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THE RELATIONSHIP BETWEEN SELECTED DEPARTMENTAL VARIABLES AND PUBLICATION PRODUCTIVITY IN THREE ACADEMIC AREAS AT MICHIGAN STATE UNIVERSITY

By

Andrew Hugine, Jr.

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ABSTRACT

THE RELATIONSHIP BETWEEN SELECTED DEPARTMENTAL VARIABLES AND PUBLICATION PRODUCTIVITY IN THREE ACADEMIC AREAS AT MICHIGAN STATE UNIVERSITY

By

Andrew Hugine, Jr.

Institutions of higher education almost universally describe their primary functions in terms of instruction, research, and public service. Of the three functions, instruction has received the greatest amount of attention for allocation purposes. While the others are equally important, investigations in the area of public service have been made difficult by a lack of a fundamental definition. On the other hand, the purposes and descriptions of research and scholarly activities are fairly well accepted and understood. And increasingly, it is being suggested by various task forces on the funding of higher education and by authorities in the field of institutional management that research activities should be subject to the same degree of scrutiny as instructional activities for allocation purposes. The purpose of the study, therefore, was to investigate the impact of

various aspects of a department's staffing, funding, instructional workload, and instructional model employed on its publication productivity.

Methodology of the Study

The sample for the study consisted of thirty-five academic departments of Michigan State University. The departments were selected and grouped on two dimensions of Biglan's Clustering of Academic Departments. The departments represented three academic areas: Applied Sciences, Natural Sciences, and Humanities-Social Sciences.

The data for the study were collected from several administrative reports and publications routinely prepared at M.S.U. for the 1976-77 academic year. The dependent variable was publication productivity which was operationalized on the basis of a composite measure of the department's published output. The thirty-five independent variables described various aspects of the department's funding, staffing, workload, and instructional model employed. Included were variables such as the number of SCH's generated, number of majors, size of the instructional staff, number of course sections offered, and average class size. Correlation and stepwise regression were employed to determine the extent of relationship between the independent and dependent variables.

Andrew Hugine, Jr.

Summary of Major Findings

1. Of the eight support variables, the amount of grant funds had the highest positive simple correlation with publication productivity in all of the areas while the size of the instructional staff had only a low correlation with publication productivity regardless of the academic area.

2. The variables which described various aspects of a department's undergraduate instructional workload were generally inversely related to publication productivity while the graduate level variables were generally positively related to publication productivity.

3. Departments that distributed their instructional workload so that some faculty members had a light teaching load generally had a higher publication productivity rate.

4. The instructional model employed by the department was found to be positively related to publication productivity. For example, departments that offered a large number of courses with large enrollments generally had a higher publication productivity rate.

5. For the simple correlations as well as for the multiple regression analyses results, the variables from the instructional output subset were predominantly related to publication productivity, thus it appeared that the instructional workload was the critical factor in determining a department's publication productivity.

This dissertation is dedicated to my wife, Abbie; my son, Andrew, III (Ron); and my parents, Andrew, Sr., and Irene.

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CHAPTER I

RATIONALE FOR THE STUDY

Introduction

The subject of resource allocation and reallocation has received increased attention in light of the current exigencies which face higher education. Funds are being cut back, maintained at current levels or experiencing a slower rate of increase in the face of rising demands for services. Other social needs including mental health, welfare, and primary and secondary education are becoming increasingly competitive in the battle for public funds and legislatures are demanding greater accountability. Also, enrollments are declining and inflation continues to reduce the effectiveness of resources that are available. At the same time, institutions are expected to offer new programs of education, research, and public service related to environmental, urban, and social problems of the American society.

While an expanding student populous or increased state and federal funding could have provided the additional revenues needed to meet these demands in the past, this is no longer the case. Instead, the flexibility needed to respond to new initiatives must be obtained through internal adjustments. As the president of a large landgrant university puts it: "The challenge which we now face is to make adjustments within the university in order to generate a part of the flexibility essential to maintain quality and initiate some new high priority academic activities and programs" (MSU Planning Document, 1977, p. 1). If this flexibility is to be obtained, then tradeoffs between program areas are inevitable. That is, existing funds must be reallocated to higher priority activities consistent with institutional missions, objectives, and resources.

The allocation decisions made may be primarily subjective in nature and to a large extent based upon tradition, cultural norms, and personal experiences, but the availability of relevant information will do much to improve the process. And judging from the rapid growth in the number of offices of institutional research and management information systems, data gathering is by no means lacking.

The mere collection and aggregation of data are not enough, however. Since administrative decisions are generally predicated on a belief in the existence of a causal relationship between some educational outcome and a particular means selected to achieve it, information only becomes useful if it helps to identify this relationship (Astin, 1974). In other words, the object of data analysis is to identify a small set of data elements and a unifying relationship which exists among them (Simpson, 1975). The relationship identified may not be as theoretically based, sophisticated, or stable as those found in economics, but it will at least raise the right questions and direct attention to important tradeoffs (Williams, 1966). Only then will the allocation process become more systematized. The end result being a procedure which is more rational and equitable, one in which the sources of judgments are more readily identifiable, and one in which resources are allocated consistent with institutional missions and objectives.

Problem

Institutions of higher education almost universally describe their primary functions in terms of instruction, research, and public service. Of the three functions, instruction has received the greatest amount of attention for allocation purposes (Toombs, 1972; Sagen, 1974). While the others are equally important, investigations in the area of public service have been made difficult by a lack of a fundamental definition. On the other hand, the purposes and descriptions of research and scholarly activities are fairly well accepted and understood. And increasingly, it is being suggested that these activities be subject to the same degree of scrutiny as instructional activities for allocation purposes.

That research and scholarship should be more carefully scrutinized is evident from the recommendations of various task forces on higher education funding and the writings of authorities in the field of institutional management. For example, the recommendation of the task force developing a formula for allocating research funds to Michigan's universities states in part

> Return on investments must be monitored, and institutions should demonstrate "acceptable" research activity in order to justify continued funding. Further, if an institution provides no results with research money, then it should be dropped from the model. (Michigan Higher Education Funding Model Task Force Recommendations, 1976, p. 17A)

Balderston (1974) in discussing the allocation of funds within the university lends further support. He states: "Where the pattern of instruction and the pattern of research and scholarship are reasonably congruent with departmental organization, as they are in most foundational disciplines, the first task is to achieve some alignment of the resources being used with evidence of the level of activity . . ." (p. 258). And Bowen (1974), though maintaining that the products of research, scholarship, and artistic creativity are difficult to measure, takes a similar stance. He states

> Despite the many problems [of measurement] we must still form judgments about the output. Inevitably we must allocate resources to producing these outcomes. [And] if there is to be any semblance of

> rationality in the allocation process, we must somehow estimate the amount or worth of the product as compared with possible returns from alternative uses of resources. (pp. 17-18)

Despite these urgings, however, very little attention has been directed to the analysis of research and scholarly activities for allocation purposes. In reviewing the literature on the topic, virtually no studies were found which addressed the subject. That is, they failed to address a fundamental question which forms the basis for allocation decisions. Namely, if funds could be diverted from other institutional programs to research and scholarly activities, what would be the rationale for doing so and what outcomes could be expected in return.

One reason that existing studies fail to provide this basis is that the primary unit of analysis in most has been the individual rather than the department. Yet, it is the department that represents the basic organizational unit in the university (Dressel, Johnson, and Marcus, 1971; Miyataki and Byer, 1976). It is to this unit that funds are allocated and faculty are assigned. It is this unit that exists primarily for the purpose of producing teaching, research, and public service. And it is at this level that allocation decisions are made. It would seem, then, that productivity would be assessed at the department rather than the course or faculty member level. Peterson (1976) provides support for this contention when he states that "the need to produce teaching, research, and service is the widely recognized reason for departmental existence, yet production is measured primarily at the course or faculty-member level." He further states that "the quantity and efficiency of departmental outcomes are seldom analyzed. However, this controversial area will probably receive greater attention as more sophisticated measures become available" (p. 29).

Although information pertaining to departmental characteristics such as instructional mode, workload requirements, student credit hours generated, financial resources, and staffing patterns is routinely collected, the impact of these parameters on research and scholarly activity remains to be investigated. What is needed at this juncture, then, is a method of combining this information in a manner that might aid institutions in making allocation decisions. Hanushek (1975) suggests that this may be accomplished by statistically analyzing the relationship between departmental parameters and research and scholarly activity outputs. If a small set of data elements which characterizes the unifying relationship which exists can be identified, it would then be possible to make some statements about the likely influence of some of these factors on publication productivity.

Purpose of the Study

The study is descriptive in nature and is intended to fill, in part, the need as already expressed for research which examines the impact of a department's instructional workload, instructional model employed, staffing, and funding on its publication productivity. The relationship between these factors or variables and the department's published output is investigated in this study. Hopefully, the analysis will identify those departmental variables that are most strongly associated with publication productivity and those which might have implications for the allocation process.

More specifically, the study will address the following questions:

1. Does the amount of supplies and services, equipment, research grant funds, and support personnel available relate to the publication productivity of a department?

2. Is there a relationship between the instructional output of a department and its publication productivity?

3. To what extent is there a relationship between the instructional model utilized by a department and its publication productivity?

4. What is the relative importance of selected departmental variables on publication productivity?

Assumptions

The assumptions of the study are the following:

1. A department's volume of published output may be explained in part using productivity and financial data routinely collected on academic units at Michigan State University. It is recognized, however, that these variables do not represent the total universe of factors which might influence a department's publication productivity.

2. The data for this study will be collected from several administrative reports and publications routinely prepared by the Registrar's Office, the Office of Institutional Research, and the Business Office at Michigan State University. Since the majority of these reports and publications are official sources of information for the university, they represent the best available source of data for this study.

Limitations and Scope of the Study

The limitations and scope of the study are the following:

1. This study is limited to an investigation of the relationship between departmental variables and publication productivity in only thirty-five of the 106 instructional units at Michigan State University.

2. While the study is primarily concerned with volume relationships, the quality of the published output cannot be overlooked. Quality, however, is multi-dimensional. In an attempt to assess it some have used peer evaluations such as the Roose-Andersen Ratings or have applied differential weightings to articles based on the "prestige" of the journal in which they appear. The fact remains, however, that there is no widely acknowledged standard by which to judge quality.

   Nevertheless, some general statements can be made regarding the "quality" of professional activities and publications. For publications in referred journals it can be assumed that articles submitted are judged by reputable members of the profession and if published, it can be assumed that at least some members of the field believe that the standards of "quality" have been met (Axelson, 1959). For professional activities such as consulting, it is generally agreed that consulting to the federal or a foreign government is more prestigious than consulting to a local government or organization (Marver and Patton, 1976).

In an attempt to incorporate the "quality" dimension, the quantitative measure of output used in the study has been limited to four types of publications which are subjected to some form of editorial review or at least the scrutiny of peers in the field.

Definition of Terms

Each subject or topic has certain words, phrases, or terms that are germane to its discussion. As is usual, these words have different meanings or different connotations dependent upon the interpretations of the reader. Consequently, to insure clarity and uniformity of interpretation, the terms listed below are defined as they will be used in the study. Other terms will carry their usual meaning.

Published output.--the noninstructional outputs of a department which result from research and scholarly, artistic, or creative activities. Operationally defined, it includes the number of books written, the number of articles published in journals or bulletins, and the number of talks or papers presented at national conferences.

Variables.--characteristics, attributes, or descriptors of a department expressed in numerical or statistical terms.

Full-time Equivalent Faculty (FTEF).--these are calculations based on the proportion of the total salary that is paid from a funding source. For example, if an individual received one-half of his salary from the Mathematics department and one-half from the Statistics Department, then each unit would be credited with .50 FTEF.

Ranked faculty.--primarily instructors, assistant professors, associate professors, and professors, but including any others such as specialists or lecturers who have teaching responsibilities.

Full-time Equivalent Total Faculty (FTETF).--the total academic staff of a department. It is the sum of the full-time equivalent faculty plus the full-time equivalent graduate assistants.

Instructional model.--refers to a method of imparting or acquiring a body of knowledge such as lecture, recitation, independent study, tutorial, and the like. Proxies used for instructional model in this study are weighted average section size, number of contact hours, number of sections, and student credit hours by type of instructional model.

Instructional output.--a measure of the instructional outcomes produced by the department such as the number of student credit hours produced.

Support variables.--refers to supplies and services, equipment, and research grant expenditures as well as the number of graduate assistants, clerical personnel, and faculty.

Contact hours.--the number of hours that faculty and students are in contact in organized classes. For example, a three-credit course taught by means of a two-hour lecture and a two-hour laboratory session represents four contact hours.

Credit hours.--weights given to effort expended by students and faculty on a course.

Organized courses.--classes meeting for a specified number of hours per week. Courses of this type are assigned fixed credit values.

Independent study courses.--learning arrangements in which student and faculty arrange on an individual basis to fulfill course requirements without requiring organized class meetings.

Student credit hours.--the credit value of a course multiplied by the number of students enrolled in the course.

Weighted average class size.--the student credit hours generated in a course divided by the total course credits.

Variable credit courses.--classes taught for different credits depending upon the nature and extent of the subject matter.

Course level.--suggests the general level of maturity which the course demands of the students (Doi, 1960). Five levels are used in this study: sub-college, lower division, upper division, graduate-professional, and doctoral.

Overview of Dissertation

In Chapter II, the pertinent literature is reviewed. The review includes a discussion of the definitions and purposes of research and scholarly activities, the measurement of individual scholarly output, the assessment of departmental prominence, objective correlates of peer ratings of departments, and correlates of individual productivity. The design of the study is presented in Chapter III, which includes the description of the sample, data, variables, and procedures of analysis. In Chapter IV, the results of the analysis are reported. The summary, findings, conclusions, and recommendations are included in Chapter V.

CHAPTER II

REVIEW OF RELATED LITERATURE

The literature on the relationship between departmental parameters and publication productivity is limited. Coolidge (1970), although referring to the impact of sponsored projects on the department, states that this lack of research is due to the macro-orientation as opposed to the micro-orientation of most studies. That is,

> . . . most authors show a far greater concern for the national and regional issues involved than they do for the problems of the individual institution. Further, when the institution is considered few of the problems mentioned deal with the financial aspects. . . ." (p. 16)

On the other hand, numerous studies have investigated the relationship between individual characteristics and publication productivity and the determinants of prestige in selected academic areas. Although these studies do not concentrate on the impact of selected parameters on departmental research and scholarly output as expressed in the hypotheses of this study, they will be reviewed to enrich the conceptual framework of the study and provide an understanding of the general nature of these professional activities. It should be noted, however, that no attempt has been made to present a comprehensive review but instead to present a representative sample of the literature in the field.

The literature review is divided into five major parts. The five parts are:

(1) Definitions and Purposes of Research and Scholarly Activities
(2) Measurement of Individual Scholarly Output
(3) Correlates of Individual Productivity
(4) The Assessment of Departmental Prominence
(5) Objective Correlates of Departmental Prestige Ratings

Definitions and Purposes of Research and Scholarly Activities

While research and scholarly activities have been a part of the university since the 1870s (Rudolph, 1962), what should be subsumed under the generic research and scholarship is still subject to debate. Dressel and others (1971) stated that it "includes all efforts dedicated primarily to the discovery and application of new knowledge" (p. 197). On the other hand, Shils (1972) maintained that the activity must culminate in a solution that receives a full critique by qualified peers in order to be considered as research and scholarship.

Blackburn (1972) in his definition pointed out the distinction that is sometimes made between research and scholarship. He stated

> Scholarship--as contrasted with research--is sometimes taken as the more general term of faculty creativity that culminates in publication. Sometimes the distinction is based on the nature of the product, the discipline in which the inquiry is conducted. In these cases, those who work principally with words (literature and history, for example) are said to be engaged in scholarship while those who utilize "hard" data (physics and economics, for example) are said to be conducting research. (p. 20)

Romney and Manning (1974) of the National Center for Higher Education Management Systems separated research, scholarship, and creative activities into two categories: specific projects and general scholarship and professional development. According to their typology specific projects include activities such as reviewing a colleague's research work, writing or developing research proposals, giving recitals, writing articles, books and reviews, and creating new art forms. While general scholarship and professional development include all activities related to keeping current in a professional field such as attending professional meetings, serving as an officer in a professional society, and serving as an editor of a journal.

Relative to purposes, Balderston (1974) cited three reasons often given. First, research and the researcher are necessary for good teaching; second, society needs new knowledge; and third, the university gains prominence through the reputation of its research scholars. Four purposes of research and scholarly activities are seen by Dressel (1976): (1) the enhancement of teaching programs, (2) improvement of the curriculum, (3) the production of knowledge which enhances or expands the basic discipline, and (4) the solution of industrial, community, and social problems.

