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A Study of the NSF College Science Improvement Program

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A Study of the NSF College Science Improvement Program

Massive Federal expenditures for science research and development have been commonplace since World War II and the spectacular technical success of the Manhattan Project. Shortly after the war the case for continued government support of basic science research was made by Vannevar Bush (1945) and others; the major science organization which grew out of this Federal concern was the National Science Foundation. Subsequently the late fifties (and the voyage of Sputnik) saw science education become a national priority. That period spawned a wide array of measures in support of science education, e.g., the National Defense Education Act.

The passage of time brought increased governmental concern with monitoring federally supported programs and a reluctance simply to underwrite projects with a blank check. Thus, for example, the landmark 1965 Elementary and Secondary Education Act (ESEA) contained measures requiring evaluation of projects it was launching. The present research grew out of a request for this kind of evaluation by the directors of a key National Science Foundation program. This NSF unit is the College Science Improvement Program (COSIP) which dispenses millions of dollars each year with the goal of improving undergraduate science education.

The data used in these analyses were derived from the longitudinal research program of the American Council on Education (ACE) Office of Research. While, in the past, research which has used this data bank has focused on educational issues, several studies have been performed with these data evaluating the impact of specific projects. These have included analyses of other NSF programs (e.g., Astin, 1969) and studies of the effects of special programs for disadvantaged students (Astin, 1970).

An empirical evaluation of the COSIP logically requires two stages, each in effect a separate study. In the impact research itself it is necessary to take into account any initial differences which existed between schools receiving COSIP grants and other schools in the eligible population prior to the awarding of the funds. Identifying these initial differences constituted Phase 1, which yielded considerable information about the kinds of schools which receive COSIP grants. The major analysis of the relationships between an influx of COSIP funds and a variety of student outcomes is Phase 2. This paper reports the results of Phase 2.

The College Science Improvement Program

The College Science Improvement Program was launched in 1966 and has as its stated goal "...to accelerate the development of the science capabilities of predominantly undergraduate institutions and to enhance their capacity for continuing self-renewal" (National Science Foundation, 1969, p. 90). Between the program's inception and the end of fiscal year 1969, COSIP made 105 grants representing a total amount of over $18,000,000 to such institutions.[1] The range of departments which receive funds from COSIP grants is wide and falls into the following NSF categories:

Biological Sciences	Physics
Chemistry	Psychology
Computer Science	Social Sciences
Earth Sciences	Interdisciplinary Studies
Engineering	Multidisciplinary Studies
Mathematics	

[1] It should be emphasized that the focus of this study is only upon those schools which received major COSIP institutional grants. In fiscal year 1969, for the first time, NSF also awarded eight interinstitutional grants. These are smaller special awards, typically given to a consortium consisting of a number of schools. Also excluded were interinstitutional grants awarded to consortia of two-year colleges; all of the schools considered in this research are four-year institutions.

Within any given department the use of the money may vary among the following categories:

Faculty research and scholarly activities
Local course and curriculum studies
Instructional equipment
Undergraduate student activities
Other activities

The ACE Longitudinal Research Program

As indicated above, the data presented in this research report are a direct product of the Cooperative Institutional Research Program (CIRP) being conducted by the Office of Research of the American Council on Education. Since this program was launched in 1966, over a million undergraduates have completed questionnaires. Work prior to the CIRP program included a prototype study carried out with students who entered college in 1961 and a pilot study of 1965 freshmen. Each fall since 1966, when the full-scale research program was launched, approximately a quarter of a million students from a wide range of colleges and universities have filled out questionnaires containing items about their previous academic experiences, educational and professional aspirations, attitudes, etc. In addition, followup questionnaires have been sent to subsamples of each entering cohort at periodic intervals.

Method

The research goal was to assess the relationship of the receipt of COSIP funds by an institution to the academic performance and the educational, vocational, and scientific aspirations of undergraduates at that institution. In light of the time periods involved, it was clear that the best cohort of students for the study were those who entered college in 1966 (before COSIP was launched).

Tracing the possible impact of COSIP funds required measurement of the criterion variables during the student's senior year through a questionnaire survey as well as measurement of freshmen control variables and of a series of institutional characteristics (also used as control variables).[2]

Data on institutional characteristics were taken from a file prepared for use in educational research (Creager and Sell, 1969) which contains extensive information about each college. Among the variables used in the analyses below are indicators of the institution's enrollment, level of selectivity, percentage of Ph.D.'s on the faculty, number of volumes in the library, amount of student fees, value of the endowment, total Federal support per student, and on whether the institution was public or private, a men's or women's or coeducational college.

The freshman questionnaire, the Student Information Form (SIF), is a four page document containing a series of multiple-choice items. The questionnaire was constructed so that the responses could be optically scanned and recorded on a data tape for subsequent computer analysis. The responses to these questions were given by the freshmen after matriculation but before they had actually been exposed to the college: i.e., during their orientation

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[2]This approach was dictated in part by both the short time period which has passed since the creation of the College Science Improvement Program and the availability of data. In defining the area of study in this manner, it should be clear that certain kinds of issues are specifically excluded from consideration. A study of undergraduates can, of course, give no information about the impact -- whether positive, negative, or nonexistent -- of COSIP funds upon the faculty, administration, or physical facilities of a college. Even in considering undergraduates certain limitations result as a function of this short time interval. Changes in, say, equipment or the science curriculum as a function of COSIP funds may affect undergraduates who enter college five or ten years from now but not the current group. Alternatively, the effects upon the current cohort may not be apparent until five or ten years after college. Neither of these issues can be resolved in a study which must limit its focus to the 1966 cohort during the four years when that group of students is in college.

period. Though in some cases it was necessary to collapse categories in the computer processing, these variables give an accurate reflection of the contents of the SIF.

