number of students taught and get a cost-per-student enrollment figure. (If it cost $100 to produce a slide-tape segment and 500 students used it during the year, the cost per student is $.20.)

Certain technology cannot be treated in this simple manner. Television, for example, might be used more than once by each student during the term.

Some universities compute use of television by adding up enrollments in all courses in which TV is used at least once and then dividing by the annual cost of operating the system. (If courses enrolling 20,000 students use TV during the year and the system costs \$60,000 to operate and amortize, the cost per student is \$3.00 per student.) A refinement of this transforms student enrollments into SCH's, and assuming a three credit average, the cost is \$1.00 per SCH. This technique obviously gives television undue credit, and the cost figures are unrealistic.

A more realistic way of counting instruction using technology is to add up only the time per week a student is actually interacting with the medium. One formula which can be used is to calculate technology SCH:

$$TSCH = \frac{\text{credits}}{\text{class hours per week}} \times T \text{ hours} \times \text{Enrollments}$$

where

T = Technology

SCH = Student Credit Hours

Example: CCTV is used in a three credit course with five class hours per w ek. Two of the five class hours are on TV and there are 60 students in the course.

By substitution:

$$TSCH = 3/5 \times 2 \times 60$$

$$= .60 \times 120$$

$$= 72$$

This formula can be applied to courses which only use media occasionally during the term by substituting <u>term</u> class hours for <u>weekly</u> class hours.

$$TSCH = \frac{\text{credits}}{\text{class hours per term}} \times \text{T hours} \times \text{Enrollment}$$

Example: Films are shown four times during a ten week five credit course that meets five timesper week and enrolls 1,000 students.

By substitution:

TSCH = 5/50 x 4 x 1,000

= .10 x 4,000

= 400

SCH/Direct Instructional Salary Costs. A second way to arrive at a cost estimate is to use direct instructional salary cost data applied to courses in which technology is used. In order to understand this technique, several basic definitions need to be presented.

1. Student Credit Hour Production (SCH). The number of students enrolled in each section multiplied by the number of credits assigned each section. Total production figures are based on a fiscal year which includes all four terms. (Each course section taught from summer term through spring term comprises the annual SCH production for the fiscal year. A three credit course enrolling 5,000 students during a given fiscal year would have an annual SCH production of 15,000.)

2. Direct Instructional Salary Costs (DISC). General fund salary dollars for academic staff (graduate student through full professor) who taught at least one student during the fiscal year and held an appointment in an instructional department or research unit. (If an associate professor with an annual salary of $12,000 per year was paid half time from Federal funds, his direct instructional salary cost would be $6,000 per year.)

3. Section Credits of Teaching (SCT). The credit-hour teaching load of an individual instructor, determined by summing credit values of classes or sections he taught. (If he taught four 3 credit sections of introductory work, three 3 credit courses for majors and one 3 credit seminar, his total section credits of teaching would be 24 for the year.)

4. Direct Instructional Salary Cost Per Course. Instructor's salary assigned to sections in proportion to the credits in the sections he taught. (If an associate professor taught 24 credits during the academic year at a direct salary cost of $12,000, then each credit he taught would be assigned $500. If he taught four 3 credit sections in the introductory courses, $6,000 would be assigned to that course.)

5. Difference Between SCH Production and DISC Expenditures. For each course the percent of the university SCH production for one year compared with the SCH production of another year and the same comparison for DISC expenditures of each course. (If a course produced .10% of the SCH with a .10% of the DISC in 1963-64, and in 1966-67 increased its SCH production to .22%, it should expect to increase its DISC to 22%. If, however, the DISC decreased to .02% in 1966-67, there would be a difference of .20%.) When this difference is computed in terms of an approximately twenty million dollar 1966-67 DISC budget, the total difference is $40,400. The arithmetic follows:

Difference Between SCH Production and DISC Expenditure
for A Sample Introductory Course 1963-64 and 1966-67

	University Total		Introductory Course			
			% of University		Actual	
	1963-64	1966-67	1963-64	1966-67	1963-64	1966-67
SCH Production	1,040,000	1,400,000	.10%	.22%	1,040	3,080
DISC Expenditure	$12,600,000	$20,200,000	.10%	.02%	$12,600	$ 4,040
Expected DISC*				.22%		$44,440
Difference				-.20%		-$40,400

*Based on SCH Growth and University DISC Budget

This technique makes it possible to compare the productivity of a given course over time. It is also possible to compare the difference between SCH production and DISC expenditures with cost of instructional technology. It is possible to do this for any course regardless of which technology was involved. For example, the unit cost savings of courses which use television and other courses which do not use television can be compared. One medium can be compared with another. General statements to those responsible for allocation of university resources can be made about the impact of media upon institutional resources.