Peseau (1975) viewed research activities as fulfilling three sociocultural purposes. These are: (1) the clarification and renewal of the cultural and social traditions of the people, (2) providing the technical expertise to the central agencies of the culture, and (3) providing a critical analysis and evaluation of the sociocultural system and its institutions through a continuous analysis of the system's trends and dynamics.

For the individual faculty member, Fellman (1971) viewed research and scholarly activities as providing for the professor "status and reputation, access to the national marketplace, an opportunity to follow his intellectual interests, a chance to render important service, and a mechanism for attracting competent graduate students" (p. 250).

Measurement of Individual Scholarly Output

One of the major problems confronting academic institutions is the evaluation of the research output of individual faculty members. The difficulty in establishing evaluative criteria "centers on the issue of quality versus quantity, in that the quality of the individual's effort is after all, the essence of scholarship" (Blackburn, 1974, p. 87). In an attempt to reconcile this quality-quantity dilemma, bibliographic counts and citation counts have been used.

Of the two measures, the more frequently employed measure has been bibliographic counts. This procedure consists of simply counting the number of publications or applying differential weightings to articles depending upon the "prestige" of the journal in which it was published. Examples of both procedures are numerous in the literature.

Lewis (1968) based his measure of productivity on the number of professors whose works appeared in the American Sociological Review (ASR) between 1956 and 1965. Knudsen and Vaughan (1969) weighted two research notes in the ASR or two articles in Social Forces as equivalent to one article in the ASR, and one book or theoretical monograph as equivalent to three ASR articles. Straus and Radel (1969) assigned two points to an edited book, four points to a jointly authored book, and six points to a solely authored book. Lightfield (1971) weighted a single article, a chapter in a book of readings or editorship of a collection, and each one hundred pages of a book as equivalent to one journal article. Meltzer (1949) weighted a book as equivalent to eighteen articles. Cartter (1966) weighted four short notes or eight book reviews as equivalent to one article, an edited work or translation as two articles, and a theoretical or research book as six articles. While these weightings were designed to incorporate a quality factor in the bibliographic counts, "none of the researchers had an objective or empirical basis for their choice of weights and several admit to the subjectivity of the weighting system they employed" (Folger and Bayer, 1966, p. 382).

Though bibliographic counts give some indication of productivity, they have limitations. Four limitations are seen by Smith and Fiedler (1971):

(1) a poorly conceived paper published in a badly edited journal will count as much as a major contribution to the field published in a well-referenced journal;

(2) it is difficult to assign an a priori weighting system;

(3) it is difficult to compare publication counts across fields since publication norms differ widely from field to field; and

(4) studies of the relation between the quantity of publication and various measures of eminence give mixed results.

The other measure of scholarly performance is citation counts. Citation indexing is predicated on the notion that the more frequently a person's work is cited, the higher its quality (Blackburn, 1974). While citation counts may be obtained from standard texts, handbooks, annual reviews, and journal articles critically reviewing the literature, the most frequently used source is the Science Citation Index. The Science Citation Index lists citations by cited senior author and citing authors. The media in which the work is published, the type of work, the year of issuance of the work, and the volume and page numbers of the work are provided.

The validity of citation counts has been investigated in several studies. Cole and Cole (1967) found that the quality of output (measured by citation counts) was more significant than quantity in eliciting recognition through the receipt of awards, appointments to prestigious academic departments, and being widely known to one's colleagues. Clark (1957) found that recognition as measured by the number of votes a person received from his peers had a higher correlation with citation counts (r=.67) than with bibliographic counts, income, or number of professional offices held.

Like bibliographic counts, citation counts have both advantages and disadvantages. Five advantages of citation counts are seen by Smith and Fiedler (1971).

1. They are not greatly influenced by quantity since a few published papers might be so outstanding that they are cited frequently.

2. Quantity of publication can be systematically eliminated by dividing the number of citations by the number of publications over a given period.

3. The index of citation is relatively easy to obtain for certain fields.

4. The index is based on evaluation of research rather than the individual.

5. A citation is in a sense a rating: it implies that the writer considers the cited work significant enough to be examined; therefore, it is an unobtrusive measure reflecting the impact or significance of a work.

Six disadvantages of citation measures have been pointed out by Cole and Cole (1971). These are:

1. Significant work may not be recognized for a considerable period of time.

2. Citations may refer to papers that are being criticized and rejected rather than utilized.

3. The number of citations a scientist receives may in part depend upon the quantity of his output. Therefore, a scientist who publishes a large number of papers and receives only a few citations for each may accumulate as many citations as the scientist who publishes only a few papers that are heavily cited.

4. Research may become so famous that it is no longer cited by name, for example $E=MC^2$.

5. If two authors have the same name, the work may appear under only one name--the author who is more renowned.

6. The number of times a scientist's work is cited may be a function of the number of people actively working in the field. Therefore, two writings of equal importance may not be cited the same number of times.

Despite the criticisms enumerated, citation counts represent the best available measure of individual scholarly performance (Smith and Fiedler, 1971; Blackburn, 1974; Folger, Astin, and Bayer, 1970; Cole and Cole, 1971).

Correlates of Individual Productivity

A problem which engages the continuing concern of most participants in the academic world is that of productivity in scholarship. Because of its significance both to the development and expansion of knowledge in the various fields and its contribution to the continued intellectual and academic viability of the faculty, numerous researchers have attempted to identify predictive correlates of research productivity. These studies may be placed into four broad categories: (1) those which deal with productivity as dependent upon time; (2) those which give some insight about productivity as it is affected by environment; (3) those which relate personal variables to faculty output; and (4) those which give some insight about productivity as it is affected by the discipline (Blackburn, 1972, 1974).

Productivity as a Function of Time

The studies of a professional's productivity as a function of time are not mutually corroborating (Blackburn, 1972). Three different age-productivity relationships are revealed in the literature.

Davis (1954) studied the scholarly productivity of the faculty at the University of Colorado between 1920 and 1939 and found that productivity peaked at age forty-five and then dropped off. His findings were later corroborated by Lehman (1953) in a study conducted five years later. His analyses revealed that the outstanding scientific achievement often occurred between the ages of thirty and forty.

Axelson (1959) studied the publication productivity of sociologists who received their Ph.D. degrees between 1936 and 1956 and noted that output rose for the first fifteen years following the receipt of the doctorate and then fell off. Bayer and Dutton (1975) observed the same trend among biochemists. Publication productivity peaked at the twentieth year after the receipt of the doctorate and then declined. Gaston (1970) compared British and American scientists and found a correlation of .65 between professional age and publication productivity.

In contrast, Pelz and Andrews (1966) discovered a saddle-shaped curve of performance with age among scientists in eleven different research settings. They noted that productivity would rise, then fall, but rise again when a scholar neared retirement. Their findings were later corroborated by Behymer (1974) in a study of 7,484 faculty members randomly selected from the respondents to a mailed survey jointly sponsored by the Carnegie Commission and the American Council on Education.

When productivity and age were examined by academic area, the same pattern was noted. Pearse and others (1976) found a saddle-shaped curve among the medical faculty at the Virginia Commonwealth University. The greatest average number of publications occurred at age forty-two to forty-four with a lesser peak at age fifty-seven to fifty-nine. For chemical engineers, Bayer and Dutton (1975) observed a peak at the tenth and thirtieth professional years and for experimental psychologists, economists, and sociologists, the first peak occurred at the tenth professional year with the second peak occurring near retirement age.

A third set of studies suggests that productivity neither peaks and then falls off nor conforms to a saddle-shape curve but instead increases continuously with age (Fulton and Trow, 1974; Roe, 1953; Behymer, 1974).

The age at first publication affects productivity as well. Clemente (1973) and Meltzer (1949) reported correlations of .20 (r=.20) and -.25 (T=-.25) between productivity and age at first publication. These statistics, according to Meltzer (1949) "suggest that certain conditions--whether psychological or situational or both--which influence the early preprofessional activity of social scientists and their production tend to persist in their influence well into the professional career" (p. 27).

Productivity as a Function of Environment

It is generally assumed that the quality of the department where one receives professional training has an impact upon the later productivity of the individual. This contention is based upon the premise that the larger and more prestigious institutions are more adequately prepared to train students in empirical research methods and techniques, have more funds available to support research activities, and renowned professors who can serve as "role models" for their graduate students (Clemente and Sturgis, 1974).

Crane (1965) in a study of 150 scientists located at three universities of varying prestige found that scientists at major schools were more likely to be productive and to win recognition than scientists at minor universities. When the educational backgrounds of the scientists were reviewed, it was found that "having attended a major graduate school had more effects on a scientist's later productivity than current location at a major university" (p. 73). Similar results were reported by Lightfield (1971), Fulton and Trow (1974), and Manis (1951).

In contrast, Clemente and Sturgis (1974) found in their study of 2,205 sociologists who received the Ph.D. degree between 1940 and 1970 that the quality of the doctoral training institution had little impact upon productivity. They concluded that "a Ph.D. from a top quality department may be a necessary, but not a sufficient condition of high productivity" (p. 295).

Related to the issue of institutional quality and productivity is the issue of size. Axelson (1960) hypothesized that greater publication productivity would be found among sociologists receiving their doctorates from the larger colleges and universities. When mean publications were compared, he observed that graduates of schools producing fewer than one doctorate per year were the least productive (.0362 articles/year), those coming from schools granting more than one but less than four doctorates were moderately productive (.0692/year), and graduates of universities granting more than four doctorates per year were the most productive (.0973/year).

Three other studies reviewed tended to support Axelson's findings. Wispe (1969) compared the size and productivity of psychology departments at sixty-seven universities and found a high correlation (r=.86, p .01) between publication productivity and department size. Oromaner (1970) looked at the relative size of sociology departments rated in the Cartter Report and observed that department size decreased as the prestige ratings decreased. Manis (1951) also reported a relationship between institutional size as measured by the production of doctorates and productivity (T=.19) but found an insignificant relationship between size as measured by faculty count and productivity.

The manner in which one distributes his time among various activities, level of courses taught, amount of funds available, and interaction with colleagues affects productivity. Through a mailed questionnaire, Andrews and Pelz (1969) found that scientists who spent full time on their technical work had a lower level of productivity than those who spent part time in administration and teaching. This led them to conclude that "the more productive people are those with moderate diversity in the content of their work" (p. 82).

Fulton and Trow (1974) and Behymer (1974) examined the relationship between the level of courses taught and publication productivity. They found that faculty who taught primarily graduate level courses published more than faculty who taught primarily undergraduate level courses.

The relationship between freedom, funds, and productivity was investigated by Meltzer (1956). He reported a correlation of .38 ($r=.38$) between the amount of funds available and the number of published papers, and a correlation of .21 ($r=.21$) between published papers and the extent to which researchers were free to direct their own inquiries.

Biglan (1973) and Hagstrom (1971) examined the impact of social connectedness (desire to work with others) and communications on productivity. It was found that high producers tended to interact and communicate with their colleagues more than did low producers.

Productivity as a Function of Personal Variables

Conspicuously absent from the studies cited thus far are intrinsic variables such as motivation, ability, satisfaction, and the sex of the individual which may be associated with research and scholarly prolificity.

Glueck and Thorp (1974) investigated the relationship between satisfaction and productivity among 252 research professors at the University of Missouri-Columbia. They found that the more satisfied the researcher was with his research environment, the more productive he was.

Meltzer (1949) and Folger, Astin, and Bayer (1970) examined the relationship between motivation and productivity. Defining motivation as the lapse time between the B.A. and Ph.D. degree, they found correlations ranging from -.14 to -.18 and -.33. Conversely, Bayer and Folger (1966) and Folger and others (1970) found an insignificant relationship between educational ability (IQ) and productivity.

Finally, interest and the gender of the individual affects productivity. Fulton and Trow (1974) and Behymer (1974) found a strong relationship between interest in research and publication output. Bernard (1964), Astin (1969), Clemente (1973), and Behymer (1974) in their studies found that men tended to be more productive than women but when other relevant variables such as disciplinary affiliation and teaching loads were removed, differences in publication productivity were negligible.

Productivity as a Function of Academic Area

The academic area of the professor affects both the nature and the amount of his scholarly output. As part of his report on the ratings of departments, Cartter (1966) compared the publication productivity of the departments of English, economics, and political science. He observed that "the correlation between reputation of the faculty of English departments and their publication records, although strongly positive, is not nearly as close as it is in economics and political science" (p. 88).

Behymer (1974) noted that "faculty in the natural sciences tend to publish more articles than faculty in the humanities but scientists write fewer books during their career than either social science or humanities faculty" (p. 22).

In a 1968 study conducted at the University of Illinois, Biglan, Oncken, and Fiedler (1971) examined both the quantity of output and the relative importance of various publication media by field. The departments were clustered according to their concern with a single paradigm (hard versus soft); concern with application (pure versus applied); and concern with life systems (life systems versus nonlife systems). The analyses revealed that scholars in applied areas produced significantly fewer monographs than did their colleagues in soft areas.

Differences were also noted in the rated contribution of various scholarly media. They observed that:

1. Scholars in hard areas rated the contribution of both patents and presentations at professional meetings more highly than scholars in soft areas.

2. Scholars in applied areas considered presentations at professional meetings and technical reports to be a greater contribution to the field than did scholars in pure areas.

3. Scholars in soft, nonlife system areas such as accountancy and English rated the popular press as a greater contribution to their field than did scholars in other areas.

These findings led them to conclude that "taken together, the results for the level of scholarly output and contribution of scholarly media point to the necessity for considering academic area when developing individual and departmental performance criteria" (p. 12).

The Assessment of Departmental Prominence

As previously noted, one purpose of research and scholarly activities is to bring prominence to an institution. Prominence like quality, however, is subjective. As Cartter (1966) aptly puts it "[prominence] is an elusive attribute, not easily subjected to measurement" (p. 4).

Despite the difficulty of measurement, institutions, if they are to be accountable, must provide some indicators of quality or excellence. Typically, quantitative indices such as the size of their endowment, the number of Ph.D. degrees granted, the number of Nobel laureates on the faculty, the number of National Merit or Woodrow Wilson scholars enrolled, and the publication records of the faculty are pointed to as being indicative of quality or prominence. A more commonly employed index, however, are departmental rankings. To obtain these ratings the opinions of "qualified" judges are elicited and then aggregated to form a rank ordering of quality in graduate departments. Though the procedure has been used in several studies (Crane, 1965; Clark, 1957; Cole and Cole, 1967) there have been only six major nationwide surveys that have attempted to assess the excellence of departments in several academic areas concurrently.

The first study was conducted by Raymond Hughes of Miami University of Ohio in 1924. He sent a questionnaire to a selected group of distinguished national scholars who evaluated the quality of graduate instruction in thirty-eight of the sixty-five universities then offering the Ph.D. degree. Hughes replicated his study ten years later for the American Council on Education. In that study he classified graduate departments into two categories: adequate and distinguished (Heiss, 1970).

In 1957, a third major evaluation was undertaken by Hayward Keniston. Since its purpose was to determine the relative position of the University of Pennsylvania to similar senior universities, only the twenty-five institutions belonging to the American Association of Universities were rated (Keniston, 1959).

In 1965, Cartter replicated and expanded the Hughes and Keniston surveys. Twenty-nine academic fields in the humanities, social sciences, engineering, physical sciences, and biological sciences at 106 institutions were ranked. The departments were rated as "distinguished," "strong," "good," "adequate," or "adequate plus," based upon the responses of 4,008 of the 5,367 department chairmen, senior scholars, and junior level faculty members surveyed.

A fifth nationwide study was conducted four years later by Roose and Andersen (1970). Though thirty-six academic fields in 130 institutions were rated, the study was essentially a replication of the 1966 Cartter Study.

More recently, Blau and Margulies (1974-75) surveyed graduate programs in accredited professional schools. On the basis of the responses of 1,181 deans, programs in architecture, business, dentistry, education, engineering, forestry, journalism, law, library science, medicine, nursing, optometry, pharmacy, public health, social work, theology, and veterinary medicine were ranked.

Since prestige rankings are based on the opinions of renowned scholars, they have a moderate degree of validity (Heiss, 1970). Despite this advantage, they have several shortcomings. Smith and Fiedler (1971) lists four:

(1) The high halo effect from which the department benefits or suffers as a result of being part of a well-or-little-known university.
(2) The considerable time lag between actual changes in a department's personnel and teaching program and the reflection of these changes in ratings by scholars at other institutions.
(3) The rater's loyalty to his doctoral alma mater or employing institution.
(4) The undue influence of departmental size since a large department is likely to be more visible than a small department.