The criterion variables came from a followup questionnaire, developed by ACE in collaboration with the Carnegie Commission on Higher Education, which was distributed to the students in December of 1969, their senior year. While it was mailed to students at 186 institutions in the ACE data bank, only 90 of these were also COSIP-eligible institutions.[3] A detailed description of the procedures used to determine the subset of COSIP-eligible schools can be found in the Phase 1 report (Drew, 1970) which also discusses the methods for determining which schools had received COSIP grants within the period of study.

A followup questionnaire was mailed to each student who matriculated at a small college (in which the 1966 freshman class had numbered 300 or less); samples of 300 were selected from the larger institutions. Thus, the total sample of students to whom questionnaires were mailed numbered 51,459. Of the respondents, 10,686 were students from COSIP-eligible schools and 3,487 were from schools which had been granted funds by NSF.[4]

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[3] In fact, 94 institutions were used in the Phase 1 analyses. Four institutions had to be dropped from the followup survey because of a data processing error.

[4] The total number of valid questionnaires received from the followup sample was 19,431 which represented a 37.8 percent response rate. Several factors probably combined to produce this low figure, primarily the prohibitive length of the questionnaire. A special analysis of the response pattern was done by John A. Creager and yielded the following profiles. Respondents were significantly more likely to report a record of good high school grades, membership in a high school honor society and a high level of aspiration. Nonrespondents were significantly more likely to be nonwhite, southern, Jewish and to report having won a varisty letter or an art prize while in high school. Respondents were more likely to major in Mathematics, Statistics or the Biological Sciences and less likely to major in Business. There were no significant sex differences between respondents and nonrespondents.

As indicated above the general research goal was to assess the relationships between receipt of COSIP funds and a number of outcomes in the senior year, while controlling for significant freshman and institutional variables. Phase 1 of this research centered on an extensive analysis of the characteristics differentiating schools which had received grants from the rest of the COSIP-eligible population.

The specific analysis strategy for Phase 2 involved several steps for each of the senior year outcomes. The criterion variables included:

College Major
Anticipated Future Occupation
Persistence in College
Review of the Student's College Education
Student's Satisfaction with his College
The Nature of the Student's Planned Future Work.

The control variables for <u>each</u> dependent variable were determined through a three stage multiple regression process. In the first stage all significant ($p < .05$) freshman characteristics which predicted the criterion were determined using a stepwise algorithm. Virtually all information from the freshman questionnaire was included in the item pool here. Thus the potential student control variables included the student's sex, age, race, high school grades and accomplishments, objectives, financial situation, etc. In the second stage, those significant student variables were forced into the regression equation and additional variables from the freshmen questionnaire which assessed the college image or environment were allowed to enter the equation. (While these items were part of the student questionnaire, it was felt that they should be interpreted as a special set reflecting characteristics of the institution rather than as student variables.) In the third and final stage, all previous significant variables were forced into the equation and any institutional characteristics which were significantly related to the criterion were allowed

to enter. The pool of potential institution control variables included whether the school was under public or private control, the racial composition of the school, faculty characteristics, the enrollment, selectivity, etc.

The relationship of each measure of COSIP support to each senior year outcome was determined by computing a partial correlation while controlling for all the variables uncovered in the preceding steps. The file containing data on all 10,686 students was used. (The control variables had been determined through analysis of a one-fourth random sample [i.e., 2,672 students] from the total sample at the 90 COSIP-eligible schools.) As in Phase 1, the measures of NSF support included not only a dichotomy indicating whether or not the schools received a COSIP grant during the time period, but also a series of additional dichotomies indicating whether or not COSIP funds were given in one of the particular fields or for one of the purposes listed on page 3.

Results

The Student's Choice of a Future Career

Each student, when he matriculated and again as a senior, was asked to select his probable career from rather detailed lists. The science-related career fields (categorized as indicated in Appendix A) were:

Scientific researcher
Scientific technician
Engineer
Health professional
Social worker, counselor

Since improvement of undergraduate science education also could be reflected in subsequent teaching careers, several additional fields dealing with education were analyzed as well:

Teacher
College professor
Other educator

As indicated above, analysis began by determining all the control variables for each of the eight senior career choice categories. Then, the partial correlations between the careers and the COSIP variables were examined. (It should be noted here that the control variables for each senior career choice included the initial freshmen choice of that field. Thus, what these partial correlations measure is the degree to which students from other career paths are attracted to the criterion field as well as the degree to which students initially committed to that occupation were retained and prevented from defecting to other choices.) The results from these analyses are summarized in Table 1, which contains all significant ($p < .05$) partial correlations between senior career choice and the COSIP variables. In addition, Table 1 includes a measure of the significance of each partial (the F value) and indicates the number of control variables used in computing it. Examination of that table leads to some general conclusions.