SCH/Direct and Indirect Costs. While the two techniques described above provide a cost estimate related to student credit hour production, not all indirect and overhead costs have been assigned. An attempt to assign these costs was made by Dr. Gardner M. Jones in two separate studies of a CCTV operation. (Jones, 1965 and 1968.) He established several basic cost categories:

1. Instructional Staffing: Costs of instructional personnel or an instructional substitute therefore in the form of the instructional personnel cost portions of taped programs. Instructional personnel include all those

in the classroom, or performing on TV, but do not include student engineers or studio staff or tape room staff.

2. Room Costs: Room occupancy, including building maintenance, viewing set maintenance and repair, depreciation on classroom buildings and equipment and viewing sets, and channel charges. In the case of several courses, it also includes talkback equipment (telephones and related connections, wiring, etc.)

3. CCTV Operating Costs: This includes the costs of studio operation in the case of live telecast, and tape room operation for replays. If taping is done during live telecast, such taping is considered to be for the purpose of subsequent telecast by replay, and no part of the live telecast production cost is assigned to taping.

Administration and overhead for studio and tape room are included, and are assigned arbitrarily to the two functions of studio operations and tape room operations. For both studio and tape room, repair, maintenance, and depreciation on equipment (i.e., amortization of original cost) are recognized as necessary operating costs.

CCTV operating costs are recognized on an hours-of-operation basis. Thus, a production using xxx hours of studio time will be charged with related costs at $y.yy per hour. Tape room costs are attached similarly to replays on a time basis: so many $ per hour of replay time for a tape for a course.

Total costs of studio operation are divided by the practical studio operating capacity per year, of 2,000 hours, to arrive at an average hourly operating cost. This is the rate at which studio costs (exclusive of crew costs) are applied to programs using studio time. Total costs of tape room operation are divided by an annual tape operating capacity, 14,000 hours (7 units @ 2,000 hours each.)

The specific costs of a studio crew as required for a particular program are identified and applied on an hourly basis to the program. Some programs require differently constituted crews, thus, there is no "standard" studio crew. Crew costs, then, are not included in the "average per hour studio costs" described above.

Each of the three basic categories of cost is constructed from the "best" information available about it, and is broken down to some basic unit. Each cost is then applied to each course for each term according to the most closely identifiable related usage factor.

Any of these techniques can provide an estimate of cost-over-time of instructional technology. The difference in cost accounting and the implications of each is presented in the following section.

Three Cost Analysis Methods Applied to the Same CCTV Operation

To illustrate how several cost analysis methods can be applied to a single use of instructional technology, the three year operation of CCTV at Michigan State University was selected. This TV system is large and complex. It produces about 75,000 TV SCH per year covering 10% of the undergraduate instruction of the university. As many as seven video tape playbacks and two studios are active during peak hours with an average of four program sources feeding the system from 8:00 a.m. to 10:00 p.m. five days a week.

SCH/Academic Budget Expenditures. The first analysis, found in Table I, presents enrollments, student credit hours and television student credit hours during a three year period.

TABLE I

Basic Data For a CCTV Operation
1964-65 to 1966-67

	Enrollments	Total SCH	TV-SCH	Academic Budget Expenditures
1964-65	31,324	93,972	26,026	$228,083
1965-66	53,250	159,750	56,440	$267,426
1966-67	62,263	186,786	73,372	$303,072

Ratios of costs based on academic budget expenditures are found in Table II.