Objective Correlates of Departmental Prestige Ratings

Since the publication of the Cartter Report in 1966, numerous investigators have been interested in establishing objective correlates with the subjective ratings of quality in graduate education. An underlying interest has been to assess the validity of the subjective ratings by comparing them to objective criteria of quality (Beyer and Snipper, 1974).

Lewis (1968) and Solomon (1972) ranked sociology departments on the basis of their publication productivity and found a close correspondence between publication output and the rankings of the departments in the Cartter and Roose and Andersen reports. In contrast, Glenn and Villemez (1970), Knudsen and Vaughan (1969), and Solomon and Walters (1975) found little correspondence between publication productivity and the American Council on Education Ratings. They noted that "the close correspondence between objective and subjective rankings holds only for those institutions at the very top" (Knudsen and Vaughan, 1969, p. 19). And that the "current prestige of graduate sociology departments is essentially a function of prior prestige rather than of staff productivity . . ." (Solomon and Walters, 1975, p. 305).

In addition to publication productivity, the impact of factors such as department size, financial resources, and departmental enrollments on prestige ratings have been investigated. Dressel and others (1971) in a study of selected departments in fifteen colleges and universities found low to moderate correlations between the Cartter ratings and the general fund budget (r=.48), research grants (r=.31), faculty size (r=.30), Ph.D. degrees granted per faculty (r=.39), and publications per faculty (r=.34).

Elton and Rose (1972) and Elton and Rodgers (1973) hypothesized that the institutional ratings of departments appearing in the Cartter Study could be predicted by the use of simple data in the public domain which incorporates variables related to size. Data were collected for each department of mathematics, physics, chemistry, geology, and psychology rated in the Cartter study. The data consisted of the following size variables: (1) number of areas of specialization within a department, (2) number of faculty, (3) number of Ph.D. degrees awarded between 1960 and 1964, (4) number of full-time students, (5) number of first-year students, and (6) ratio of part-time to full-time students.

Results of the multiple discriminant analyses indicated that the overall efficiency of prediction among the departments ranged from a high of 75 percent in physics to a low of 60 percent in mathematics. Generally, the best prediction occurred for the psychology departments rated as "attractive" and in the other departments for those rated as "extremely attractive" and "less than acceptable plus." Further, the mean departmental profiles of departments rated as "extremely attractive" and "attractive" were found to be related to number of faculty, number of Ph.D.'s awarded, and number of full-time students while profiles for departments rated "acceptable plus" and "less than acceptable plus" were influenced by number of areas of specialization, and ratio of part-time to full-time students.

Beyer and Snipper (1974) replicated Elton and Rodgers' study and added five other variables: mean faculty salary, mean research funds per faculty, percentage of faculty with doctorate degrees, and mean quality of the institution from which faculty members obtained their highest degree. It was found that the (1) quality of the department where faculty members earned their highest degree was significantly related to quality across all fields, (2) mean faculty and mean research funds per faculty were unrelated to prestige in all areas except chemistry, (3) the ratio of part-time to full-time graduate students was a fairly strong predictor, and (4) the size of department related to quality in all fields except sociology. These results generally agree with the earlier findings of Hagstrom (1971) who found, in order of significance, that research production, number of post doctoral fellows, quality of faculty members doctoral department, awards and offices held, mean time spent on research, and department size were significantly related to departmental prestige.

Biglan and others (1971) in a 1968 study at the University of Illinois observed that

> Departments which are highly rated by the ACE are also higher in number of journal articles per faculty (r=.52), number of dissertations per faculty member (r=.67), and journal article quality (r=.51). . . . The relationship with journal article quantity and quality suggest that the ACE ratings are meaningfully assessing research productivity and not just reputation. [Further] ACE ratings correlate .54 with the total number of faculty members in the department . . . which suggests that the department's visibility may be an important factor in determining a department's high ratings on the ACE measure. (p. 28)

More recently, Blau and Margulies (1974-75) identified objective indicators of prestige ratings for departments in professional schools. Their analyses revealed that

> . . . a school's library and reputation are strongly correlated in business, education and law; weakly correlated in nursing; and there is no correlation in engineering, pharmacy, and social work. [And] in engineering, pharmacy, and social work, reputation is closely related to the department's operating budget. (p. 47)

Summary

The literature on research and scholarly activities is quite replete and in some instances not mutually corroborating. Nevertheless, a number of general conclusions seem plausible based upon the literature reviewed.

First, there is a general consensus that research and scholarly activities serve three basic purposes in the university. These are the enhancement of the instructional programs, the production of new knowledge which enhances or expands the basic discipline, and the resolution of industrial and societal problems.

Second, although citation indexing has limitations, it represents the best available measure of individual scholarly output. This measure of performance is related to honorific awards and other forms of recognition.

Third, intrinsic and personal factors such as interest in research, satisfaction with the research environment, and motivation tend to be more highly correlated with indivisual research and scholarship productivity than extrinsic factors. Other conclusions regarding the correlates of individual research productivity as well as departmental prestige rankings are presented in Tables 2.1 and 2.2. The tables list the researchers and their major findings relative to the variables indicated.

Fourth, though the relationship between age and publication productivity is cyclical rather than linear, the earlier an individual earns the Ph.D. and publishes, the greater will be his publication rate.

And fifth, the majority of the studies reviewed investigated the correlates of individual productivity. That is, the unit of analysis was the faculty member. There were studies which used the department as the unit of analysis but the objective of these studies was to

TABLE 2.1.--Relationship of selected variables to Research Productivity

Variable	Researcher(s)	Findings: Relationship to Research Productivity — Related	Findings: Relationship to Research Productivity — Not Related
Prestige or Institutional Quality	Crane	X	
	Clemente and Sturgis		X
Size of Institution or department	Alexson	X	
	Wispe	X	
	Oromaner	X	
	Manis		X
Diversity of activities	Andrews and Pelz	X	
Level of Courses Taught	Fulton and Trow	X	
	Behymer	X	
Research Funds	Meltzer	X	
Interaction with colleagues	Biglan	X	
	Hagstrom	X	
Academic Area	Cartter	X	
	Behymer	X	
	Biglan and others	X	
Supportive work Environment	Glueck and Thorp	X	
Interest in Research	Fulton and Trow	X	
	Behymer	X	

TABLE 2.2.--Relationship of selected variables to Departmental Prestige

Variable	Researcher(s)	Findings: Relationship to Departmental Prestige — Related	Not Related
Faculty Publication productivity	Lewis	X	
	Solomon	X	
	Glen and Villemez		X
	Knudsen and Vaughan		X
	Solomon and Walters		X
	Hagstrom	X	
	Biglan and others	X	
Number of Ph.D. degrees awarded	Dressel and others	X	
	Elton and Rose	X	
	Elton and Rodgers	X	
Number of full-time students	Elton and Rose	X	
	Elton and Rodgers	X	
Size of the department	Dressel and others	X	
	Elton and Rose	X	
	Elton and Rodgers	X	
	Beyer and Snipper	X	
	Biglan and others	X	
	Hagstrom	X	
Ratio of full- to part-time students	Elton and Rose	X	
	Elton and Rodgers	X	
	Beyer and Snipper	X	
Quality of the faculty's doctoral department	Beyer and Snipper	X	
	Hagstrom	X	
Amount of Research grants	Dressel and others	X	
	Beyer and Snipper		X
Percent time spent on research	Hagstrom	X	
Departmental Operating budget	Dressel and others	X	
	Blau and Margulies	X	

either identify the correlates of peer rankings of departmental prominence or to determine the extent to which various types of publications converged across disciplines.

Not included in the literature reviewed, however, were studies which sought to determine the correlates of published output at the department level. As such, a void exists in the literature of the field and the lack of this information represents a handicap for institutions in their attempt to evaluate the productivity of departments and make decisions regarding the allocation and reallocation of scarce resources. This is the case because the department is the basic organizational unit in the university. Therefore, from an institutional perspective, any decisions or policies implemented to foster and increase research productivity would be directed to the department and not the individual faculty member.

Clearly then, there is a need to have available for departments the same type of information that is now available, through existing research, for the individual faculty member. That is, there is a need to determine how factors such as instructional workload, financial resources, and staffing patterns of departments affect their published output. The objective of this study is to provide some preliminary insights into the relationships which exist between these factors and the published output of departments.

CHAPTER III

DESIGN OF THE STUDY

The purpose of the study was to investigate the impact of selected departmental variables on publication productivity. Four questions were posed to guide the investigation:

1. Does the amount of supplies and services, equipment, research grant funds, and support personnel available relate to the publication productivity of a department?
2. Is there a relationship between the instructional output of a department and its publication productivity?
3. To what extent is there a relationship between the instructional model utilized by a department and its publication productivity?
4. What is the relative importance of selected departmental variables on publication productivity?

Presented below is the research design which was developed to analyze the data related to these questions. The chapter includes a discussion of the procedures followed in selecting the sample, the description and sources of the data, and the statistical procedures employed in analyzing the data.

Selection of the Sample

The sample for the study consisted of thirty-five of the 106 academic departments of Michigan State University. The principle reason for restricting the sample was the necessity of grouping departments in the analysis phase of the study. The procedures followed in selecting the sample are discussed below.

To identify departments for inclusion in the study, Biglan's (1973) three-dimensional clustering of departments was used as a frame of reference. The model, as presented in Table 3.1, clusters departments on one of three dimensions.

The first dimension, hard-soft, reflects the extent to which departments are paradigmatic. A paradigm refers to a commonly accepted set of problems for study and agreed upon methods to be used in their investigation subscribed to by all members of the field. This dimension separates hard areas such as the physical and biological sciences from soft areas such as education and the humanities which do not have a clearly defined paradigm.

TABLE 3.1.--Biglan's clustering of academic departments in three dimensions

	Hard		Soft	
	Nonlife System	Life System	Nonlife System	Life System
Pure	Astronomy Chemistry Geology Math Physics	Botany Entomology Microbiology Physiology Zoology	English German History Philosophy Russian Communications	Anthropology Political science Psychology Sociology
Applied	Ceramic engineering Civil engineering Computer science Mechanical engineering	Agronomy Dairy science Horticulture Agricultural economics	Accounting Finance Economics	Educational administration and supervision Secondary and continuing education Special education Vocational and technical education

SOURCE: From "Relationships Between Subject Matter Characteristics and the Structure and Output of University Departments" by A. Biglan, _Journal of Applied Psychology_ 57 (1973): 204-13. Copyright 1973 by the American Psychological Association. Reprinted by permission.

Another dimension, pure-applied, distinguishes departments that are concerned with practical application from those that are not. The final dimension, life systems-nonlife systems, distinguishes academic areas such as education and the social sciences which are concerned with life systems from those that are concerned with inanimate objects.

Biglan's model was appropriate for use in this study for three reasons. First, the model was developed at the University of Illinois which, like Michigan State University, is a large, state-supported institution with an extensive commitment to research and graduate education. Second, the departments are grouped based upon the similarity of their subject matter. And third, the departments within each cluster represent fairly homogeneous groupings relative to the criterion measure (publication productivity) used in this study (Biglan and others, 1971).

Using the three dimensions of Biglan's model, eight different subgroups can be formed. Since this would have resulted in small cell sizes, the model was modified as follows in order to increase the size of the individual clusters.

First, only the hard-soft and pure-applied dimensions were utilized in grouping the departments. These dimensions were chosen because they were, according to Biglan and others (1973), "the most important for distinguishing between areas" (p. 13). As a result of this modification departments could be placed into one of four groups: pure-hard, pure-soft, applied-hard, or applied-soft. The applied-soft cluster was eliminated, however, because over half of the M.S.U. departments in this cluster were in the College of Education. The organizational structure of the college made such a deletion necessary. At Michigan State University the departments in the College of Education are not administratively separate; therefore, no departmental data summaries existed for these departments. Thus, in the study only three subgroups of departments were used.

The second modification was the addition of several departments. Of the twenty-seven departments in the three selected subgroups of Biglan's model, twenty-five were at Michigan State University. These twenty-five M.S.U. departments were used as a reference group in selecting other departments for inclusion. When the M.S.U. college affiliation of the twenty-five departments was noted, it was found that they were in the Colleges of Agriculture and Natural Resources, Arts and Letters, Engineering, Natural Sciences, Communication Arts and Sciences, and Social Sciences. The Ph.D. granting departments from the above M.S.U. colleges not already included in Biglan's model which had corresponding HEGIS codes at the University of Illinois and Michigan State University were then selected. From this group, the creative and empirical liberal arts departments such as music, art, speech, and drama were excluded since they did not appear in Biglan's model. This left a total of ten departments. The ten were added to the other twenty-five department, thus increasing the sample size to thirty-five.

Despite the modifications discussed above, it was felt that the homogeneity of the clusters would not be adversely affected since (1) Biglan's model was intended to be representative of academic areas and not individual departments, (2) criteria similar to those used by Biglan in selecting departments for inclusion in his model were employed, and (3) the ability of the two dimensions, hard-soft and pure-applied, to adequately distinguish between academic areas has been validated in a previous study (Biglan and others, 1971).

The Michigan State University departments grouped on two dimensions of Biglan's model as modified are listed in Table 3.2. For the purposes of this study, the departments in the pure-hard cluster will be referred to as the Natural Sciences; those in the applied-hard cluster as the Applied Sciences; and those in the pure-soft cluster as the Humanities-Social Sciences.

TABLE 3.2.--Clustering of M.S.U. departments on two dimensions of Biglan's model

	Hard		Soft	
Pure	Biochemistry[a] Botany & Plant Pathology Chemistry Entomology Geology	Mathematics Microbiology & Public Health Physics Physiology Zoology	English History German & Russian Philosophy Romance & Classical Languages[a]	Anthropology Geography[a] Psychology Sociology Communications Political Sciences
Applied	Agricultural Economics Agricultural Engineering[a] Animal Husbandry[a] Crop & Soil Sciences[b] Dairy Science Food Science & Human Nutrition[a] Chemical Engineering[a] Horticulture	Forestry[a] Civil & Sanitary Engineering Electrical Engineering & Systems Science[a] Mechanical Engineering Computer Science Metallurgy, Mechanics, & Material Science[a]		

[a]Added utilizing the criteria discussed above.

[b]Listed as Agronomy in Biglan's model.

Data Collection

The data for the study were collected from several administrative reports and publications routinely prepared at Michigan State University. Included were the *Section Size Analysis (Fall, 1976)*, *Volume of Instruction (Fall, 1976)*, and the *Annual Evaluation and Report (1976-77)*. The first two reports are considered as primary sources of university information since they contain data that are readily verifiable and subjected to periodic audits. The third report, the Annual Evaluation and Report (AER), is considered as a secondary source of information since the data contained in this report are derived from basic sources such as the registrar's report and the financial records of the university. However, the data in the AER are still verifiable and subjected to periodic audits. From these sources, the data described below were collected for each of the thirty-five departments in the sample for the 1976-77 academic year.

The data collected were divided into two major sets: independent or explanatory variables and the dependent variable.

Dependent Variable

The dependent variable in the study was publication productivity. Publication productivity was operationalized on the basis of a composite measure of the department's published output. The development of the measure or index proceeded as follows.

First, the literature was reviewed. The purpose of the literature review was to identify the type of publications which might be appropriate criterion measures for the academic areas included in the study. Based upon the review, four types of publications were identified: journal articles, delivered papers, technical reports, and books. Consistent with the convention utilized in the majority of the studies reviewed, books were converted to journal article equivalencies. The particular weight used in this study was four. That is, each book was considered to be equivalent to four journal articles. The weight of four represents the mean of the more conservative weightings of books found in the literature.

Second, the number of books, journal articles, and technical reports written as well as the number of papers delivered at national and international professional meetings by the faculty in the sample departments was then obtained from the Professional Accomplishments section of the Annual Evaluation and Report.

In the third step, three different measures or indices of publication productivity were developed based on different linear combinations of the four types of publications identified in the literature. For the first measure, books and journal articles were combined since books were in essence equivalent to journal articles. For the second measure, technical reports and delivered papers were combined since these two types of publications were highly correlated (see Table A.1, Appendix A for results). The third measure was a simple linear combination of the four types of publications. The departmental productivity index was derived by dividing each of the linear combinations above by the number of full-time equivalent ranked faculty in the department.