The most striking observation is that the career field associated with the most forms of COSIP support is engineering. There appears to be no relationship between COSIP support and the number of undergraduates planning careers as scientific researchers. Students at schools where COSIP funds were given for undergraduate student activities were less likely to plan careers as scientific technicians or computer programmers (and more likely to plan on becoming engineers). Similarly several kinds of COSIP support were negatively related to the choice of social worker or counselor. For the most part, there was no relationship between COSIP funding and plans to pursue careers in teaching at any level.

Student Choice of Major

Each student was also asked to indicate his major on the freshman and senior questionnaires. The specific major field alternatives were collapsed into

categories (indicated in Appendix A) deliberately constructed in an attempt to replicate the rubrics used by NSF in giving COSIP grants. Thus, the major fields examined included Biological Sciences, Chemistry, Computer Science, etc. In addition, another set of categories was created for several fields which, it was hypothesized, might be affected by changes in the funding of undergraduate science education at the institution. These included, e.g., other physical sciences, Education, Agriculture, etc.

Table 2 indicates the significant COSIP partial correlations for each of the 14 major fields. Examination of the table leads to some general conclusions about the relationships between COSIP grants and major field selection.[5]

The primary question is whether an influx of NSF funds into a particular field is associated with a flow of students toward that field during the undergraduate years. As can be seen in Table 2, this association was evident in each of two fields: Engineering and Physics. Note also that seniors were more likely to select "other physical sciences" if COSIP support had been given to the Biological Sciences or Physics; in addition, "other physical sciences" was the only major field category which was significantly related to

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[5]Multiple regression analysis and computation of partial correlations clearly provided the appropriate statistical mechanism to control for the large number of student and institutional characteristics. However, the fact that some of the key variables used were dichotomies with relatively low base rates (e.g., the number of seniors majoring in Computer Science) introduced a note of caution in interpreting some of the results. With these concerns in mind, an additional analysis was performed; the results of this analysis lent more support to the conclusions presented in this report. A special data tape was created containing all Computer Science majors and a one percent random sample of the remaining students from the data file (of 10,686 students), thus retaining the computer majors while substantially increasing the base rate of that variable. The entire set of analyses with Computer Sciences as a criterion was rerun with the small data tape. The results obtained did not differ substantially from those in the original analysis.

the fundamental dichotomy indicating whether or not a school got a COSIP grant. While the choice of Psychology was not significantly associated with funding in that field, it was associated with grants for the Biological Sciences and Mathematics, two fields closely related to the discipline of Psychology. In general, then, the fields which have been most affected by NSF support are Physics, the other physical sciences and Mathematics. That is, seniors were more likely to select those fields at schools which had received COSIP funds (in a variety of departments and for a variety of purposes) than were seniors at other schools.[6]

Viewed from another perspective, Table 2 provides an indication of the number of (positive and negative) associations with major selection of the 11 particular disciplines in which COSIP funds are given. Thus each of the following fields (in which grants are given) -- Chemistry, Engineering, Physics and Biological Sciences -- has more than one significant positive partial correlation (in fact, the field of Biological Sciences yields three such partials). All but Chemistry also were associated with one negative partial correlation. Several other fields had a positive relationship with one major field criterion: Computer Science, Mathematics, Psychology, Social Sciences, Multidisciplinary Studies. One field yielded only a negative effect -- Earth Sciences. In general, the funding field which yielded the largest partial correlations (whether positive or negative) was Engineering.

Attrition from College

The next outcome was attrition from college, by which is meant (1) the

[6] In examining Table 3, one should recall that NSF funds typically are given to more than one department in a school. Certain combinations are more likely to receive grants than others. It is not completely surprising, then, that COSIP funds in one field may be associated with an increase in the students majoring in a different but related field, since, in effect, the dispensing of funds in those fields may be highly correlated.

student's dropping out of his college of matriculation for a term or more or (2) his transferring to another institution. In a way, the issue of attrition is more fundamental than those of major field and career choice. These two aspects of persistence were the next senior year criteria examined.[7]

The relationships among the COSIP variables -- i.e., grants to specific fields and for specific purposes -- and these outcomes (as well as the other outcomes discussed below) are summarized in Table 3. In that table, the COSIP measures are arrayed across the top while the senior outcomes are listed on the side. Each cell in the table is blank except those representing a statistically significant relationship; here the direction of the relationship is indicated by either a plus or minus sign. Thus, the table can be read in either of two ways. Examination of the rows indicates which COSIP variables were significantly associated with a given senior year criterion. Examination of the columns reveals all the significant

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[7] Throughout the analyses of all the other outcomes, each student was identified with the first institution he attended. The research methodology included several checks to ensure that noise was not introduced into the system because some of the students had subsequently transferred to other schools. (This kind of problem could also have existed, although to a lesser degree, with respect to students who had attended only one institution but had dropped out for a term or more.) It was assumed that the impact of thisphenomenon would not be significant given the small proportion of transfer students. However, as a further check, all analyses were rerun in a special study in which the two persistence variables (temporarily dropping out and transferring) were added to the list of potential control variables. As expected there was virtually no change in the number or nature of the significant COSIP variables. The few differences noted were trivial and could easily be the result of random fluctuation -- in statistical terms "type 1" and "type 2" errors. Thus, it is highly unlikely that the results reported here have been confounded by a phenomenon in which students who began at COSIP schools transferred to non-COSIP institutions or vice versa.

associations of a given COSIP variable with these criterion variables. In addition, Appendix B presents each significant partial correlation between the COSIP variables and these senior year criteria in a format parallel to Tables 1 and 2.