TABLE II

Cost Ratios For a CCTV Operation
1964-65 to 1966-67

	Cost Per Enrollment	Cost Per SCH	Cost Per TV-SCH
1964-65	$7.28	$2.43	$8.67
1965-66	$5.02	$1.67	$4.74
1966-67	$4.87	$1.62	$4.13

Cost ratios are computed for each of these measures. Any measure of the TV system indicates increased production without a corresponding increase in general fund expenditures. The more accurate TV-SCH is most often used at Michigan State; however, in some reports, a SCH ratio is necessary to compare costs with other data used by the university. When given the choice between reporting enrollment or student credit hour data, the enrollment figures turn out to be a better approximation of the more accurate TV-SCH figures.

SCH/Direct Instructional Salary Costs. The second analysis is found in Table III which shows the amount the CCTV system is helping to "save" instructional costs, based on the assumption that if a course produces 1% of the university SCH it should have 1% of the university direct instructional salary costs and that an increase in SCH production will yield an increase in instructional costs. Earlier in this paper it was noted that perhaps a major contribution of instructional technology is this saving in instructional costs.

TABLE III

Difference Between SCH Production and DISC Expenditures for a Sample of Ten Courses* that Did Not Use TV 1963-64 but Used TV for a Major Part of the Instruction Between 1964-65 and 1966-67.

	University Total		10 CCTV Courses			
			% of University		Actual	
	1963-64	1966-67	1963-64	1966-67	1963-64	1966-67
SCH Production	1,040,000	1,400,000	5.7%	8.4%	59,652	117,174
DISC Expenditures	$12,600,000	$20,200,000	5.2%	3.0%	$293,177	$606,690
Expected DISC				4.9%		$989,800
				-1.9%		-$383,110

*Enrollment in these 10 courses represented 63% of the total SCH produced on CCTV 1966-67.

Total General Fund Expenditures For All CCTV Operations 1966-67 $303,072

The sample includes all courses which did not use CCTV prior to the three year period but became major uses during the period. The cost comparison is between the cost of instruction prior to going on TV and the cost of instruction during the third year with equated SCH production. This analysis indicates that the growing system described in Table I is saving more in instructional costs per year than it costs in general funds to operate the system. These ten courses account for the majority of the SCH production of the entire system. An analysis could be made for the remaining courses; however, the many minor uses would require attaching so many qualifications to the analysis that its meaning would be severely limited.

Both the analyses deal only with university general fund expenditures for closed circuit television operation and direct instructional salary. They do not deal with the more complex issue of indirect and overhead cost.

SCH/Direct and Indirect Costs. The data presented in Table IV assigns both direct instructional costs and indirect costs of TV production and room occupancy to a course in accounting. A detailed breakdown of the TV production costs assigned is found in Table V.

TABLE IV

Detailed Cost Analysis of a Basic Course in Accounting

Accounting 201:

	Fall '66	Winter '67	Spring '67
Instructional Staffing	$ 7,050	$ 8,900	$ 6,800
Room Costs	730	694	456
CCTV Operations	3,859	3,859	3,859
Total Costs	$11,639	$13,543	$11,114
Sections	14	13	8
Enrollment	656	526	354
Costs per Enrollment	$17.74	$25.61	$31.66
Cost per Credit Hour	$ 3.55	$ 5.13	$ 6.40

Accounting 202:

	Fall '66	Winter '67	Spring '67
Instructional Staffing	$ 5,500	$ 7,950	$ 6,850
Room Costs	403	595	697
CCTV Operations	3,859	3,859	3,859
Total Costs	$ 9,762	$12,404	$11,406
Sections	7	11	11
Enrollment	311	461	412
Costs per Enrollment	$31.39	$26.91	$27.70
Cost per Credit Hour	$ 6.28	$ 5.38	$ 5.54

TABLE V

Detailed Cost Analysis of TV Production

Cost Per Broadcast Hour
Production Personnel:

Cameramen	2 men for	$1\frac{1}{4}$ hrs.	@ $2.96	$7.40
Director	1	$1\frac{1}{4}$	@ 3.88	3.88
Audio	1	1	@ 1.45	1.45
Video	1	1	@ 3.54	3.54

Repairs, average cost per hour of broadcast	8.50
Depreciation on equipment	10.63
Depreciation - studio	4.17
Administrative and office expense	27.64
Total Cost per hour	67.18
Hours telecast per quarter	50
	$3,359.00
Rental of talkback facility	500.00
Total	$3,859.00

The analysis made by Gardner Jones covers only one course. Here, in addition to instructional costs and CCTV operation costs, room costs are added and CCTV costs detailed on a broadcast hour base. It is interesting to note that the average cost/SCH using this technique is $4.71 and that the university carries the cost at $5.17 without the additional TV costs. Further, using the method illustrated in Table II it can be demonstrated that this course "saves" $36,491 per year in direct instructional salary costs.