During the initial phases of the analysis, the independent variables were correlated with each of the three publication productivity indices developed. When the correlation coefficients were compared, they were essentially the same for all of the indices. Consequently, it was decided to use the sum of the four types of publications as the publication productivity measure in this study.

Independent Variables

Thirty-five independent variables were included in the analysis. The thirty-five variables were divided into three major subsets. The three subsets were support, instructional output, and instructional model variables.

The support variables included the full-time equivalent faculty (FTEF), full-time equivalent ranked faculty (FTERF), and full-time equivalent graduate assistant (FTEGA) counts; the department's clerical-technical ratio; and the ratio of full-time equivalent faculty to full-time equivalent graduate assistants. These variables represent a measure of the amount of human resources available in a department to support its professional activities. Also included in the support variables was information pertaining to the financial resources of the unit. The financial data consisted of the supplies and services and equipment budgets plus the amount of research grant and contract funds available. To derive the departmental measure, each financial support variable was divided by the number of full-time equivalent faculty in the unit. The support variables were obtained from the financial records of the university as recorded in Schedule A, Section 1.3 of the Annual Evaluation and Report.

Data pertaining to the instructional output of the department made up the second set of independent variables. These included the number of student credit hours (SCH) produced at the sub-college, lower division, upper division, masters, and graduate-professional and doctoral course levels; the number of undergraduate, masters, and graduate-professional and doctoral majors;

and the number of undergraduate and graduate contact hours. Each of the instructional output variables above was divided by the number of full-time equivalent total faculty in the department. Two reports served as the sources for these data. The number of student credit hours by course level and the number of contact hours by student level was collected from the Volume of Instruction report, and the number of majors by student level was obtained from the registrar's term report as recorded in Schedule A, Section 1.3 of the Annual Evaluation and Report.

Also included in the set of instructional output variables was the percentage of the department's full-time equivalent total faculty that met in organized courses for fewer than four contact hours per week. Since four contact hours is the approximate time spent in one class, this percentage should provide an indication of how the instructional workload is handled in the department. If the percentage is small, this would tend to suggest that a differential staffing pattern is used. That is, there are a few faculty members in the department that do relatively little, if any, teaching and presumably devote their time to research. On the other hand, if the percentage is large, this would tend to suggest that the instructional workload is fairly evenly divided among the faculty and all faculty members within the department are expected to teach a comparable load as well as publish. The source of this information was Schedule A, Section 1.3 of the Annual Evaluation and Report.

The final set of independent variables described the instructional model employed in the departments. Since type of instructional model is a nominal variable, several proxies were used to describe the various models. The proxies included the weighted average section size, the number of credits taught, the number of sections offered, and the number of student credit hours produced in the lecture-recitation, laboratory-workshop, and independent study-variable credit instructional modes. All of the instructional model variables except the weighted average section size were divided by the number of full-time equivalent total faculty in the department. The Section Size Analysis report served as the source for this information.

The foregoing listings are not complete or detailed but provide examples of the type of data that was utilized in the study. The complete listing may be found in Appendix B.

Research Questions and Statistical Procedures

The basic objective of this study was to investigate the impact of various departmental variables on publication productivity. The research questions of interest and the statistical procedures used in analyzing the data are discussed below.

1. <u>Does the amount of supplies and services, equipment, research grant funds, and support personnel available relate to the publication productivity of a department</u>?

Graduate assistants, the clerical staff, supplies and services, equipment, and research grant funds perform significant tasks for the academic department. Supplies and services provide funds for journal and magazine subscriptions; the purchase of books and computer time; and travel funds which provide faculty personnel with a means of attending conferences and meetings for the purpose of maintaining active contact with their academic discipline. For the science areas, equipment funds are needed to purchase the sophisticated laboratory devices needed in advanced research. Grant funds provide a means for the department to give release time to some faculty and/or support research projects not covered by general fund monies. Graduate assistants provide additional release time by teaching many of the lower level courses. And the clerical staff performs many of the support functions such as typing, filing, and bookkeeping that are related to the administration of grants and the preparation of manuscripts. It would seem then that departments with more support funds per staff member, adequate clerical support, and a large number of graduate assistants would have a higher publication productivity rate. To ascertain whether this relationship held, Pearson Product Moment Correlation Coefficients were computed for each support variable with the measure of publication productivity. These coefficients were computed for the total sample as well as each academic group.

2. Is there a relationship between the instructional output of a department and its publication productivity?

In education, instructional output is generally expressed in terms of the number of majors, number of sections offered, and the number of student credit hours produced. Theoretically, then, these variables should impact on the publication productivity of a department. To assess the relationship between the instructional outputs of the department and its publication productivity, Pearson Product Moment Correlation Coefficients were computed for the total sample as well as for each academic area.

3. To what extent is there a relationship between the instructional model utilized by a department and its publication productivity?

The manner in which a department organizes for instruction affects the total activities of the unit. The instructional models employed vary from large lecture classes supervised by a few faculty to small multiple sections of the same course. While this organization may be determined to an extent by the academic area, it still has an impact on the professional activities of the department. To determine the extent to which the instructional model employed related to publication productivity, several proxies of instructional models were correlated with the measure of publication productivity. Pearson Product Moment Correlation Coefficients were used to assess this relationship. Coefficients were computed for the total sample as well as each academic area.

4. What is the relative importance of selected departmental variables on publication productivity?

Although many of the variables included in the study may correlate with publication productivity, there may be certain key variables which explain the relationship as well as the total set. Since parsimony was a major concern of the study, an attempt was made to reduce the total set of variables to those with the greatest explanatory power. Using the stepwise multiple regression analysis method, the relative importance of selected variables was determined by noting its contribution to the R^2. Each subset of the independent variables was regressed on the publication productivity measure and then selected variables were entered into a general regression equation. This was done for each of the academic areas as well as the total sample.

Statistical Methods Employed

Two statistical procedures were used in analyzing the data. The procedures--correlation analysis and multiple regression analysis--are discussed below.

Correlation

The research questions of this study were concerned with the association or relationship between variables. Correlation provides one means of assessing this relationship. It provides a means of determining to what extent two things are related and to what extent variations in one cause variations in the other.

The particular type of correlation analysis used in this study was Pearson Product Moment. In this type of correlation, the relationship between two variables is noted by r. The r is referred to as the coefficient of correlation and expresses the degree of linear relationship between the variables. R may take on values ranging from -1 to +1. The algebraic sign--positive or negative--indicates the direction of the relation. For example, an r of +1 would indicate a perfect positive relationship. As the value of one variable increased the other would increase also. On the other hand, an r of -1 would indicate a perfect inverse relationship. As the value of one variable increased the other would decrease.

Intermediate values, however, are not as easily interpreted. To aid in the interpretation of these values, a general guide such as the one presented below is often used (Best, 1970, p. 257).

Coefficient (r)	Relationship
00 to ±.20	Negligible
±.20 to ±.40	Low or slight
±.40 to ±.60	Moderate
±.60 to ±.80	Substantial or marked
±.80 and above	High to very high

The foregoing, however, is only a crude indication of the relationship. The significance of a coefficient really depends upon the nature of the factors being related, the number of cases involved, and the purposes of the application of the measure. As Glass and Stanley (1970) point out, "whether or not a particular r is high, low, or moderate depends upon how the two variables being correlated have been related in the past, what use one intends to make of the relationship between the variables, etc." (p. 118). To get a feel for the typical r values that may have resulted in the study, the r values reported in the literature were reviewed. The majority of the r values reported in the literature were between ±.30 and ±.60. Consequently, resulting r values in this study within this range were considered reasonable.

One other point is worthy of note regarding correlation. This point has to do with the propriety of computing correlation for sample data. Regarding the assumptions necessary for the computation of correlation coefficients, Hays (1973) points out

> It is not necessary to make any assumptions at all about the form of the distribution, the variability of Y scores within X columns or "arrays," or the true level of measurement represented by the scores in order to employ . . . correlation indices to describe a given set of data. So long as there are N distinct cases, each having two numerical scores, X and Y, then the descriptive statistics of correlation . . . may be used. In so doing, we describe the data as though a linear rule were to be used for prediction, and this is a perfectly adequate way to talk about the tendency for these numerical scores to associate or "go together" in a linear way in these data. . . . [To make inferences] beyond the sample, assumptions do become necessary. (p. 636)

Multiple Regression

Multiple regression is a general statistical technique through which one can analyze the relationship between a dependent variable and a set of independent variables. As a descriptive tool, regression can be used to: (1) find the best linear prediction equation and evaluate its prediction accuracy; (2) control for other confounding factors in order to evaluate the contribution of a specific variable or set of variables; and (3) find structural relation and provide explanation for complex multivariate relationships (Kim and Kohut, 1975).

The general linear regression model which expresses the relationship between the independent and dependent variables is:

$$Y = a + b_1X_1 + b_2X_2 + . . . b_kX_k + e$$

where:

Y = the dependent variable;

X = the independent variables;

b = the regression coefficients or weights;

a = the constant;

e = the error term or residual.

Several descriptive statistics are associated with this model. These are the multiple R, R^2, Beta, the F ratio, and the residuals.

The <u>multiple R</u> is a measure of the strength of the association between one variable and two or more other variables taken together. The index is defined to be only positive, with limits 0 and 1.

<u>R^2</u> is the coefficient of determination. It expresses the proportion of variance in the dependent variable that is dependent upon, associated with, or predicted by the independent variables combined with

the regression weights used. For example, if amount of grant funds available and the total number of student credit hours produced were regressed on publication productivity and an R^2 of .7213 was obtained, then it could be said that 72.13 percent of the variance in publication productivity is accounted for by the two variables. This statistic is also a measure of the overall "goodness of fit" of the regression equation.

The b's are the partial regression coefficients or weights applied to the X's in the attempt to optimally predict Y. The b's indicate the expected change in Y when one of the independent variables increases or decreases assuming that all of the other independent variables remain unchanged. That is, the regression coefficients indicate the rate of change in one variable per unit of change in the other.

The Beta weights are the normalized or standard partial regression coefficients. The beta coefficients are occasionally used to make statements about the relative importance of the independent variables in a multiple regression model. A beta coefficient of .7 may be interpreted to mean that a standard deviation change in the independent variable will lead to a .7 standard deviation change in the dependent variable. The coefficient of multiple determination (R^2) is the sum of the beta weights times their respective simple r's (Pindyck and Rubinfeld, 1976).

The F ratio indicates whether the regression of Y on the independent variables is statistically significant. A significant F means that the relation between Y and a linear least squares combination of the independent variables was probably not due to chance. The F statistic is used to test the null hypothesis that none of the explanatory variables helps to explain the variation of Y about its mean.

The final statistic is the residual or error term (e). The residual is the difference between the predicted Y (publication productivity) and the actual Y. The residuals are useful in locating observations that do not follow the model and observations that do, and in isolating unmodeled trends in the data (Fin, 1974).

There are several assumptions associated with the computation and interpretation of regression coefficients. For computational purposes, the following assumptions must be met.

1. The number of subjects or cases must exceed the number of independent variables. Stated symbolically, $N \geq q+1$ where N is the number of subjects and q is the number of independent variables.

2. No independent variable can be a linear combination of other independent variables.

The various significant tests associated with multiple regression are based on the following assumptions:

1. The Y scores are normally distributed at each value of X.

2. The Y scores have equal variances at each X point.

3. The error terms or residuals are normally distributed.

4. The residuals are independent.

Since the F and t tests are fairly strong or robust statistics, significance testing in multiple regression analysis may proceed without worrying too much about violations of assumptions 1, 2 (if sample sizes are equal), or 3.

The particular method of regression analysis used in the study was stepwise. The stepwise procedure works as follows. If no order of entry for variables is specified, then the variable that explains the greatest amount of variance in the dependent variable will be entered in the equation first; the variable that explains the greatest amount of variance in conjunction with the first will enter second, and so on. However, at each step variables already in the equation are re-examined to determine whether or not they still make a unique contribution to the equation. If the variable no longer provides a significant contribution, then it is removed.

The process continues until no more variables will be admitted (Draper and Smith, 1967).

The stepwise procedure does have a shortcoming, however. Because the value of the regression coefficients depend on the other variables in the equation and with the stepwise method additional variables are only entered if they make a unique contribution to the equation, variables which may be significant may not ever enter the equation. It is imperative, therefore, that the order of entry be specified so that the effects of the variables of interest to the researcher may be discerned. This procedure was recommended by several researchers (Fin, 1974; Draper and Smith, 1967; Kim and Kohut, 1975) and was followed in this study.

Despite this shortcoming, the stepwise method was appropriate for the purposes of this study because no single variable had been established as a totally appropriate evaluation criteria. Further, the stepwise procedure, according to Draper and Smith (1967), is "the best of the variable-selection procedures . . ." (p. 172).

Data Analysis

Although the study was descriptive in nature and specific hypotheses were not stated, significance levels were reported. Pearson Product Moment Correlation Coefficients, regression coefficients, and R^2 values significant at the .10 level were indicated.

The overall analysis was conducted via two statistical procedures included in the SPSS-6000, Version 6.5 as modified and adapted for use on the CDC 6500 computer at Michigan State University. The two routines were Subprogram Pearson Corr and Subprogram Regression.

Summary

In this chapter the design of the study was presented. The dependent and independent variables were defined and discussed. The sources of the data were indicated. The general research questions were stated and the procedures used in analyzing the data related to the questions were indicated. Each statistical procedure employed was discussed. This included a general overview of the technique, a description of the interpretive statistics associated with each model, the essential assumptions, and the appropriateness of the procedure for use in this study.

CHAPTER IV

ANALYSIS OF RESULTS

The study was intended to fill, in part, the need for research which examined the impact of selected departmental variables on publication productivity. The relationship between publication productivity and thirty-five variables which described various aspects of the department's staffing, funding, workload, and the like were investigated. Four questions were posed to guide the investigation. The first three questions examined the simple relationship between these variables and an index developed to describe the department's published output. Two procedures were used to analyze the data related to these questions. First, the means of the subset of variables related to that question were computed. While this step was not outlined in the design of the study, it was felt that the means of the variables would provide an overview of the similarities and differences among the groups and aid in the interpretation of the results for the correlation analysis. Second, the subset of variables relating to the question was correlated with the publication productivity measure. The fourth question investigated the combined effects of subsets of the departmental variables on publication productivity. The data related to each of these four questions are presented in this chapter.

1. Does the amount of supplies and services, equipment, research grant funds, and support personnel available relate to publication productivity?

The analysis of the data related to this question proceeded in two stages. In the first, the means of the eight support variables were computed for the three academic groups and the total sample. In the second, the eight support variables were correlated with the publication productivity measure. The results of these analyses are reported in Tables 4.1 and 4.2.

To facilitate the reporting of the data, the eight variables may be divided into two major categories: staffing variables and funding variables. The staffing variables include the graduate assistant, FTE Ranked faculty, and FTE faculty counts, variables which denote the size of the instructional staff; and the ratio of FTE faculty to graduate assistants and the clerical-technical ratio, variables which denote the size of the support staff. The funding variables include the supplies and services and equipment budgets, variables which

TABLE 4.1.--Means of the support variables in the Total Sample, Humanities-Social Sciences, Natural Sciences, and Applied Sciences

Variables	Total Sample N=35	Humanities Social Sciences N=11	Natural Sciences N=10	Applied Sciences N=14
FTE Graduate Assistant Count	10.72	13.50	19.54	2.23
FTE Ranked Faculty Count	27.53	27.34	37.14	20.80
FTE Faculty Count	20.41	26.09	28.66	10.06
Supplies and Services Budget	$ 2,675.57	$1,139.64	$ 3,856.00	$ 3,039.21
Equipment Budget	$479.34	$60.82	$875.50	$525.21
Grant funds	$13,005.74	$3,186.82	$22,302.60	$14,080.00
Graduate Assistant Ratio	2.27	1.75	1.69	4.34
Clerical-technical Ratio	3.13	4.17	2.94	2.63

TABLE 4.2.--Simple correlation of the support variables with publication productivity in the Total Sample, Humanities-Social Sciences, Natural Sciences, and Applied Sciences

Variables	Total Sample	Humanities-Social Sciences	Natural Sciences	Applied Sciences
FTE Graduate Assistant Count	-.08	.27	-.30	-.22
FTE Ranked Faculty Count	-.08	-.08	-.32	.09
FTE Faculty Count	-.13	-.17	-.21	-.24
Supplies and Services Budget	.26*	.65*	.03	-.05
Equipment Budget	.23*	.34	.04	-.08
Grant Funds	.51*	.81*	.27	.58*
Graduate Assistant Ratio	-.02	.64*	-.25	-.12
Clerical-technical Ratio	.27*	.73*	-.11	.22

*Significant at the .10 level.

describe a subset of the general fund budget; and grant funds, which describe the amount of outside support the department had attracted.