The dropout measure was an item which asked whether the student had ever dropped out of school for a term or longer (disregarding summers). As Table 3 shows, students in schools which received funds for undergraduate activities or for multidisciplinary studies were significantly less likely to drop out of school than were other students when all biasing student and institutional factors were controlled.

The transfer variable was an item which asked how many different colleges the student had been enrolled in (disregarding temporary summer attendance). It is clear that receipt of COSIP funds by an institution is associated with retention of the students in that school, i.e., they are likely to attend fewer colleges. This relationship held up regardless of how the grant was distributed. Merely receiving a grant was significantly associated with the criterion as was receiving a grant for any one specific purpose and every specific field except Engineering.

This finding may provide some insight, as well, about the previous results concerning engineering as a future career. Several of the COSIP-eligible schools are engineering schools. A plausible interpretation of the "engineering" finding is that fewer students transfer out of a planned engineering career in COSIP schools (as opposed to an alternative hypothesis that the result reflects attraction of students to engineering). If this hypothesis is correct, a substantial portion of the phenomenon may simply involve the retention of students,i.e., the reduction in transfers, by these engineering schools.

Student Review of His College Education

The next criterion was derived from an item which asked how much of each of the following the student felt he received at his college:

A detailed grasp of a special field
A well-rounded general education
Training and skills for an occupation

The significant relationships between this outcome and receiving COSIP funds were rather meagre, appearing only with respect to the last item: training and skills for an occupation. Here there was a significant positive relationship with COSIP funds for Computer Science and significant negative relationships between the criterion and funds in Mathematics and the Social Sciences. The explanation for these findings seems obvious enough: fields that are more theoretical and abstract were negative whereas undergraduate training in computers is more likely to develop specific occupational skills.

Student Satisfaction with the College

The next item examined asked the undergraduate how satisfied he had been with each of the following at his college:

The college's academic reputation
The intellectual environment
Faculty/student relations
The quality of classroom instruction
The variety of courses he could take
The administration

The results here were rather puzzling, in that, with a few exceptions, the significant relationships between these satisfaction items and the COSIP variables were negative. That is, as can be seen in Table 3, students at institutions which received funds for certain purposes or in certain fields tended to be less satisfied about one or more aspects of the college. The basic dichotomy simply indicating whether or not a COSIP

grant was received was negatively related to satisfaction with the quality of classroom instruction. In addition there was significantly less satisfaction with the quality of classroom instruction at schools which received COSIP funds for the purposes of faculty research, curriculum studies, and instructional scientific equipment, and in a variety of fields (with the one startling exception of Computer Science).

One can offer several explanations for these findings, bearing in mind that satisfaction is a general feeling which is much more difficult to measure or assess than are concrete behaviors. Perhaps grants for curriculum studies (and for equipment) temporarily diminish faculty involvement in the classroom although they may result in improvement of science teaching after a delay of several years. Possibly COSIP funds directed to the faculty are being used by some professors to expand and to strengthen their research activities and not to improve their teaching activities. In short, COSIP funds for faculty research and scholarly activity may, in effect, be having a negative impact upon their teaching and thus upon the quality of science education as viewed by the undergraduate. These notions are given support when we consider that funds geared toward undergraduate projects and "other" purposes did not have a negative association with the students' satisfaction with the quality of classroom instruction.

There is an alternative explanation. Note that any COSIP measure, for example, funds for the Biological Sciences, referred to the institution and thus were considered as applicable for every student in that institution. In fact, however, the undergraduates receiving the benefits, direct or indirect, of any of these funds are only a small group of all the students in that institution. A "relative deprivation" effect may

be operating here: those students in the school who did not receive the benefits of COSIP funds resent this fact, develop higher expectations for their own field or become generally dissatisfied with their lot as compared with that of their more fortunate friends. Given the structure of the data analyses, the dissatisfaction of these students would still be defined as dissatisfaction by students in schools which had received COSIP funds. This phenomenon could lead to negative findings with respect to these dimensions. Only further and more extensive research, in which the analysis were performed separately for students in science fields and students in nonscience fields, would reveal whether this explanation is correct.

As can be seen in Table 3, dissatisfaction was apparent with respect to several other items. For example, COSIP funds for the same three purposes (faculty research, curriculum studies and scientific equipment) were related to dissatisfaction with the administration. This parallel effect can be seen in most of the same fields. Once again, however, receipt of a grant for Computer Science is positively related to satisfaction. Several specific COSIP measures were negatively related to satisfaction with the college's academic reputation; two others were negatively related to satisfaction with faculty/student relationships. Surprisingly, while two measures -- COSIP funds to Engineering and to undergraduate activities -- were negatively related to satisfaction with the intellectual environment, two other measures -- COSIP funds to Computer Science and the Social Sciences -- had a significant positive relationship with this criterion. Finally, the single satisfaction item that had only positive relationships was that in which the student indicated his reaction to the variety of courses available. Here grants received in the Social Sciences and in Psychology were positively related to satisfaction.

