DOCUMENT RESUME

ED 197 974 SE 034 141

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TITLE	An Evaluation of the National Science Foundation Comprehensive Assistance to Undergraduate Science Education Program, Volume I: Overview and Findings.
INSTITUTION	Development and Evaluation Associates, Inc., Syracuse, N.Y.
SPONS AGENCY	National Science Foundation, Washington, D.C. Directorate for Science Education.
PUB DATE	[80]
CONTRACT	NSF-SER-7809547
NOTE	117p.: For related documents, see SE 034 140-143.
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	College Science: *Educational Improvement: *Evaluation Methods: *Federal Programs: Higher Education: Program Evaluation: Science Education: *Science Instruction: *Undergraduate Study
IDENTIFIERS	National Science Foundation

ABSTRACT

Presented is the initial volume of a three-volume report detailing the evaluation of the National Science Foundation Comprehensive Assistance to Undergraduate Science Education (CAUSE) program, a program developed to encourage the improvement in quality and effectiveness of undergraduate science education in institutions of higher education. Chapter One describes the operation and history of the CAUSE program. Methodology of the evaluation framework is provided in Chapter Two, including a discussion of the elements of the design of the evaluation, i.e., the issues, evaluation framework, data collection techniques and activities, and data analysis. Chapters Three and Four deal with conclusions regarding issues and recommendations, respectively. (CS)

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AN EVALUATION OF THE NATIONAL SCIENCE FOUNDATION COMPREHENSIVE ASSISTANCE TO UNDERGRADUATE SCIENCE EDUCATION PROGRAM

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VOLUME I:
OVERVIEW AND FINDINGS

Prepared for:
Office of Program Integration
Directorate for Science Education
National Science Foundation
Washington, D.C. 20550

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SE 034 141

This report is based upon work supported by the National Science Foundation under contract number SER-7809547. Any opinions, findings, conclusions, and recommendations expressed herein are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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CHAPTER ONE

OVERVIEW OF THE EVALUATION

This initial chapter provides an overview of both the CAUSE program and this evaluation effort. The chapter begins with a description of the operation and history of the CAUSE program. A concluding section outlines the development and general design of the evaluation.

Description of the CAUSE Program

According to the 1979 program announcement the Comprehensive Assistance to Undergraduate Science Education (CAUSE) program encourages the improvement in quality and effectiveness of undergraduate science education in institutions of higher education. The primary objectives of the CAUSE program are to: (1) strengthen the resources for undergraduate science education components of 2-year and 4-year colleges and universities; (2) improve the quality of science instruction at the undergraduate level; and (3) enhance the capability of institutions for self-assessment, management, and evaluation of their science programs.

Any nonprofit, degree-granting institution or consortium of institutions in the United States is eligible to submit a proposal. Program objectives are to be achieved through projects identifying and meeting local science education needs. CAUSE is intended to provide for comprehensive revitalization of an instructional program either within or across departments. Funds cannot be requested for major construction or additional faculty except as required for improving an instructional program.

Support is intended to result in improvements which will continue beyond the actual funding period. Grants may be requested for up to $250,000 over a 3-year period. The proposing institution must provide at least one-third of the total project costs.

Any physical or social science discipline is eligible for CAUSE funds as are interdisciplinary efforts in the sciences. Each institution is allowed to submit only one proposal. At the institutional level this necessitates the development of some procedure, formal or informal, for determining which department or group of departments will submit a proposal to the CAUSE program.

Proposals are grouped for review into categories of 2-year colleges, baccalaureate-granting institutions, Ph.D.-granting institutions and consortia. A consortium may be formed for the sole purpose of planning a project which will benefit several institutions. A system of peer review has been established for assessing the proposals. The majority of peer reviewers assigned to read proposals from baccalaureate-granting institutions are themselves members of such institutions. The same is true for the other institutional types. Similarly, biologists tend to be assigned to read biology proposals, physicists to read physics proposals, and so on.

The CAUSE program was founded by an act of Congress in 1975 and awarded its first 59 grants on June 18, 1976. It has just completed its fourth year.

A Profile of One Year of the CAUSE Program

As an example of projects funded in one year by CAUSE a profile of 1979 projects is presented. In the current year NSF received a total of 307 proposals and funded 72 of these. Table 1 portrays proposals received compared to proposals funded according to institutional type.

Table 1

Summary of Requests and Actions

CAUSE FY 1979

Institutional Type	Proposals Received	Amounts Requested	Projects Recommended	Success Ratio (%)	Award Funds Requested	Award Funds Recommended
Two-Year	68	$11,165,340	16	23.5	$2,612,626	$2,523,467
Four-Year, non Ph.D.	128	22,206,700	30	23.4	4,986,696	5,104,775
Ph.D.	100	19,737,409	23	23.0	5,218,010	5,149,342
Consortia	11	2,271,128	3	27.3	549,847	521,859
TOTAL	307	$55,380,577	72	23.5	$13,367,179	$13,299,443

Broken out by distribution of proposals submitted and funded by region of the United States, FY '79 funding looks like this:

Table 2

Distribution of Proposals Recommended/Received by Census Region

CAUSE FY 1979

Census Region		Number of Proposals Received	Number of Proposals Awarded	Success Ratio (%)
I	New England	21	4	19.0
II	Middle Atlantic	61	18	29.5
III	East North Central	44	9	20.5
IV	West North Central	28	8	28.6
V	South Atlantic	56	12	21.4
VI	East South Central	23	5	21.4
VII	West South Central	28	6	21.4
VIII	Mountain	20	3	15.0
IX	Pacific	26	7	26.9
	TOTALS	307	72	23.5

The 1979 proposals portrayed by institution type according to groups of students served by the proposed project are shown in Table 3.