Means of the Support Variables

The data in Table 4.1 showed that the Natural Sciences had the largest instructional staff as measured by the number of graduate assistants and the FTE Ranked faculty counts. It also had more supplies and services, equipment, and grant funds than any of the other areas.

While the ratio of FTE faculty to graduate assistants in the Natural Sciences was larger, it was not significantly larger than the ratio in the Humanities-Social Sciences. Both areas had approximately two graduate assistants for each faculty member. A similar pattern emerged when the clerical-technical ratio was considered. This time, however, the ratios were similar in the Natural Sciences, the Applied Sciences, and the Total Sample. The clerical-technical ratio for all three groups was approximately three to one (3:1).

Relationship Between Support Variables and Publication Productivity

In the second phase of the analysis of the data related to this question, the eight support variables were correlated with the dependent variable, publication productivity. The resulting r values are displayed in Table 4.2 (p. 73).

<u>Staffing Variables</u>

Examination of the data in Table 4.2 revealed that the size of the instructional staff had minimal impact on publication productivity regardless of the academic area. The graduate assistant, FTE faculty, and FTE faculty counts had a low correlation with publication productivity. This low correlation may be explained by the fact that the faculty counts included graduate assistants, lecturers, and specialists who performed primarily instructional related activities and were under little, if any, obligation to publish. It follows then that the correlation would tend to be low unless the publication rate of the department as a whole was large enough to compensate for these nonpublishing individuals.

The second set of staffing variables was the ratio of FTE faculty to graduate assistants and the clerical-technical ratio. Except for the correlations in the Humanities-Social Sciences, the relationship between these two variables and publication productivity was also low. The correlations in the Humanities-Social Sciences were .64 and .73 for the graduate assistant and clerical-technical ratios respectively. Therefore, in the Humanities-Social Sciences, publication productivity increased as the size of the support staff increased.

Funding Variables

Three variables describing various aspects of the department's funding were correlated with the publication productivity measure. The first two variables, supplies and services and equipment, represented a subset of the department's general fund budget. The data in Table 4.2 indicated that both of the general fund variables had a low and significant correlation with publication productivity in the Total Sample; and supplies and services evidenced a marked (.65) correlation with publication productivity in the Humanities-Social Sciences. However, in the Applied Sciences and the Natural Sciences the correlations were extremely low.

The third funding variable described the amount of outside support the department had attracted. The data in Table 4.2 revealed that the amount of grant funds was related, at least slightly, to publication productivity in all of the groups and the correlation coefficients were statistically significant in three of the groups. The correlations were highest in the Humanities-Social Sciences (.81); lowest in the Natural Sciences (.27); and moderate in both the Total Sample (.51) and the Applied Sciences (.58). Therefore, as the amount of grant funds available to support research activities increased, the publication productivity of the department increased as well, though only slightly in the Natural

Sciences. It is noteworthy that the degree of the relationship between grants and publication productivity was not only higher than it was for the general fund variables, but of the eight support variables, grants evidenced the highest positive correlation with publication productivity in all of the groups.

As reported above, the correlations between the general fund variables and publication productivity were extremely low in the Applied and Natural Sciences and the correlation for grant funds was low in the Natural Sciences. These low correlations may be attributed to two factors. First, only the budgeted dollars for supplies and services and equipment were correlated with the publication productivity measure. As a result, the value of equipment and other supplies acquired in previous years was not included. Second, the nature of the research conducted in the Natural Sciences is quite different from that in the Humanities-Social Sciences. Quite often a three- to five-year period of time elapses between the time that a grant is received and the time that the findings are reported in published form. Since the study utilized data for only one year, the productivity measure employed in this study may not have adequately assessed the research output of the Natural Sciences. This seemed to be the case even though technical reports and papers presented at professional meetings, two types of publications that are generally prepared during the interim period of a project, were included as components of the publication productivity measure. Thus, the correlations reported may in fact be spurious. In any event, it should be noted that although the correlation between grants and publication productivity in the Natural Sciences was low, the correlation was within the range of r values reported in the literature. For example, Manis (1951) reported a correlation of .19 between grant funds and publication productivity.

2. Is there a relationship between the instructional output of departments and their publication productivity?

Two procedures were employed in analyzing the data related to this question. First, the means of the sixteen instructional output variables were computed, and second, the variables were correlated with the publication productivity measure. The results of these analyses are reported in Tables 4.3 and 4.4. To facilitate the reporting of the data, the sixteen variables were divided into three sets. The three sets were student credit hours by course level, majors by student level, and contact hours by student level.

TABLE 4.3.--Means of the instructional output variables in the Total Sample, Humanities-Social Sciences, Natural Sciences, and Applied Sciences

Variables	Total Sample N=35	Humanities Social Sciences N=11	Natural Sciences N=10	Applied Sciences N=14
Sub-college SCH	13.64	3.11	6.76	26.83
Lower division SCH	81.35	119.08	63.21	64.65
Upper division SCH	70.86	72.74	83.42	60.40
Undergraduate SCH	165.84	194.93	153.39	151.87
Masters SCH	8.85	9.52	9.59	7.80
Graduate-professional and and doctoral SCH	6.16	4.73	10.72	4.03
Total graduate SCH	15.20	14.25	20.32	11.84
Total department SCH	189.85	209.18	173.70	163.70
Number undergraduate Majors	239.00	273.00	188.00	248.00
Number masters majors	43.00	50.00	38.00	41.00
No. graduate-professional and doctoral majors	37.00	37.00	54.00	24.00
Total number department majors	318.00	360.00	280.00	313.00
No. undergrad contact hours	6.28	7.16	6.22	5.64
No. graduate contact hours	4.12	1.53	8.16	3.27
Total contact hours	10.40	8.70	14.37	8.91
Percentage FTETF with less than four contact hours	.28	.23	.31	.27

TABLE 4.4.--Simple correlation of the instructional output variables with publication productivity in the Total Sample, Humanities-Social Sciences, Natural Sciences, and Applied Sciences

Variables	Total Sample	Humanities-Social Sciences	Natural Sciences	Applied Sciences
Sub-College SCH	.20	.24	-.44*	.39*
Lower division SCH	.09	.45*	-.16	.53*
Upper division SCH	-.13	-.27	-.03	-.55*
Undergraduate SCH	.12	.24	-.34	.54*
Masters SCH	.23*	.81*	.02	.08
Graduate-professional and doctoral SCH	.23*	.22	.01	.43*
Total graduate SCH	.29*	.76*	.01	.33
Total department SCH	.17	.36	-.34	.57*
Number undergraduate majors	-.26*	.19	-.68*	-.33
Number masters majors	.03	.63*	-.21	-.01
No. graduate-professional and doctoral majors	.14	.12	-.04	.35
Total number department majors	-.20	.24	-.65*	-.26
No. undergrad contact hours	.29	.64*	.03	.43*
No. graduate contact hours	.46*	.65*	.05	.64*
Total contact hours	.47*	.74*	.04	.66*
Percentage FTETF with less than four contact hours	.47*	.15	.52*	.55*

*Significant at the .10 level.

Means of the Instructional Output Variables

Table 4.3 shows the distribution of the instructional workload by academic area and course level. For the first set of instructional output variables, the data indicated that the Applied Sciences generated more student credit hours at the sub-college level than any of the other areas. The high productivity rate of the Applied Sciences at this level reflects the off-campus public service role of the Agriculture and Natural Resources departments within this area. Because of their public service role, the departments within the College of Agriculture and Natural Resources offer many agri-business related short courses through their extension programs. At M.S.U. the student credit hours generated in these courses are counted at the sub-college level.

On the other hand, the departments within the Natural Sciences are generally considered as service departments since they offer a large number of courses for students enrolled in other programs. At the upper division, masters, and graduate-professional and doctoral levels the Natural Sciences area was the high producer. The higher SCH productivity rate at the upper division level reflects the service function of these departments to the university as a whole, while the higher SCH productivity rate at the graduate-professional and doctoral level reflects the specialized service function which the departments within the Natural Sciences perform for the medical colleges.

The second set of instructional output variables was the number of majors by student level. The Humanities-Social Sciences had the largest number of majors at all levels except the graduate-professional and doctoral. At this level, Natural Sciences had the largest number of majors.

The third set of instructional output variables was the number of contact hours by student level. The faculty in all of the areas spent approximately the same amount of time in organized courses at the undergraduate level, but there was quite a disparity at the graduate level. The contact hours ranged from a low of 1.53 in the Humanities-Social Sciences to a high of 8.16 in the Natural Sciences. Since contact hours are a measure of the amount of time that faculty spend in organized classes, the higher contact hour ratio in the Natural Sciences indicates, as would be expected, that laboratory instruction requires more faculty time.

In addition to having the highest contact hour ratio, the Natural Sciences also had the highest percentage of full-time equivalent total faculty that spent less than four contact hours per week in organized classes. Therefore, the Natural Sciences made more use of a differential staffing pattern than the other areas.

Relationship Between Instructional Output Variables and Publication Productivity

Three sets of instructional output variables were correlated with the publication productivity measure. The resulting r values are displayed in Table 4.4.

Student Credit Hour Variables

As reported in the literature, faculty members who taught primarily graduate level courses published more than faculty who taught primarily undergraduate level courses. Inspection of the data in Table 4.4 revealed that, in general, a similar relationship was true for the department. In each of the academic areas, at least one of the undergraduate SCH variables was negatively related to publication productivity. Upper division student credit hours had the highest negative correlation with publication productivity in the Total Sample (-.13), the Humanities-Social Sciences (-.27), and the Applied Sciences (-.55); while sub-college SCH had the highest negative correlation with publication productivity in the Natural Sciences (-.44). On the other hand, all of the graduate level student credit hour variables were positively related to publication productivity, though only slightly in the Natural Sciences.

Number of Majors

The relationship between the number of majors and publication productivity was essentially the same as the relationship between the undergraduate SCH variables and publication productivity. There was generally an inverse relationship between these variables and publication productivity in all of the areas except the Humanities-Social Sciences. Therefore, it appeared that the number of majors in a department had an adverse affect on the department's publication productivity in all of the areas except the Humanities-Social Sciences. The discrepancy in the direction of the relationship between the number of majors and publication productivity among the areas may be explained by the fact that the instruction in the Applied Sciences and the Natural Sciences is lab intensive and therefore requires more faculty time, particularly for the department majors.

Contact Hour Variables

Four contact hour variables were correlated with the publication productivity measure. The first three variables were the number of contact hours by student level. The data in Table 4.4 indicated that these variables were significantly related to publication productivity in three of the groups. Contact hour variables evidencing a significant correlation with publication productivity by group were: number of undergraduate contact hours (.46) and total contact hours (.47) in the Total Sample; and undergraduate, graduate, and total contact hours in the Humanities-Social Sciences and the Applied Sciences.

The fourth contact hour variable was the percentage of the total instructional staff that met in organized courses for less than four contact hours per week. This variable, which described the manner in which a department distributed its instructional workload was positively related to publication productivity in all of the groups. However, the correlations were moderate and statistically significant in the Total Sample (.47), the Natural Sciences (.52), and the Applied Sciences (.55). Thus, it appeared that in those departments where some faculty members were assigned a lighter instructional load so that they could devote more time to research, the publication productivity was higher.

3. <u>To what extent is there a relationship between the instructional model utilized by the department and its publication productivity</u>?

Two procedures were employed in analyzing the data related to this question. First, the means of the eleven instructional model variables were computed, and second, the instructional model variables were correlated with the publication productivity measure. The results of these analyses are reported in Tables 4.5 and 4.6.

Means of the Instructional Model Variables

Table 4.5 shows the means for the eleven instructional model variables. The data indicated that the Natural Sciences had the largest class sizes at the undergraduate and graduate levels and offered more course sections. This came as no surprise since the departments within the Natural Sciences' area offer a large number of service courses. However, the percentage of course sections offered in the Natural Sciences with large enrollments (greater than fifty) was small when compared to the percentage offered in the Applied Sciences.

Table 4.5 also shows the distribution of SCH by academic area and instructional model. As would be expected, the Humanities-Social Sciences generated more SCH in the lecture-recitation instructional mode than the other areas. On the other hand, the Applied and Natural Sciences generated more SCH in the laboratory-workshop instructional mode. These figures once again illustrated the point that the instruction in the Applied Sciences, and particularly the Natural Sciences, is heavily laboratory oriented.

TABLE 4.5.--Means of the instructional model variables in the Total Sample, Humanities-Social Sciences, Natural Sciences, and Applied Sciences

Variables	Total Sample N=35	Humanities-Social Sciences N=11	Natural Sciences N=10	Applied Sciences N=14
Weighted average undergrad section size	57.98	40.88	82.58	53.86
Weighted average graduate section size	17.53	13.31	28.14	13.28
Credits, organized courses	4.09	5.95	2.91	3.46
Credits, independent study-variable credit courses	3.92	3.82	3.87	4.03
Number undergraduate sections	1.46	1.42	1.71	1.30
Number graduate sections	.16	.17	.12	.17
Total number sections	1.62	1.59	1.84	1.47
Percentage sections with enrollments greater than fifty	.18	.16	.15	.21
Lecture-recitation SCH	141.54	188.15	115.87	123.25
Laboratory-workshop SCH	18.47	2.43	28.12	25.91
Independent study-variable credit SCH	10.20	9.67	14.02	7.89

TABLE 4.6.--Simple correlation of the instructional model variables with publication productivity in the Total Sample, Humanities-Social Sciences, Natural Sciences, and Applied Sciences

Variables	Total Sample	Humanities-Social Sciences	Natural Sciences	Applied Sciences
Weighted average undergrad section size	.25*	.20	-.06	.54*
Weighted average graduate section size	.37*	.74*	.15	.37*
Credits, organized courses	-.24*	-.19	-.36	.06
Credits, independent study variable credit courses	.41*	.48*	.11	.69*
Number undergraduate sections	-.07	-.06	-.21	-.09
Number graduate sections	-.19	.20	-.53*	-.29
Total number sections	-.08	-.01	-.23	-.13
Percentage sections with enrollments greater than fifty	.15	145*	.05	.13
Lecture-recitation SCH	-.09	.20	-.48*	.41*
Laboratory-workshop SCH	.53*	-.01	.65*	.58*
Independent study-variable credit SCH	.30*	.48*	.09	.54*

*Significant at the .10 level.

Relationship Between the Instructional Model Variables and Publication Productivity

Eleven variables describing the instructional model utilized in a department were correlated with the publication productivity measure. The results of these correlations are displayed in Table 4.6.

Weighted Average Section Size

With the exception of weighted average undergraduate section size in the Natural Sciences, the undergraduate and graduate section size variables were positively related to publication productivity. The correlation coefficients ranged from slight to moderate in all of the groups (see Table 4.6). Therefore, as the section size increased there was also an increase in the publication productivity rate of the department. This positive relationship may be attributed to the fact that the utilization of large section sizes allows the department to offer fewer sections of the same course and thereby provide more time for the faculty to devote to research.

Number of Credits Taught

Number of credits taught was split as a variable between organized courses and independent study-variable credit courses. There was generally a low and inverse correlation between the credits taught in organized courses and publication productivity. However, there was a positive and slight to moderate correlation between the number of credits taught in independent study-variable credit courses and publication productivity. Therefore, as the total number of credits taught in independent study variable credit courses increased, there was generally a moderate increase in publication productivity. The differences in the direction of the relationship (negative versus positive) between these two variables and publication productivity may be explained by the fact that independent study courses tend to make fewer demands on faculty time than organized classes.

Number of Sections

Four variables indicating the number of course sections offered by a department were correlated with the publication productivity measure. The first three variables were the number of sections offered by student level. The data in Table 4.6 indicated that with the exception of number of graduate sections in the Humanities-Social Sciences, there was generally an inverse correlation between publication productivity and the number of course sections offered by a department. The correlations were negligible in the Total Sample and the Humanities-Social Sciences; negligible to low in the Applied Sciences; and low to moderate in the Natural Sciences with the correlation of -.53 between number of graduate sections and publication productivity being statistically significant. These correlations generally agreed with the results reported earlier for the correlations between publication productivity and the number of credits taught in organized courses. That is, as the number of course sections offered increased, the publication productivity of the department decreased. These inverse correlations may be explained by the fact that each course section offered either requires direct instruction by faculty or supervision of graduate teaching assistants. As such, the amount of time available for noninstructional activities is reduced.