Nature of the Student's Planned Future Work

In any discussion of the anticipated work of future scientists, postgraduate educational aspirations must be considered. Each senior answered an item which inquired about his educational goals. A special variable was constructed from this item indicating whether or not he planned to get a Ph.D.; this was the next outcome to be analyzed. This seemed particularly salient in light of current manpower issues with respect to the production of Ph.D's. As can be seen in Table 3, there was a significant positive association between plans to get the Ph.D. and COSIP grants in Chemistry, Mathematics, and the Social Sciences as well as with the basic dichotomy indicating that the school received a COSIP grant. While there is no way of knowing, at the moment, whether these undergraduates will eventually obtain doctorates, it seems clear that NSF support to the COSIP program is related to increased aspirations on the part of graduating seniors toward that degree.

Each student was asked to indicate the importance he attached to a number of long-range objectives, one of which was "making a theoretical contribution to science." The results of this analysis were disappointing. Only two of the COSIP variables were significantly related to giving high priority to this goal -- and those relationships were negative. It may be that COSIP funds for these two purposes (curriculum studies and scientific equipment) orient the student to pragmatic and applied science and, thus, leave him less inclined to emphasize making theoretical contributions. Alternatively, grants for these purposes may show this relationship because they decrease the professor's contact with and influence upon undergraduates -- at least temporarily.

The final outcome examined was the student's view as to what job activity he would most likely be devoting his time to in the future:

Teaching
Research
Administration
Service to clients or patients.

Not one of the COSIP variables was related to either of the last two job activities. Apparently the undergraduates' inclination to engage in work which involves these activities is unaffected by his institution's receiving COSIP funds.

NSF grants for undergraduate projects and for Engineering had significant positive associations with the students' orientation toward teaching.

The remaining job activity -- research -- yielded extremely interesting results. Clearly, students at schools which received COSIP funds were much more likely to plan to do research in their future work. This was evident first in the basic variable indicating whether the school got a grant; the impact was also significant with respect to one specific field -- Engineering -- and for three specific purposes -- equipment, undergraduate projects, and other.

Review of Disciplines and Purposes for which Grant was Given

Several patterns emerge in Table 3 when one reviews the findings in terms of the categories of COSIP grants. Each discipline had at least one positive association, usually with the student's remaining with his original college rather than transferring. The field with the most significant positive relationships was Computer Science; the runner-up was Social Sciences. Engineering, a particulary interesting case, had a negative association

with a number of the satisfaction measures and, at the same time, a positive relationship with plans to teach and to do research.

Turning to findings about grants for a specific purpose, one finds that the largest number of positive relationships was associated with grants for undergraduate student activities, which were related to a reduction in dropouts and transfers and a higher proportion of students planning to do both teaching and research. There was only one negative relationship: satisfaction with the intellectual environment of the institution. The category of grants for "other purposes" had two positive associations -- on plans to do research and retention of transfers -- and none which were negative. Grants for instructional scientific equipment were positively related to plans to do research and retention of transfers but negatively related to three other variables. Finally, funds for faculty research and scholarly activities and for local course and curriculum studies showed the "transfer" relationship but each had three significant negative associations (see Table 3).

The implication of this analysis may be that NSF funds have their most beneficial effects upon undergraduates when the money is channeled directly to the students; they are least effective when the funds are given to the faculty, and their effect on undergraduates is, presumably, indirect.

A standard litany among current critics of higher education, including students, is that the criteria for faculty success and advancement (notably research productivity) are, at best, unrelated to superior teaching. Bayer (1970) has found that undergraduate ratings of their institutions in terms of concern for the individual student were significantly <u>lower</u> in schools which had a faculty rated <u>high</u> in terms of traditional measures

of faculty excellence. These measures included the percentage of faculty holding doctorates, the percent of faculty graduating from the top twelve institutions, etc.

Perhaps the same phenomena have been tapped in these current analyses. COSIP grants are given with the noble goal of improving the science education received by the undergraduate. Some of these grants, particularly those given for faculty research and scholarly activities, may be used largely to strengthen and extend the research activities of the professors involved. If so, there may be neglible or even negative immediate impact upon the classroom. This hypothesis would explain why there appear to be so many positive associations in the data for undergraduate student activities relative to the results for faculty research and scholarly activities -- and also why students are more dissatisfied with the quality of classroom instruction at COSIP schools.

A finding from Phase 1 may be relevant at this juncture. It was discovered then that, while grant recipients tended to be more affluent schools then the rest of the eligible population, these institutions had received significantly less money for research in the past. In addition, it is intriguing to recall in this context that COSIP funds were significantly associated with an increase in the number of students planning to do research, whereas only certain kinds of COSIP grants were related to plans to teach. Perhaps some COSIP grants are going to schools which had not been research institutions in the past and are being used to promote the academic research ethos.

Finally, in addition to the measure of whether a school received COSIP funds in a given department or for a given purpose, the analysis included, of course, the dichotomous variable which simply indicated

whether the school had received a COSIP grant or not (regardless of field or purpose). This basic, more general, measure was significantly related to reduction of transfers and to plans by the undergraduates to seek the Ph.D. and to do research. There was a negative association with satisfaction with the quality of classroom instruction.