A final kind of analysis is possible using the more detailed procedures of Table VI to compare the TV costs with the cost of teaching accounting without TV, based on equivalent enrollment data and the course model necessary if TV were not available. The assumptions for each term of the course are:

Assumptions: Students have two lectures a week, two recitations, all 75 minutes long.

Fall: Three lecture sections; two by full professor, one by assistant professor, who also has two recitation sections. Remaining sections staffed by graduate assistant @ $2,700 annual rate.

Winter: Same as for Fall.

Spring: Two lectures by full professor; all recitations by graduate assistants.

TABLE VI

TV and Non-TV Costs For a Basic Accounting Course

AFA 201 Summary:

	Fall '66		Winter '67		Spring '67	
	TV	Non-TV	TV	Non-TV	TV	Non-TV
Total Costs	$11,639	15,554	13,453	15,088	11,114	9,848
Per Enrollment	$ 17.74	23.71	25.61	28.68	31.66	27.51
Per Credit Hour	$ 3.55	4.74	5.13	5.74	6.33	5.50
Enrollment	656		526		354	
Lecture Sections	1	3	1	3	1	2
Ave. Lecture Size		219		175		177
Rec. Sections	14	14	13	13	8	8
Ave. Rec. Size		47		41		44

AFA 202 Summary:

	Fall '66		Winter '67		Spring '67	
	TV	Non-TV	TV	Non-TV	TV	Non-TV
Total Costs	$ 9,762	9,382	12,404	11,246	11,[illegible]6	11,246
Per Enrollment	$ 31.39	30.16	26.91	24.39	27.70	27.44
Per Credit Hour	$ 6.28	6.03	5.38	4.88	5.54	5.49
Enrollment	311		461		412	
Lecture Sections	1	2	1	2	1	2
Ave. Lecture Size		155		230		206
Rec. Sections	7	7	11	11	11	11
Ave. Rec. Size		44		42		37

As can be seen, TV costs are higher when enrollments are under 500 and TV costs lower when enrollments are over 500, suggesting a break-even point of 500. If, however, prerecorded taped lectures are used over and over for several terms, TV costs will be substantially less than non-TV even though enrollments fall well below 500.

In a music course, for example, 4 sections met fall term three times each week with two sections staffed by a full professor and two staffed by an assistant professor. When TV replaced these faculty for winter and spring terms, the TV cost showed considerable savings.

TABLE VII

TV and Non-TV Costs for a Music Course

Music 272 Summary:

	Fall '66		Winter '67		Spring '67	
	TV	Non-TV	TV	Non-TV	TV	Non-TV
Total Course Costs	$3,578	6,596	3,470	6,596	3,473	6,596
Per Enrollment	$36.88	68.00	24.10	45.80	18.90	35.84
Per Credit Hour	$12.29	32.69	8.03	15.27	6.29	11.98
Enrollment	97		144		184	
Rec. Section	5	4	4	4	4	4
Ave. Section Size	24		36		46	

Each of these analyses has its own contribution to make in gaining an understanding of cost analysis of instructional technology. Hopefully, in the years ahead, these techniques can be improved so that better decisions on the uses of instructional technology can be made.

REFERENCES

Davis, Robert H. "SLATE Your Students for Structured Self-Tutoring." College and University Business, Vol. 44, (April 1968), pp. 78-83.

Jones, Gardner M. A Procedural and Cost Analysis Study of Media in Instructional Systems Development. U.S. Office of Education Contract No. OE-3-16-030, Part B, September 1, 1965.

Jones, Gardner M. CCTV Cost Study Report. Michigan State University, 1968, (Mimeographed).

Schuller, Charles F. The Economics of Instructional Media in Higher Education. Michigan State University, June, 1965, (Mimeographed).

Stamp, Sir Josiah. Some Economic Factors in Modern Life. London: P. S. King, 1929.