The fourth variable was the percentage of course sections with large enrollments (greater than fifty). The correlation between this variable and publication productivity was essentially the same as the correlation between the section size variable and publication productivity. The coefficients were positive in all of the areas even though the correlation was statistically significant only in the Humanities-Social Sciences (.45). As with the section size variables, the correlations for the percentage of sections with enrollments greater than fifty illustrated the point that the utilization of large classes has a positive influence on publication productivity.

Number of Student Credit Hours (SCH) by Instructional Type

The number of student credit hours produced in the lecture-recitation, laboratory-workshop, and independent study-variable credit instructional modes were correlated with the publication productivity measure. The data in Table 4.6 revealed the following: (1) the number of lecture-recitation SCH was inversely related to productivity in the Total Sample and the Natural Sciences; (2) the number of laboratory-workshop SCH was positively related to productivity in all of the areas except the Humanities-Social Sciences; and (3) the number of independent study-variable credit SCH was positively related to publication productivity in all of the groups.

4. What is the relative importance of selected departmental variables on publication productivity?

A stepwise multiple regression procedure was utilized to analyze the data related to this question. The results of the multiple regression analyses are reported in Tables 4.7 through 4.13.

The analysis proceeded in two steps. First, each subset of variables was entered into a regression equation and allowed to explain as much of the variance as possible. While it was desirable to include all of the variables within a subset so that the relative importance of the variables could be determined, it was necessary to delete selected variables in order to meet the assumption of the regression model regarding linear combinations of variables.

In deciding which variables should be deleted, the correlation of the variable with publication productivity as well as the intercorrelation among the variables within each subset was considered. For example, the variable, total number of sections, is a linear combination of the variables number of undergraduate and graduate sections. Further, the correlation between total number of sections and number of undergraduate sections was .99 in all of the groups (see Tables C.9 through C.12, Appendix C). Consequently, the inclusion of all three variables in a regression equation would not only be a violation of the nonlinearity assumption but the inclusion of both total number of sections and number of undergraduate sections would lead to multicollinearity since the two variables are so highly related. To avoid this situation, total number of sections was deleted since it would have provided redundant information and the simple correlation of both total number of sections and number of sections with publication productivity was essentially the same. A procedure similar to the one discussed above was followed in selecting the other variables for inclusion in the regression equations.

In the second step, six variables were chosen from the three subsets and included in a general regression equation. The six variables were selected as follows: from the subset of variables that explained the largest amount of the variance, three variables were chosen; from the subset of variables that explained the second highest amount of the variance, two variables were chosen; and from the subset of variables that explained the least amount of the variance, one variable was chosen.

Regression for Support Variables

Table 4.7 presents the results of the regression analysis for the support variables. The table lists the variables which were included in the regression and the relative importance of each variable as determined by its contribution to the total R^2.

Comparisons of the results across the four groups revealed that the support variables explained the highest proportion of the variance in the Humanities-Social Sciences followed, in order of decreasing R^2, by the Applied Sciences, the Total Sample, and the Natural Sciences. The comparison further revealed that one variable made the largest contribution to the total R^2 across all groups: the amount of grant funds.

Considering the individual groups, the results indicated that grants (.6496), graduate assistant ratio

TABLE 4.7.--The relative importance of selected support variables in explaining publication productivity in the Total Sample, Humanities-Social Sciences, Natural Sciences, and Applied Sciences

Variables	Contribution of Individual Variables to Total R^2			
	Total Sample R^2	Humanities-Social Sciences R^2	Natural Sciences R^2	Applied Sciences R^2
FTE Graduate Assistant Count	.0204	.1036*		
FTE Ranked Faculty Count		.0383		
FTE Faculty Count	.0018*	.0009*		
Supplies & Services Budget	.0003*	.0087*	.0061 (2)	
Equipment Budget	.0026*	.0396*		
Grant funds	.2612*	.6496*	.0708 (1)	.3349*
Graduate Assistant Ratio	.0074*	.1198*		
Clerical-technical Ratio	.0338*	.0249*		
Total R^2	.3274	.9853*	.0769	.3349*

*Significant at the .10 level.

(.1198), and graduate assistant count (.1036) together accounted for 87.30 percent of the total explained variance (.9853) by the support variables in the Humanities-Social Sciences with about two-thirds of this total variance being attributed to the amount of grant funds. For the Applied Sciences, the R^2 of .3349 was totally accounted for by the amount of grant funds.

The results for the Total Sample are presented in column one of Table 4.7. Six of the seven variables that entered the equation made a significant contribution to the total R^2. The one exception was the graduate assistant count. Subtracting the contribution made by this variable from the total R^2 leaves a significant R^2 of .3070 most of which can be attributed to one variable, the amount of grant funds (.2612). The other five support variables collectively only explained about 5 percent of the variance.

The results for the Natural Sciences are presented in column three of Table 4.7. Of the eight variables which were selected for inclusion in the regression, two, supplies and services and amount of grant funds, entered the equation. Together the two variables explained less than 8 percent of the variation in publication productivity and the R^2 was not significant.

Regression for Instructional Output Variables

Table 4.8 presents the results of the regression analysis for the instructional output variables. As before, the table lists the variables which were included in the regression and the relative importance of each variable as determined by its contribution to the total R^2.

The results revealed that the instructional output variables explained a very large proportion of the variation in publication productivity as evidenced by the relatively high R^2. The highest R^2 was obtained for the Humanities-Social Sciences (.9940) followed by the Natural Sciences (.9808), the Applied Sciences (.8889), and the Total Sample (.4549). These values were in all instances higher than the respective R^2 obtained when the support variables were entered (see Table 4.7). However, when the coefficients of multiple determination (R^2) were compared across the four groups, no variable emerged as the single best predictor as had been the case with the support variables. Nevertheless, there were individual variables which explained approximately half of the variance in each case. The variables were total contact hours in the Total Sample; graduate SCH in the Humanities-Social Sciences; percentage of the total instructional staff that met in organized courses

TABLE 4.8.--The relative importance of selected instructional output variables in explaining publication productivity in the Total Sample, Humanities-Social Sciences, Natural Sciences, and Applied Sciences

Variables	Contribution of Individual Variables to Total R^2			
	Total Sample R^2	Humanities-Social Sciences R^2	Natural Sciences R^2	Applied Sciences R^2
Sub-college SCH	.0157*	.0029*	.0200	
Lower division SCH				.1101*
Upper division SCH	.0162*			
Undergraduate SCH		.0310*	.1159	
Masters SCH				
Graduate-professional and doctoral SCH		.0250*	.1378*	.0208*
Total graduate SCH	.0009*	.5735*	.0032	
Total department SCH	.0034*			.1343*
Number undergraduate majors	.0455*			.0855*
Number masters majors	.0265*			.0647
Number graduate-professional and doctoral majors	.0154*			.0295*
Total number department majors		.0014*	.3295	
No. undergraduate contact hours	.0117*			.0004
Total contact hours	.2232*	.3485*	.0709	.4357*
Percentage FTETF with less than four contact hours	.0964*	.0117*	.3035*	.0078*
Total R^2	.4549*	.9940*	.9808*	.8889

*Significant at the .10 level.

for less than four contact hours and number of department majors in the Natural Sciences; and total contact hours in the Applied Sciences.

Considering the individual groups, the results indicated that in the Total Sample, total contact hours (.2232), percentage of the total instructional staff that met in organized classes for less than four contact hours (.0964), and number of undergraduate majors (.0455) together accounted for 36.51 percent of the total explained variance (.4549). Note that total contact hours accounted for about half of this variance by itself.

The results for the Humanities-Social Sciences are presented in column two of Table 4.8. Two variables, graduate SCH (.5735) and total contact hours (.3485), accounted for almost all of the variance explained (.9940). Were the contribution of the other five variables to be subtracted, these two variables would still explain over 90 percent of the variation in publication productivity.

The results for the Natural Sciences are presented in column three of Table 4.8. The instructional output variables explained 98.08 percent of the variation in publication productivity. Percentage of the total instructional staff that met in organized classes for less than four contact hours per week (.3035), department majors (.3295), graduate-professional and doctoral SCH (.1378), and undergraduate SCH (.1159) together accounted for 88.67 percent of the total R^2. Though undergraduate SCH and department majors did not make a significant contribution to the total R^2 when they entered the equation, their contribution can still be included since the total R^2 was significant. That is, a significant R^2 indicates that all variables which have entered the regression equation up to that point are important. This is true because the value of the regression coefficients and in turn the R^2 is dependent upon all of the other variables in the equation.

Finally, in the Applied Sciences, the total R^2 obtained was .8889. Of the nine variables that entered the equation seven variables made a significant contribution to the total R^2. These seven instructional output variables collectively explained 82.38 percent of the variation in publication productivity with total contact hours (.4357), department SCH (.1343), and lower division SCH (.1101) accounting for over two-thirds of this total (see Table 4.8).

Regression for Instructional Model Variables

The results of the regression analysis for the instructional model variables are reported in Table 4.9. The table lists the variables which entered the equation and the relative importance of each variable as determined by its contribution to the total R^2.

TABLE 4.9.--The relative importance of selected instructional model variables in explaining publication productivity in the Total Sample, Humanities-Social Sciences, Natural Sciences, and Applied Sciences

Variables	Contribution of Individual Variables to Total R^2			
	Total Sample R^2	Humanities-Social Sciences R^2	Natural Sciences R^2	Applied Sciences R^2
Weighted average undergrad section size				.0305*
Weighted average graduate section size	.1734*			.1074*
Credits, organized courses		.1054		
Credits, independent study-variable credit courses				.4709*
Number graduate sections	.0018*			.0587*
Number undergraduate sections				
Percentage sections with enrollments greater than fifty				
Lecture-recitation SCH		.0217	.0130	
Laboratory-workshop SCH	.2830*	.0161	.4201*	.0619*
Independent study-variable credit SCH		.2303		
Total R^2	.4582*	.3735	.4331	.7295*

*Significant at the .10 level.

Comparisons of the results across the four groups revealed that the highest R^2 was obtained in the Applied Sciences (.7295) followed by the Total Sample (.4582), the Natural Sciences (.4331), and the Humanities-Social Sciences (.3735). As was the case with the instructional output variables, no single variable emerged as the best predictor across all four groups. Nevertheless, there were individual variables which explained over half of the variance in each group. The variables were lab-workshop SCH in the Total Sample and the Natural Sciences; independent study-variable credit SCH in the Humanities-Social Sciences; and credits in independent study-variable credit courses in the Applied Sciences.

Considering the results for the individual groups, the following was noted:

1. In the Total Sample, weighted average graduate section size (.1734) and lab-workshop SCH (.2830) accounted for almost all of the explained variance (.4582). The combined R^2 for the two variables was .4564.

2. In the Natural Sciences, lab-workshop SCH accounted for 42.01 percent of the explained variance (.4331). The other variable, lecture-recitation SCH, added very little.

3. In the Applied Sciences, credits in independent study-variable credit courses accounted for 47.09 percent of the total explained variance (.7295) by itself. The other five instructional model variables together only added about 25 percent.

4. In the Humanities-Social Sciences, an R^2 of .3735 was obtained. However, the total R^2 was not statistically significant and none of the instructional model variables made a significant contribution to explaining the variation in publication productivity in the Humanities-Social Sciences.

Regression for Selected Variables

In the preceding subsections, separate regressions were run for each subset of variables. The purpose of that analysis was to determine the relative importance of individual variables within each subset of independent variables. The analysis, however, did not provide an opportunity for one to look at the combined effects of the support, instructional output, and instructional model variables on publication productivity. Since it was impossible to enter all thirty-five variables in one equation and no causal theory existed for determining which variables should be chosen, it was decided that the variables should be selected based upon the ability which they exhibited in explaining publication productivity in the preceding regression equations. Based upon the regression results for the support, instructional output, and instructional model variables, six variables were selected as follows: from the subset of variables that explained the largest amount of the variance, three variables were chosen; from the subset of variables that explained the second highest amount of the variance, two variables were chosen; and from the subset of variables that explained the least amount of variance, one variable was chosen.

Tables 4.10 through 4.13 show the results of these regression runs. In this section, the standardized partial regression coefficients (Beta weights) will be used to give some idea of the relative importance of each variable when the others are held constant.

Table 4.10 presents the results of the multiple regression analysis for the Total Sample. The multiple regression equation including laboratory-workshop SCH, grant funds, total contact hours, weighted average graduate section size, percentage of the total instructional staff that met in organized courses for fewer than four contact hours per week and number of undergraduate majors yielded a significant R^2 of .5040. The

TABLE 4.10.--Multiple regression equation predicting publication productivity from selected departmental variables (Total Sample)

Independent Variable	Regression Coefficients	Beta Weights	Contribution of Individual Variables to Total R^2
Laboratory Workshop SCH*	.0307	.4549	.2830
Grant funds*	.00003	.2035	.1258
Total Contact hours*	-.0111	-.0525	.0005
Weighted average graduate section size*	.0324	.2424	.0699
Percentage FTETF with less than four contact hours*	1.7990	.1281	.0083
Number undergraduate majors*	-.0015	-.1325	.0166
Constant	1.6456		

NOTE: Multiple r = .7099; R^2 = .5040; Overall F = 4.7422; Sign. Level = .002.

*Significant at the .10 level when excluding other variables.

two largest Beta weights were obtained for laboratory-workshop SCH (.4549) and weighted average graduate section size (.2424).

The regression results for the Humanities-Social Sciences are presented in Table 4.11. The multiple regression equation including grants, total contact hours, total graduate SCH, graduate assistant ratio, independent study-variable credit SCH, and total undergraduate SCH yielded a significant R^2 of .9808. Based on the Beta weights, the two best predictors of publication productivity in the Humanities-Social Sciences were total contact hours and total graduate SCH. The Beta weight for total contact hours was .5169 while the Beta weight for total graduate SCH was .6678. Both of these variables were from the instructional output subset.

Of the six variables included in the regression equation for the Humanities-Social Sciences, the Beta weights for independent study-variable credit SCH and total undergraduate SCH were both negative. It was reported earlier in the correlation analysis that these variables evidenced a positive relationship with publication productivity. However, the multiple regression analysis suggests that when the influence of other factors is considered, these variables no longer have a positive effect on publication productivity but instead tend to reduce the publication productivity of the area.

TABLE 4.11.--Multiple regression equation predicting publication productivity from selected departmental variables (Humanities-Social Sciences)

Independent Variable	Regression Coefficients	Beta Weights	Contribution of Individual Variables to Total R^2
Grant funds*	.000009	.02964	.6496
Total contact hours*	.22544	.51688	.1530
Total graduate SCH*	.10245	.66778	.1124
Graduate assistant ratio*	1.28104	.23678	.0584
Independent study-variable credit SCH*	-.03417	-.14462	.0063
Total undergraduate SCH*	-.00157	-.04824	.0012
Constant	-1.24509		

NOTE: Multiple r = .9904; R^2 = .9808; Overall F = 34.03710; Sign. Level = .002.

*Significant at the .10 level when excluding other variables.

A similar pattern emerged when the relative importance of grant funds was noted. While grants had a very high simple relationship (r=.81) with publication productivity and explained about 65 percent of the variation in publication productivity (see Tables 4.7 and 4.11), the relative importance of grant funds diminished when the effects of other departmental factors were considered. The Beta weight for grants was only .0296.

Table 4.12 presents the results of the regression analysis for the Natural Sciences. The multiple regression equation including total number of department majors, laboratory-workshop SCH, percentage FTETF with light teaching load, grants, graduate-professional and doctoral SCH, and lecture-recitation SCH yielded a R^2 of .7853. However, the R^2 of .7853 was not significant. The only variables that made a significant contribution to the total R^2 were total department majors, laboratory-workshop SCH and percentage of the total instructional staff with a light teaching load. Collectively, these three variables yielded a significant R^2 of .6699. Of the three significant variables, total department majors and percentage of the total instructional staff with a light teaching load had the largest Beta weights. The negative Beta weight for total department majors as opposed to the positive Beta weight for the percentage

TABLE 4.12.--Multiple regression equation predicting publication productivity from selected departmental variables (Natural Sciences)

Independent Variable	Regression Coefficients	Beta Weights	Contribution of Individual Variables to Total R^2
Total department majors*	-.00815	-.4516	.4285
Laboratory-workshop SCH*	.07492	.4160	.1501
Percentage FTETF with less than four contact hours*	13.36078	.7636	.0913
Grant funds	-.00005	-.4225	.0610
Graduate-professional and doctoral SCH	-.04163	-.3143	.0489
Lecture-Recitation SCH	.00417	.1275	.0056
Constant	2.0226		

NOTE: Multiple r = .8862; R^2 = .7853; Overall F = 1.8286; Sign. Level = .332.