Summary and Conclusions

Longitudinal data on a national sample of undergraduates and institutional data were combined to study the NSF College Science Improvement Program. The focus was the relationship between an institution's receiving a COSIP grant and a series of student outcomes in the senior year; multivariate statistical techniques were employed to impose controls for student and institutional biases. The dependent variables included the student's college major, career plans, assessment of his undergraduate education, etc.

On the basis of the analyses, the following conclusions may be drawn:

1. Students are less likely to transfer out of schools which receive COSIP grants.

2. Students in COSIP schools are significantly more likely to aspire toward the Ph.D. and to plan on doing research as part of their future work. (Bear in mind, however, that there is some evidence to indicate that the meaning of "research" to a national sample of undergraduates is varied and not always identical with a scientists' rigorous definition of that term.)

3. There were several slight positive relationships between COSIP variables and student plans to teach. There were several slight negative relationships between COSIP variables and student plans to make <u>theoretical</u> contributions to science.

4. COSIP funds for Engineering and Physics are significantly associated with a student's choosing those major fields. Students in schools which have received COSIP grants for various departments and various purposes appear to be more likely to choose the following majors as seniors: Physics, other physical sciences, and Mathematics.

5. Seniors in COSIP institutions are more likely to plan careers in engineering, a finding that may related to the first conclusion. That is, it may reflect an institution's retention of students who were committed to engineering as freshmen rather than attraction of new students into that field. It is possible that this finding stems from the fact that some of the sample schools are engineering schools. A definitive explanation would require a separate study of these schools.

6. Students at schools which received COSIP grants in various departments and for various purposes appear to be somewhat less satisfied with several aspects of their college experience, notably the quality of classroom instruction. This finding may represent a "relative deprivation" effect in that only a small portion of the undergraduates at a college are affected by the grant, yet all students from that school made the assessment. The field of Computer Science was a startling exception; grants given to this field were associated with only positive assessments. Again, the relative deprivation theory may be operating; grants for Computer Science are likely to affect a wider range of undergraduates. In addition, grants to the Social Sciences and Psychology were associated with positive reactions from students with respect to the variety of courses available.

7. COSIP grants are given for five categories of purposes; the one which yields the greatest number of positive relationships is grants for undergraduate students activities. On the other hand, grants intended to benefit the undergraduate indirectly seem to have mixed effects. It may be that some grants are used by the faculty to develop and extend their own research activities rather than to improve their teaching. Support of this inference is provided by the finding that students in COSIP schools were significantly more likely to be dissatisfied with the quality of classroom instruction. The obvious conclusion is that a larger proportion of COSIP grants should be designated for undergraduate activities and a smaller proportion for faculty research and scholarly activities.

Several directions for future research would seem worthwhile. First, as mentioned previously, one effective means of disentangling some of the problems of interpretation would be to perform the analyses separately for science majors and nonscience majors. Second, the permanence of the relationships between the COSIP variables and the various student outcomes could be examined through periodic followup studies of this cohort, five, ten, or fifteen years after college. Such studies would help to show

(1) if the relationships observed here endure over time, and (2) if COSIP support has delayed impacts. Finally, these analyses might be replicated with cohorts who entered college after the fall of 1966. Some forms of support (e.g., grants for curriculum studies or equipment) which yielded negative associations in these short-term data may require several years before their pay-offs are felt by the undergraduates at an institution.

References

Astin, Alexander W. "A Preliminary Evaluation of the Undergraduate Research Participation Program of the National Science Foundation." Journal of Educational Research, Vol. 62, No. 5 (January 1969), pp. 217-21.

Astin, Helen S. Educational Progress of Disadvantaged Students. Washington: Human Service Press, University Research Corporation, 1970.

Bayer, Alan E. "Faculty as Determinators of Students' Perceptions of the College Environment." Paper presented at the American Association for the Advancement of Science, 137th Meeting, December 1970.

Bush, Vannevar. Science, the Endless Frontier: A Report to the President. Washington: U.S. Government Printing Office, July 1945.

Creager, John A., and Charles L. Sell. The Institutional Domain of Higher Education: A Characteristics File for Research. ACE Research Reports, Vol. 4, No. 6. Washington: American Council on Education, 1969.

Drew, David E. On the Allocation of Federal Funds for Science Education. ACE Research Reports, Vol. 5, No. 7. Washington: American Council on Education, 1970.

National Science Foundation. Nineteenth Annual Report. Washington: U.S. Government Printing Office, 1969.

TABLES

Table 1.
Partial Correlations Between COSIP Variables
and Selection of a Future Career

(N = 10,686 students)

Future Career	F Value*	Partial Correlation with the Criterion
Scientific Researcher (11 control variables)		
No significant correlations with COSIP variables	--	--
Scientific Technician (10 control variables)		
Undergraduate Student Projects Grant	3.922	-.019
Engineer (19 control variables)		
Engineering Grant	19.512	.043
Undergraduate Student Projects Grant	7.652	.027
Chemistry Grant	7.529	.027
Physics Grant	7.206	.026
Earth Sciences Grant	4.177	.020
Grant for Other Purposes	3.955	.019
Health Professional (17 control variables)		
Computer Science Grant	6.467	.025
Social Worker (10 control variables)		
Multidisciplinary Grant	4.704	-.021
Local Course and Curriculum Studies Grant	4.535	-.021
Teacher (11 control variables)		
No significant correlations with COSIP variables	--	--
College Professor (18 control variables)		
No significant correlations with COSIP variables	--	--
Other Educator (13 control variables)		
Interdisciplinary Grant	6.059	.024