*Significant at the .10 level when excluding other variables.

of the total instructional staff with a light teaching load suggest that the instructional workload of the Natural Sciences' departments has an adverse effect on the publication productivity of the area but the utilization of a differential staffing pattern tends to compensate somewhat for this adversity.

Finally, the results for the Applied Sciences are presented in Table 4.13. The multiple regression equation including total contact hours, lower division SCH, weighted average graduate section size, grants, total department SCH, and credits in independent study-variable credit courses yielded a significant R^2 of .7799. The two best predictors of publication productivity in the Applied Sciences were total contact hours and lower division SCH. The Beta weight for total contact hours was .6052 while the Beta weight for lower division SCH was .5107. Both of these variables were from the instructional output subset.

Summary and Discussion

In this chapter, the data related to the four research questions were presented. The first three questions investigated the simple relationship between thirty-five departmental variables and publication productivity. Two procedures were used to analyze the data. First, the means of the variables were computed, and second, each subset of independent variables was

TABLE 4.13.--Multiple regression equation predicting publication productivity from selected departmental variables (Applied Sciences)

Independent Variable	Regression Coefficients	Beta Weights	Contribution of Individual Variables to Total R^2
Total contact hours*	.09557	.60523	.4357
Lower division SCH*	.01058	.51069	.2015
Weighted average graduate section size*	.09821	.45656	.1349
Grant funds*	-.00002	-.11504	.0056
Total department SCH	.00087	.04830	.0015
Credits in independent study-variable credit courses*	-.00122	-.03973	.0006
Constant	-.52485		

NOTE: Multiple r = .8831; R^2 = .7799; Overall F = 4.13265; Sign. Level = .043.

*Significant at the .10 level when excluding other variables.

correlated with the publication productivity measure. The fourth question investigated the combined effects of each subset of independent variables and selected variables from these subsets on publication productivity. Summarized below are the results of these analyses.

The profile of the academic areas revealed that there were differences among the groups. The means computed for the thirty-five variables indicated that the academic groups differed with respect to the size of their instructional and support staffs, financial resources available, workload, and instructional model employed. More specifically, it was determined that:

1. The Natural Sciences had the largest instructional staff and more general fund and research grant monies than the other areas. This, however, was by no means surprising since the departments within this area offered primarily laboratory courses which require large expenditures in these areas and the nature of their research requires substantial investments in equipment, supplies and services, and personnel.

2. The faculty in the Humanities-Social Sciences generally carried the heaviest instructional load, had the largest number of majors, and utilized primarily the lecture-recitation instructional model.

3. The Applied Sciences generated the greatest number of SCH at the sub-college level and offered the fewest number of course sections. However, these sections generally had very large enrollments.

The correlation analysis once again illustrated the point that there were differences among the academic areas. In most cases the correlations for the different groups were quite dissimilar. The specific variables which correlated with publication productivity, the degree of the relationship, and the direction of the relationship varied from one group to another.

Of the 140 Pearson Product Moment Correlation Coefficients computed between the publication productivity measure and the departmental variables in the four groups, only fifty-seven (41 percent) were statistically significant. These variables, which provide support for the first three research questions, are summarized in Table 4.14. The distribution by groups is as follows: eighteen in the Total Sample, seventeen in the Applied Sciences, fifteen in the Humanities-Social Sciences, and seven in the Natural Sciences. Percentage wise, the subset which had the largest number of variables which evidenced a significant correlation with publication productivity was the instructional output variables.

TABLE 4.14.--Summary of correlation results (significant r's) by Academic Group and Subset of Departmental Variables

Academic Group	Support: Variable	r	Instructional Output: Variable	r	Instructional Model: Variable	r
Total Sample	Supplies & Services	.26	Masters SCH	.23	Ave. undergrad section size	.25
	Equipment	.23	Graduate-professional & doctoral SCH	.23	Ave. grad section size	.37
	Grants	.51	Graduate SCH	.29	Credits, organized crs.	-.24
	Clerical-technical Ratio	.27	Undergrad majors	-.26	Credits, independent study crs.	.41
			Undergrad contact hrs.	.29	Lab-workshop SCH	.53
			Graduate contact hrs.	.46	Independent study SCH	.30
			Total contact hrs.	.47		
			Per cent FTETF with less than four contact hours	.47		
Humanities-Social Sciences	Supplies & Services	.65	Lower division SCH	.45	Ave. grad section size	.74
	Grants	.81	Masters SCH	.81	Credits, independent study courses	.48
	Graduate Assistant Ratio	.64	Graduate SCH	.76	Per cent sections with enrollments > 50	.45
	Clerical-technical Ratio	.73	Masters majors	.63	Independent study SCH	.48
			Undergrad contact hrs.	.64		
			Graduate contact hrs.	.65		
			Total contact hours	.74		
Natural Sciences			Sub-college SCH	-.46	No. grad sections	-.53
			Undergrad majors	-.65	Lecture-recitation SCH	-.45
			Department majors	-.65	Lab-workshop SCH	.65
			Per cent FTETF with less than four contact hrs.	.52		
Applied Sciences	Grants	.58	Sub-college SCH	.39	Ave. undergrad section section size	.54
			Lower division SCH	.53	Ave. grad section size	.37
			Upper division SCH	-.55	Credits, independent study courses	.69
			Undergrad SCH	.54	Lecture-recitation SCH	.41
			Graduate-professional & doctoral SCH	.43	Lab-workshop SCH	.58
			Department SCH	.57	Independent study SCH	.54
			Undergrad contact hrs.	.43		
			Graduate contact hrs.	.64		
			Total contact hours	.66		
			Per cent FTETF with less than fours contact hrs.	.55		

The correlations were generally highest in the Humanities-Social Sciences; lowest in the Total Sample; with the Applied Sciences and the Natural Sciences being in the middle. It should be noted that the low correlations in the Total Sample can be attributed, in part, to the large number of negative correlations in the Natural Sciences.

When only the sign of the coefficients and sets of variables rather than individual variables were considered, it was determined that (1) the undergraduate variables were generally inversely related to the publication productivity measure while the graduate level variables were generally positively related; and (2) variables which described the efficiency of the instructional model employed, such as average section size and percentage of courses with enrollments greater than fifty, were generally positively related to publication productivity.

The regression analysis identified the subset of variables which provided the best explanatory equation for each group (see Table 4.15 for summary). For the support variables the highest R^2 was achieved in the Humanities-Social Sciences. For the instructional output variables the highest R^2 was achieved in the Humanities-Social Sciences followed by the Natural Sciences and the Applied Sciences. Overall, these variables provided the

TABLE 4.15.--Summary of multiple regression results (R^2) by Academic Group and Subset of Departmental Variables

Academic Group	Subset of Variables			
	Support R^2	Instructional Output R^2	Instructional Model R^2	Selected R^2
Total Sample	.3070	.4549	.4582	.5040
Humanities-Social Sciences	.9853	.9940		.9808
Natural Sciences		.9808	.4201	.6699
Applied Sciences	.3349	.8238	.7295	.7799

NOTE: Only the significant R^2 for the subset of variables is listed.

best explanatory equations. For the instructional model variables, the highest R^2 was achieved in the Applied Sciences. And for the combination of variables from the three subsets, the highest R^2 was achieved in the Humanities-Social Sciences and the Applied Sciences.

From the regression analyses it was also determined that variables which had the greatest explanatory power in a given group did not necessarily have the same explanatory power in a different group. For example, the instructional output variables explained 99.40 percent of the variation in publication productivity in the Humanities-Social Sciences and 98.08 percent of the variance in the Natural Sciences. However, the variables which accounted for approximately 90 percent of the total R^2 in the Humanities-Social Sciences were graduate SCH and total contact hours while the variables which explained this percentage in the Natural Sciences, in rank order, were department majors, percentage of FTETF that met in organized courses for fewer than four contact hours per week, graduate-professional and doctoral SCH, and undergraduate SCH (see Table 4.8). The differential effects which the variables had in the various groups was due primarily to differences in the structure of the academic groups.

Finally, it is noteworthy that for the four general regression equations, the equations for the subset of variables, and for the simple correlations, the variables which were predominantly related to publication productivity were the instructional output variables. Even though there are disciplinary differences and specific variables do correlate differently with publication productivity depending upon the academic area, these results tend to suggest that the impact of the instructional workload on publication productivity transcends disciplinary boundaries.

CHAPTER V

THE PROBLEM, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

The Problem

Institutions of higher education almost universally describe their primary functions in terms of instruction, research, and public service. Of the three functions, instruction has received the greatest amount of attention for allocation purposes. While the others are equally important, investigations in the area of public service have been made difficult by a lack of a fundamental definition. On the other hand, the purposes and descriptions of research and scholarly activities are fairly well accepted and understood. And increasingly, it is being suggested by various task forces on the funding of higher education and by authorities in the field of institutional management that research activities be subject to the same degree of scrutiny as instructional activities for allocation purposes.

The purpose of the study, therefore, was to investigate the impact of various aspects of a department's staffing, funding, instructional workload, and instructional model on its publication productivity. More specifically, the study addressed the following questions:

1. Does the amount of supplies and services, equipment, research grant funds, and support personnel available relate to the publication productivity of a department?
2. Is there a relationship between the instructional output of a department and its publication productivity?
3. To what extent is there a relationship between the instructional model utilized by the department and its publication productivity?
4. What is the relative importance of selected departmental variables on publication productivity?

It was hoped that the analysis based on these questions would lead to the identification of a small set of data elements which characterized the unifying relationship which exists between the departmental variables and publication productivity. It would then be possible to make some statements about the likely influences of some of these factors on publication productivity and thereby provide the institution with additional information that might be of assistance in making decisions about the allocation and reallocation of resources to research activities.

Methodology of the Study

The sample for the study consisted of thirty-five academic departments of Michigan State University. The departments were selected and grouped for analysis on the basis of two dimensions of Biglan's Clustering of Academic Departments as modified to meet the needs of this study. The departments represented three academic areas: the Humanities-Social Sciences, the Natural Sciences, and the Applied Sciences.

The data for the study were collected from several administrative reports and publications routinely prepared at M.S.U. for the 1976-77 academic year. The data collected were divided into two major categories: the independent or explanatory variables and the dependent variable.

The dependent variable in the study was publication productivity. This variable was operationalized on the basis of a composite measure of the department's published output.

The thirty-five independent variables were divided into three major groups. The three groups were support, instructional output, and instructional model. The eight support variables described various aspects of the department's funding and staffing. The instructional output variables described the department's instructional workload. Variables included were number of SCH's by course level, number of majors by student level, number of contact hours by student level, and the percentage of the department's total instructional staff that met in organized courses fewer than four contact hours per week. The instructional model variables were weighted average section size, number of credits taught, number of course sections offered, and number of student credit hours produced by type of instructional model.

Correlation and stepwise multiple regression were employed to determine the extent of relationship between the independent and dependent variables for the three academic areas and the total department sample.

Summary of Findings

1. The profile of the academic areas revealed that the Natural Sciences had the largest instructional staff and general fund and research grant budgets; the faculty in the Humanities-Social Sciences carried the heaviest instructional load, had the largest number of majors, and utilized primarily the lecture-recitation instructional model; and

the Applied Sciences offered the fewest number of course sections but the sections generally had very large enrollments.

2. Of the 140 correlation coefficients computed between the publication productivity measure and the departmental variables in the three academic areas and the total sample, fifty-seven (41 percent) were statistically significant. The correlations for the variables in the Humanities-Social Sciences were generally positive and moderate to very high; positive and low to moderate in the total sample; positive and moderate in the Applied Sciences; and negative and moderate in the Natural Sciences.

3. Of the eight support variables, the amount of grant funds had the highest positive simple correlation with publication productivity in all of the areas while the size of the instructional staff had only a low correlation with publication productivity regardless of the academic area.

4. The variables which described various aspects of a department's undergraduate instructional workload were generally inversely related to publication productivity while the graduate level

variables were generally positively related to publication productivity.

5. The variable which described the manner in which a department distributed its instructional workload, though only a crude descriptor, was moderately related to publication productivity in the Applied Sciences and the Natural Sciences. The degree of the relationship did not change even when all of the departments were combined to form the total sample. Thus, departments that employed a differential staffing pattern generally had a higher publication productivity rate.

6. The instructional model employed by the department was found to be positively related to publication productivity. Departments that offered a large number of courses with large enrollments (greater than fifty) generally had a higher publication productivity rate.

7. The best regression equations for explaining publication productivity relative to the independent variables were the equations based upon the three subsets. For the support variables the highest R^2 was achieved in the Humanities-Social Sciences. For the instructional output

variables the highest R^2 was achieved in the Humanities-Social Sciences and the Natural Sciences. And for the instructional model variables the highest R^2 was achieved in the Applied Sciences.

8. It was determined that the variable which explained or correlated significantly with publication productivity varied from one academic area to another. For example, the instructional output variables explained 99.40 percent of the variation in published output in the Humanities-Social Sciences and 98.08 percent in the Natural Sciences. However, the variables which explained approximately 90 percent of the total R^2 in the Humanities-Social Sciences were total number of graduate SCH and total contact hours while the variables which explained this percentage in the Natural Sciences were, in rank order, number of department majors, percentage of total instructional staff with low contact hour ratios, number of graduate-professional and doctoral SCH, and number of undergraduate SCH.

9. For the four general regression equations, the equations for the subset of variables, and for the simple correlations, the variables which were predominantly related to publication

productivity were the instructional output variables. Thus, it appeared that the instructional workload was the critical factor in determining a department's publication productivity.

Conclusions and Implications

The conclusions drawn from the findings will be discussed in relation to the purpose of the study. This purpose was to investigate the impact of several factors on publication productivity at the department level. By so doing, it was hoped that some of the relationships identified might aid institutions in making decisions about the allocation and reallocation of resources to research activities.

It appeared that the instructional workload was the critical factor in determining a department's publication productivity. For the simple correlations as well as for the multiple regression analyses results, the variables from this subset were predominantly related to publication productivity. Whether the effect was adverse or not, however, depended to a large extent upon the academic area. For example, the simple correlation between the instructional output variables and publication productivity were generally positive and moderate to very high in the Humanities-Social Sciences; positive and moderate in the Applied Sciences; but moderate and negative in the Natural Sciences. For the institution, the implication of this finding is that efforts to improve publication productivity by decreasing the instructional workload should be directed primarily to those areas in which the nature of the subject matter minimizes the extent to which efficient instructional models may be employed.

Another noteworthy finding was the low correlation between the size of the instructional staff and publication productivity. Caution should be exercised in interpreting this result. The low and generally inverse correlations seem only to suggest that increasing the size of the staff will not necessarily increase productivity. A possible alternative for increasing productivity might be distributing the instructional workload differently. That is, to distribute the instructional workload so that some faculty members may devote the greatest percentage of their time to research while others devote their time primarily to instruction. It should be noted, however, that to implement this alternative will probably require additional staff. But based on the findings of this study, it appears that unless increased staffing is coupled with the redistribution of the instructional workload, research productivity will probably not increase appreciably.

Finally, perhaps the most important conclusion to be drawn from the findings of this study is that specific differences among academic areas should be considered when making judgments about the allocation of resources to research activities. That is, it would be unwise for institutions to initiate a uniform policy aimed at improving research productivity since various factors impact upon publication productivity differently depending upon the academic area.

Support for this conclusion may be found in the results of previous studies which have investigated differences in the rate of publication (Biglan and others, 1968) and the correlates of departmental prestige ratings across disciplines (Beyer and Snipper, 1974; Hagstrom, 1971). In this study, the results of the correlation and regression analyses support the conclusion that the academic area should be considered when making decisions about the allocation of resources to publication productivity.

The correlation coefficients for the same variable were quite different across the groups. The regression analyses demonstrated even more vividly that there is a need to consider the specific academic area. The results for the total sample depicted what would happen were all of the departments to be treated alike. In each case, the percentage of explained variance was smaller when compared to the results for the Humanities-Social Sciences, Natural Sciences, and Applied Sciences. What this suggests is that there are certain specialized needs of departments which are not reflected when departments are grouped without regard for disciplinary differences. If publication productivity is to be improved, then these specialized needs of departments must be considered when making decisions about the allocation of resources to research activities.