* $F_{05} = 3.84$; $F_{01} = 6.64$

Table 2.
Partial Correlations Between COSIP Variables
and Selection of Major

(N = 10,686 students)

	F Value*	Partial Correlation with the Criterion
Biological Science Major (18 control variables)		
Physics Grant	4.427	-.020
Chemistry Major (16 control variables)		
Social Sciences Grant	4.039	.019
Computer Science Major (11 control variables)		
Biological Sciences Grant	4.389	.020
Engineering Major (21 control variables)		
Engineering Grant	8.617	.028
Instructional Scientific Equipment Grant	6.299	-.024
Biological Sciences Grant	4.975	-.022
Psychology Grant	4.388	-.020
Mathematics Major (13 control variables)		
Multidisciplinary Grant	7.646	.027
Faculty Research and Scholarly Activities Grant	6.855	.025
Chemistry Grant	6.686	.025
Local Course and Curriculum Studies Grant	4.456	.020
Physics Major (15 control variables)		
Engineering Grant	18.095	.041
Undergraduate Student Projects Grant	8.825	.029
Physics Grant	8.093	.028
Chemistry Grant	7.212	.026
Computer Science Grant	5.550	.023
Grant for Other Purposes	4.396	.020
Psychology Major (14 control variables)		
Mathematics Grant	4.262	.020
Biological Sciences Grant	4.204	.020
Social Sciences Major (14 control variables)		
No significant correlations with COSIP variables	--	--
Other Physical Sciences Major (13 control variables)		
Grant for Other Purposes	15.717	.038
COSIP Funds granted	11.675	.033
Biological Sciences Grant	9.571	.030
Instructional Scientific Equipment Grant	7.895	.027
Psychology Grant	5.295	.022
Local Course and Curriculum Studies Grant	4.427	.020
Physics Grant	4.225	.020
Education Major (20 control variables)		
Engineering Grant	7.440	-.026
Health Professions Major (17 control variables)		
No significant correlations with COSIP variables	--	--
Preprofessional Major (16 control variables)		
Earth Sciences Grant	4.955	-.022
Agriculture Major (11 control variables)		
No significant correlations with COSIP variables	--	--
Other Technical Fields Major (13 control variables)		
No significant correlations with COSIP variables	--	--

* $F_{05} = 3.84$; $F_{01} = 6.64$

Table 3.
Significant Relationships Between COSIP Variables
and Senior Outcomes

(N = 10,686 students)

	COSIP Funds Granted	Purposes: Faculty Res. & Scholarly Activities	Local Course & Curriculum Studies	Instructional Equipment	Undergrad. Student Activities	Other	Fields: Bio Sci	Chem	Computers	Earth Sci	Engineering	Math	Physics	Psych	Soc Sci	Inter-Dis	Multi-Dis
ATTRITION FROM COLLEGE																	
Did not drop out of college					+												+
Did not transfer	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+
STUDENT STATED HE RECEIVED:																	
Detailed grasp of a special field																	
Well-rounded general education																	
Training and skills for an occupation									+			-			-		
STUDENT SATISFACTION WITH:																	
College's academic reputation		-									-	-					
Intellectual environment					-				+		-				+		
Faculty/Student relations										-						-	
Quality of classroom instruction	-	-	-	-			-	-	+	-	-	-	-	-		-	-
Variety of courses available														+	+		
The administration		-	-	-			-	-	+	-	-	-	-			-	
STUDENT'S PLANNED FUTURE WORK																	
Ph.D. Aspirations	+							+				+			+		
Theoretical contribution to science			-	-													
Teaching					+						+						
Research	+			+	+	+					+						
Administration																	
Service to clients or patients																	

APPENDIX A

Coding Scheme for Expected Career and Major Field of Study

Expected Career

Collapsed Category	Item Response Alternatives
College Teacher	College Teacher, Professor
Engineer	Engineer
Health Professional	Physician or Surgeon, Dentist, Nurse, Therapist, Lab Technician, Hygienist, Dietitian or Home Economist, Pharmacist, Optometrist, Other Medical and Health Professions
Other Education	Other Education
School Teacher	Elementary Teacher, Secondary Teacher
Scientific Technician	Scientific Technician, Programmer
Scientist	Scientist, Researcher
Social Worker	Social Welfare, Group Worker, Counselor, Psychologist

Major Field of Study

Collapsed Category	Item Response Alternatives
Agriculture	Agriculture, Forestry
Biological Sciences	Biochemistry, Biophysics, Zoology, Other Biological Sciences
Chemistry	Chemistry
Computer Science	Computer Science
Education	Education
Engineering	Engineering
Health Professional	Health Technology (medical, physical, etc.), Nursing, Pharmacy, Therapy (occupational, physical, etc.)
Mathematics	Mathematics, Statistics
Other Physical Sciences	Botany, Geology, Astronomy, Other Physical Sciences
Other Technical	Electronic Technology, Communications, Industrial Arts
Physics	Physics
Preprofessional	Other Professional (Law, Medicine, etc.)
Psychology	Psychology
Social Sciences	Anthropology, Economics, Social Work, Welfare, Criminology, Sociology, Ethnic Studies (e.g., Black Studies), Other Social Sciences

APPENDIX B

Partial Correlations Between COSIP Variables and Senior Outcomes

Partial Correlations Between COSIP Variables
and Senior Outcomes

(N = 10,686 students)

	F Value*	Partial Correlation with the Criterion
ATTRITION FROM COLLEGE		
Did Not Drop Out of College (22 control variables)		
Undergraduate Student Activities Grant	6.240	.024
Multidisciplinary Grant	4.611	.021
Did Not Transfer (29 control variables)		
Instructional Scientific Equipment Grant	40.889	.062
Computer Science Grant	39.890	.061
Local Course and Curriculum Studies Grant	35.114	.057
Chemistry Grant	32.042	.055
COSIP Funds granted	30.692	.054
Earth Sciences Grant	21.205	.045
Grant for Other Purposes	21.006	.044
Physics Grant	20.634	.044
Faculty Research and Scholarly Activities Grant	20.099	.043
Undergraduate Student Activities Grant	19.272	.042
Biological Sciences Grant	18.154	.041
Interdisciplinary Grant	15.659	.038
Mathematics Grant	7.151	.026
Multidisciplinary Grant	6.347	.024
Psychology Grant	6.062	.024
Social Sciences Grant	5.492	.023
STUDENT REVIEW OF HIS COLLEGE EDUCATION		
Received a Detailed Grasp of a Special Field (20 control variables)		
No significant correlations with COSIP variables	--	--
Received a Well-Rounded General Education (29 control variables)		
No significant correlations with COSIP variables	--	--
Received Training and Skills for an Occupation (26 control variables)		
Computer Science Grant	6.511	.025
Social Sciences Grant	6.328	-.024
Mathematics Grant	4.218	-.020
STUDENT SATISFACTION WITH:		
The College's Academic Reputation (28 control variables)		
Mathematics Grant	8.999	-.029
Engineering Grant	7.948	-.027
Faculty Research and Scholarly Activities Grant	6.762	-.025
The Intellectual Environment (32 control variables)		
Computer Science Grant	18.567	.042
Engineering Grant	17.665	-.041
Undergraduate Student Activities Grant	6.435	-.025
Social Sciences Grant	5.746	.023
Faculty/Student Relations (31 control variables)		
Interdisciplinary Grant	13.287	-.035
Earth Sciences Grant	4.021	-.019
The Quality of Classroom Instruction (21 control variables)		
Faculty Research and Scholarly Activities Grant	18.731	-.042
Earth Sciences Grant	16.787	-.040
Computer Science Grant	12.999	.035
Interdisciplinary Grant	12.306	-.034
Mathematics Grant	10.933	-.032
COSIP Funds granted	9.777	-.030
Local Course and Curriculum Studies Grant	8.972	-.029
Biological Sciences Grant	8.067	-.028
Chemistry Grant	7.906	-.027
Engineering Grant	6.524	-.025
Physics Grant	5.888	-.023
Instructional Scientific Equipment Grant	5.594	-.023
Multidisciplinary Grant	4.602	-.020
Psychology Grant	4.021	-.019
The Variety of Courses Available (23 control variables)		
Social Sciences Grant	10.687	.032
Psychology Grant	8.307	.028

Partial Correlations Between COSIP Variables
and Senior Outcomes (cont.)

	F Value*	Partial Correlation with the Criterion
STUDENT SATISFACTION WITH (cont.):		
The Administration (30 control variables)		
Chemistry Grant	16.203	-.039
Earth Sciences Grant	14.189	-.036
Physics Grant	12.421	-.034
Mathematics Grant	11.725	-.033
Instructional Scientific Equipment Grant	9.433	-.030
Interdisciplinary Grant	8.196	-.028
Computer Science Grant	8.063	.028
Faculty Research and Scholarly Activities Grant	8.018	-.027
Local Course and Curriculum Studies Grant	5.015	-.022
Biological Sciences Grant	4.878	-.021
Engineering Grant	4.389	-.020
NATURE OF THE STUDENT'S PLANNED FUTURE WORK		
Ph.D. Aspirations (19 control variables)		
Mathematics Grant	5.607	.023
Social Sciences Grant	5.397	.022
COSIP Funds granted	4.931	.022
Chemistry Grant	4.915	.021
Making a Theoretical Contribution to Science (24 control variables)		
Instructional Scientific Equipment Grant	5.647	-.023
Local Course and Curriculum Studies Grant	4.483	-.021
Teaching (20 control variables)		
Undergraduate Student Activities Grant	7.524	.027
Engineering Grant	7.132	.026
Research (18 control variables)		
Undergraduate Student Activities Grant	7.479	.026
COSIP Funds granted	6.410	.025
Engineering Grant	5.590	.023
Instructional Scientific Equipment Grant	4.776	.021
Grant for Other Purposes	3.952	.019
Administration (31 control variables)		
No significant correlations with COSIP variables	--	--
Service to Clients or Patients (31 control variables)		
No significant correlations with COSIP variables	--	--

* $F_{05} = 3.84$; $F_{01} = 6.64$