Recommendations for Further Research

Several recommendations for further research emerge from this study. First, the study was conducted for one year in only thirty-five of the 106 instructional units of Michigan State University. These departments represented three academic areas: Humanities-Social Sciences, Applied Sciences, and Natural Sciences. Excluded from the analysis were departments in the colleges of Education and Business. It would be desirable, therefore, to have the study replicated including departments within these two colleges when departmental summary data become available for the departments in the College of Education at M.S.U. Such a study would not only provide a more representative picture of the relationship which exists between the departmental variables and publication productivity but also serve as means of determining to what extent the relationships identified in this study remain stable over the years.

Second, the findings of the study only suggest the variables which are correlated with publication productivity in the academic areas used in this study. It did not, however, identify the specific variables which distinguish high producing departments from low producing departments. A study involving several comparable institutions, such as the A.A.U. universities, in which departments within each academic area are classified as high, low, or medium based on their publication productivity should be conducted. Were multiple discriminant analysis to be applied to the groups, the specific factors which distinguish high producers from low producers could be identified. The results of such a study would complement and strengthen the findings of the present study.

And third, the study utilized linear statistical models in analyzing the data. A limitation of linear models is that they do not allow one to determine the point of "diminishing returns." That is, for example, the point where increased funding would no longer result in increased publication productivity. In future research, nonlinear analysis or linear programming might be employed to determine the optimal mix between publication productivity and the department's instructional workload, funding, staffing, and the like.

APPENDICES

APPENDIX A

SUMMARY STATISTICS USED IN THE DEVELOPMENT OF THE PUBLICATION PRODUCTIVITY INDEX

APPENDIX A

SUMMARY STATISTICS USED IN THE DEVELOPMENT OF THE PUBLICATION PRODUCTIVITY INDEX

TABLE A.1.--Correlation among the individual components of the publication productivity measure by academic groups

		Papers	Books	Reports
Humanities-Social Sciences	Journals	.53*	.05	.30
	Reports	.88*	.46*	
	Books	.42*		
Applied Sciences	Journals	.69*	-.07	.19
	Reports	.59*	.41*	
	Books	.32		
Natural Sciences	Journals	.79*	.32	.86*
	Reports	.77*	.17	
	Books	.02		
Total Sample	Journals	.78*	-.22*	.43*
	Reports	.68*	.09	
	Books	-.07		

*Significant at the .10 level.

TABLE A.2.--Means of the individual components of the publication productivity measure by academic groups

Academic Area		Journal Articles	Technical Reports	Books	Delivered Papers
Humanities-Social Sciences	11	.6396	.1924	.8628	.6896
Applied Sciences	14	1.0669	.6775	.3688	1.4056
Natural Sciences	10	1.9148	.4063	.3069	1.8530
Total Sample	35	1.1749	.4475	.5064	1.3084

APPENDIX B

COMPLETE LISTING OF THE INDEPENDENT VARIABLES

APPENDIX B

COMPLETE LISTING OF THE INDEPENDENT VARIABLES

Support Variables

Number of full-time equivalent faculty
Number of full-time equivalent ranked faculty
Equipment funds per FTEF
Supplies and Services funds per FTEF
Research grants and contract funds

Number of full-time equivalent graduate assistants
Number of full-time equivalent graduate assistants per full-time equivalent faculty
Number of full-time equivalent clerical-technicals per full-time equivalent faculty

Instructional Output Variables

Student credit hours per full-time equivalent total faculty by level, Fall, 1976

Sub-college
Lower Division
Upper Division
Masters
Graduate-professional and doctoral
Total undergraduate
Total graduate
Total department

Number of majors by level, Fall, 1976

Undergraduate
Masters
Graduate-professional and doctoral
Total department

Listing of independent variables, continued

Contact hours by level, Fall, 1976

Undergraduate contact hours per full-time equivalent total faculty
Graduate contact hours per full-time equivalent total faculty
Total department contact hours per full-time equivalent total faculty
Percentage of the full-time equivalent total faculty with less than four contact hours

Instructional Model Variables

Weighted average section size by level, Fall, 1976

Undergraduate
Graduate

Credits per full-time equivalent total faculty by instructional type, Fall, 1976

Organized courses
Independent study-variable credit courses

Number of sections by level, Fall, 1976

Undergraduate
Graduate
Total
Percentage of sections with enrollment greater than 50

Student credit hours per full-time equivalent total faculty by type of instructional model, Fall, 1976

Lecture-Recitation
Laboratory-Workshop
Independent study-variable credit

APPENDIX C

INTERCORRELATION MATRICES FOR THE INDEPENDENT VARIABLES BY ACADEMIC GROUP AND SUBSET OF VARIABLES

APPENDIX C

INTERCORRELATION MATRICES FOR THE INDEPENDENT VARIABLES BY ACADEMIC GROUP AND SUBSET OF VARIABLES

TABLE C.1.--Intercorrelation matrix for the support variables in the Total Sample[d]

	No.	1	2	3	4	5	6	7	8
Graduate Assistant Count	1								
FTE Ranked Faculty Count	2	66*							
FTE Faculty Count	3	79*	85*						
Supplies & Services Budget	4	17	-16	-17					
Equipment Budget	5	26*	-17	-13	71*				
Grant Funds	6	-18	-19	-30	41*	44*			
Graduate Assistant Ratio	7	75*	19	33*	20	28*	-18		
Clerical-technical Ratio	8	-10	-02	-27*	39*	31*	17	05	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.2.--Intercorrelation matrix for the support variables in the Humanities-Social Sciences[d]

	No.	1	2	3	4	5	6	7	8
Graduate Assistant Count	1								
FTE Ranked Faculty Count	2	69*							
FTE Faculty Count	3	64*	98*						
Supplies & Services Budget	4	29	-17	-29					
Equipment Budget	5	06	-18	-34	40				
Grant Funds	6	25	-02	-08	65*	18			
Graduate Assistant Ratio	7	35	-34	-45*	68*	68*	45*		
Clerical-technical Ratio	8	39	-01	-11	89*	38	88*	64*	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.3.--Intercorrelation matrix for the support variables in the Natural Sciences[d]

	No.	1	2	3	4	5	6	7	8
Graduate Assistant Count	1								
FTE Ranked Faculty Count	2	65*							
FTE Faculty Count	3	78*	93*						
Supplies & Services Budget	4	29	-36	-20					
Equipment Budget	5	37	-34	-22	88*				
Grant Funds	6	-40	-45*	-57*	37	39			
Graduate Assistant Ratio	7	81*	13	31	52*	67*	-31		
Clerical-technical Ratio	8	-17	-42	-34	68*	38	27	-03	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.4.--Intercorrelation matrix for the support variables in the Applied Sciences[d]

	No.	1	2	3	4	5	6	7	8
Graduate Assistant Count	1								
FTE Ranked Faculty Count	2	37*							
FTE Faculty Count	3	39*	27						
Supplies & Services Budget	4	-08	-17	-23					
Equipment Budget	5	-07	-31	-10	12				
Grant Funds	6	-18	-01	19	-29	-13			
Graduate Assistant Ratio	7	81*	20	-15	02	-23	-36*		
Clerical-technical Ratio	8	27	62*	-17	-02	11	-39*	34	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.5.--Intercorrelation matrix for the instructional output variables in the Total Sample[d]

	NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sub-college SCH	1																
Lower division SCH	2	-08															
Upper divison SCH	3	-17	-38*														
Undergraduate SCH	4	50*	57*	22*													
Masters SCH	5	26*	-28*	24*	09												
Graduate-professional and doctoral SCH	6	14	-11	02	01	20											
Graduate SCH	7	25*	-24*	15	06	71*	83*										
Department SCH	8	53*	52*	24*	99*	21	15	23*									
No. Undergrad Majors	9	-17	20	18	19	-06	-07	-09	17								
No. Masters Majors	10	-19	23*	-04	06	13	-07	02	06	62*							
No. Graduate-professional & Doctoral Majors	11	-02	11	-18	-04	03	13	11	-02	18	16						
Total Majors	12	-18	22*	13	16	-03	-05	06	15	98*	69*	34*					
Undergrad contact hours	13	73*	07	-06	52*	07	01	05	52*	01	08	-15	-01				
Graduate contact hours	14	22	-25*	30*	13	37*	27*	40*	20	-11	-08	10	-09	36*			
Total contact hours	15	47*	-16	21	32*	32*	21	33*	37*	-08	-03	01	-07	69*	92*		
Per cent FTETF with less than 4 contact hours	16	02	12	09	18	11	51*	42*	25*	-05	00	15	-02	04	47*	38*	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.6.--Intercorrelation matrix for the instructional output variables in the Humanities-Social Sciences[d]

	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sub-college SCH	1																
Lower division SCH	2	-28															
Upper division SCH	3	04	-25														
Undergrad SCH	4	05	61*	58*													
Masters SCH	5	-06	47*	-04	36												
Graduate-professional and Doctoral SCH	6	05	70*	12	71*	37											
Graduate SCH	7	-04	60*	00	52*	96*	61*										
Department SCH	8	03	66*	51*	99*	50*	75*	65*									
No. Undergrad Majors	9	25	60*	33	84*	23	70*	41	82*								
No. Masters Majors	10	34	50*	26	72*	65*	60*	74*	78*	75*							
No. Graduate-professional & Doctoral Majors	11	55*	36	08	50*	14	75*	35	51*	62*	62*						
Total Majors	12	30	60*	32	84*	28	73*	46*	83*	99*	80*	69*					
Undergrad contact Hrs.	13	55*	06	-38	-11	18	-32	06	-09	08	30	-04	10				
Graduate contact hours	14	33	58*	-24	40	43	37	48*	44*	35	39	37	37	45*			
Total Contact hours	15	55*	26	-38	06	30	-11	22	09	20	37	10	22	94*	72*		
Per cent FTETP with less than 4 contact hours	16	-35	35	09	29	60*	63*	70*	39	08	26	32	12	-63*	05	-47*	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.7.--Intercorrelation matrix for the instructional output variables in the Natural Sciences[d]

	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sub-college SCH	1																
Lower division SCH	2	14															
Upper division SCH	3	15	-77*														
Undergrad SCH	4	58*	-44*	23													
Masters SCH	5	60*	-52*	52*	04												
Graduate-professional and doctoral SCH	6	03	-22	03	-27	41											
Graduate SCH	7	20	-37	21	-20	69*	94*										
Department SCH	8	65*	32	30	94*	28	05	14									
No. Undergrad Majors	9	18	16	07	34	-26	01	-09	31								
No. Masters Majors	10	15	44*	-62*	-15	-32	-13	-22	-22	-11							
No. Graduate-professional & Doctoral Majors	11	03	36	-22	23	-04	-10	-09	20	14	-32						
Total Majors	12	18	32	-08	37	-28	-04	-13	33	94*	-11	45*					
Undergraduate Contact hours	13	50*	00	42	63*	42	-11	06	66*	-35	-16	-12	-38				
Graduate contact Hrs.	14	38	-66*	86*	24	82*	27	51*	42	-19	-60*	-10	-27	65			
Total Contact Hours	15	43	-56*	82*	34	78*	20	44*	50*	-23	-54*	-11	-31	76*	99*		
Per cent FTETF with less than 4 contact hours	16	-07	-47*	31	-28	51*	67*	71*	-03	-27	-35	-04	-30	11	51*	46*	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.8.--Intercorrelation matrix for the instructional output variables in the Applied Sciences[d]

	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sub-college SCH	1																
Lower division SCH	2	-20															
Upper division SCH	3	-57*	-03														
Undergrad SCH	4	44*	69*	-02													
Masters SCH	5	23	-45*	-01	-20												
Graduate-professional and doctoral SCH	6	37*	18	-16	41	01											
Graduate SCH	7	41*	-23	-11	11	78*	63*										
Department SCH	8	48*	65*	-03	99*	-09	48*	23									
No. Undergrad Majors	9	-46*	-04	39*	-24	-29	-44*	-51*	-30								
No. Masters Majors	10	-30	04	30	-08	-01	-14	-10	-09	66*							
No. Graduate-professional & Doctoral Majors	11	23	-02	-13	12	36	52*	61*	20	00	42*						
Total Majors	12	-42	-03	38*	-21	-22	-36	-40*	-26	98*	78*	17					
Undergraduate Contact hours	13	75*	02	-48*	46*	-22	-21	-03	44*	00	11	04	02				
Graduate Contact Hrs.	14	25	16	-39*	17	18	05	17	19	-05	22	26	02	41*			
Total Contact Hours	15	52*	13	-50*	33	03	13	11	34	-04	21	21	02	75*	91*		
Per cent FTETF with less than 4 contact hours	16	08	63*	-23	61*	-48*	44*	-10	49*	02	-01	18	03	33	53*	53*	

[d]Decimal point omitted

*Significant at the .10 level.

TABLE C.9.--Intercorrelation matrix for the instructional model variables in the Total Sample[d]

	No.	1	2	3	4	5	6	7	8	9	10	11
Credits, Organized Crs.	1											
Credits, Independent Study-Variable credit Crs.	2	02										
No. Undergrad Sections	3	11	-39*									
No. Graduate Sections	4	-08	-41*	56*								
Total Sections	5	09	-40*	99*	60*							
Percentage sections with enrollments greater than 50	6	-28*	18	-42*	-08	-41*						
Lecture-recitation SCH	7	42*	38*	-05	-04	-05	47*					
Lab-workshop SCH	8	06	67*	-20	-49*	-23*	07	10				
Independent Study-Variable Credit SCH	9	-21	32*	27*	-03	26*	08	05	35*			
Weighted average undergrad section size	10	-54*	36*	-26*	-03	-24*	40*	16	08	20		
Weighted average graduate section size	11	-43*	08	-07	14	-05	24*	-21	-09	11	63*	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.10.--Intercorrelation matrix for the instructional model variables in the Humanities-Social Sciences[d]

	No.	1	2	3	4	5	6	7	8	9	10	11
Credits, Organized Crs.	1											
Credits, Independent Study-Variable credit Crs.	2	-58*										
No. Undergrad Sections	3	20	-15									
No. Graduate Sections	4	-35	12	47*								
Total Sections	5	11	-11	99*	60*							
Percentage sections with enrollments greater than 50	6	-79*	40	-30	40	-19						
Lecture-recitation SCH	7	-64*	32	23	73*	34	79*					
Lab-workshop SCH	8	03	-05	24	-18	18	-07	00				
Independent Study-Variable Credit SCH	9	-80*	79*	-13	55*	-02	72*	65*	-21			
Weighted average undergrad section size	10	-86*	49*	00	70*	13	83*	89*	-13	86*		
Weighted average graduate section size	11	-59*	39	-15	12	-10	66*	30	03	57*	45*	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.11.--Intercorrelation matrix for the instructional model variables in the Natural Sciences[d]

	No.	1	2	3	4	5	6	7	8	9	10	11
Credits, Organized Crs.	1											
Credits, Independent Study-Variable credit Crs.	2	-57*										
No. Undergrad Sections	3	69*	-78*									
No. Graduate Sections	4	56*	-48*	76*								
Total Sections	5	69*	-77*	99*	78*							
Percentage sections with enrollments greater than 50	6	-66*	72*	-78*	-45*	-78*						
Lecture-recitation SCH	7	55*	-05	35	44*	37	-03					
Lab-workshop SCH	8	-24	24	-29	-52*	-32	13	-60*				
Independent Study-Variable Credit SCH	9	-25	-14	37	06	36	-23	-24	14			
Weighted average undergrad section size	10	-56*	67*	-46*	-13	-44*	68*	32	-38	-02		
Weighted average graduate section size	11	-52*	35	-30	-04	-29	60*	-08	-20	10	65*	

[d]Decimal point omitted.

*Significant at the .10 level.

TABLE C.12.--Intercorrelation matrix for the instructional model variables in the Applied Sciences[d]

	No.	1	2	3	4	5	6	7	8	9	10	11
Credits, Organized Crs.	1											
Credits, Independent Study-Variable credit Crs.	2	08										
No. Undergrad Sections	3	46*	02									
No. Graduate Sections	4	08	-59*	36								
Total Sections	5	44*	-08	99*	50*							
Percentage sections with enrollments greater than 50	6	-27	-15	-51*	-22	-51*						
Lecture-recitation SCH	7	30	40*	-26	-49*	-33	49*					
Lab-workshop SCH	8	21	78*	22	-64*	10	-13	41*				
Independent Study-Variable Credit SCH	9	-07	74*	-09	-63*	-18	14	53*	64*			
Weighted average undergrad section size	10	-50*	57*	-61*	-62*	-67*	51*	58*	35	60*		
Weighted average graduate section size	11	00	10	-16	35	-09	24	07	-31	-24	12	

[d]Decimal point omitted.

*Significant at the .10 level.

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