Table 3

Number of Students/Year Involved in Awards

By Type of Institution

CAUSE 1979

Type	Students/Year No.	Students/Year %	Minority No.	Minority %	Women No.	Women %	Handicapped No.	Handicapped %
2-Year	9,520	16.5	2,020	21.2	4,150	43.6	280	3.0
4-Year non-Ph.D.	22,110	38.3	5,090	23.0	11,470	51.9	210	1.0
Ph.D.	21,580	37.3	2,030	9.4	9,580	44.3	280	1.2
Consortia	4,580	7.9	530	11.5	2,150	46.9	50	1.0
TOTAL	57,790	100.0	9,670	16.7	27,350	47.3	820	1.4

Across Project Years

Between 1976 and 1979, the four years that the CAUSE program has been in existence, a total of 273 projects have been funded. Numbers of projects increased somewhat from 1976 to 1978 (1976 = 59, 1977 = 69, 1978 = 73) and levelled off in 1979 (72). Similarly, the amount of money awarded by NSF increased gradually from 1976 to 1978 (1976 = $9.9 million, 1977 = $10.7 million, 1978 = $13 million). Table 4 portrays the number and amount of awards by institution type.

Table 4

Proposals Received, Awarded and Amount

CAUSE 1976-1979

Type	1976 Rcd.	1976 Awarded	1976 $M	1977 Rcd.	1977 Awarded	1977 $M	1978 Rcd.	1978 Awarded	1978 $M	1979 Rcd.	1979 Awarded	1979 $M	Total Rcd.	Total Awarded	Total $M
Two-Year	186	17	2.3	105	19	2.6	82	20	3.1	68	16	2.5	441	72	10.5
Four-Year	372	23	3.3	211	28	4.6	137	34	6.0	128	30	5.1	848	115	19.0
Ph.D.	157	17	3.9	138	16	3.0	111	17	3.5	100	23	5.2	506	73	15.6
Consortia	45	2	0.4	29	6	0.5	16	2	0.4	11	3	0.5	101	13	1.8
TOTAL	760	59	9.9	483	69	10.7	346	73	13.0	307	72	13.3	1896	273	46.9

What Table 4 illustrates is that the number of proposals submitted has dropped steadily each year, while the number awarded has risen each year until 1979, when the number of awards leveled off. On the next page, Table 5 portrays the success rate of institutions which resubmit proposals to CAUSE after being turned down initially. This table suggests that the likelihood that an institution's project will be funded improves on resubmission. The success rate for first-time submissions ranges from 8.1% to 16.9%; second submissions are successful 16.8% to 23.6% of the time; and third and fourth tries have success rates of 26% and 25% respectively. Considered together, the evidence of Tables 4 and 5 suggests that the CAUSE program is providing good funding opportunities to higher education institutions.

Table 5

Success Rates by Number of Resubmissions Per Institution[a]

CAUSE 1976-1979

	New			2nd Try			3rd Try			4th Try			Total		
	Total	Award	%	Total	Award	%	Total	Award	%	Total	Award	%	Total	Award	%
1976	715	57	8.1	---	--	---	---	--	---	--	--	---	715	57	8.1
1977	133	9	6.8	321	54	16.8	---	--	---	--	--	---	454	63	13.9
1978	98	13	13.3	89	21	23.6	143	37	25.9	--	--	---	330	71	21.5
1979	83	14	16.9	94	22	23.4	56	15	26.8	64	16	25.0	290	67	23.1
TOTAL	1029	93	9.0	504	97	19.2	199	52	26.1	64	16	25.0	1789	258	14.4

[a] Data does not include proposals from consortia, or proposals/awards from/to previous awardees. A resubmission is any proposal from an institution with a prior year submission, without regard to content match.

Table 6 indicates that the number of institutions submitting proposals for the first time has dropped over the four years that CAUSE has been in existence. Given the newness of the program, however, little significance can be attached to this drop, particularly since the number of first-time submissions has remained a constant proportion of the total number of submissions over the last three years.

Table 6

	1976	1977	1978	1979	TOTAL
New Institutions (not including Consortia)	715	133	98	83	1029

Across project initiation years, the relative percentages of funds given to different types of institutions has been stable. Table 7 portrays the number and percentage of awards given to institutions categorized according to the Carnegie classification system. The left side of the table lists the number and percent of institutions and their enrollments by Carnegie classification as they existed nationally for 1979. The right side of the table presents the total number and percent of CAUSE awards to institutions by classification for the period 1976-1979.

Table 7

CAUSE Awards (1976-1979) by Type of Institution Using Carnegie Classification

	All Institutions for 1979				CAUSE Awards 1976-1979[a]	
	Institutions		Enrollment			
	Number	%	Total	%	Number	%
Doctoral Granting Institutions	184	7	3,056,132	28	53	20
Comprehensive Universities and Colleges	594	23	3,169,495	29	74	29
Liberal Arts Colleges	583	23	531,174	5	56	22
Two-Year Colleges and Institutes	1,147	45	3,978,034	37	70	27
Schools of Engineering and Technology	46	2	69,508	1	5	2
TOTAL	2,554	100	10,804,343	100	258	100

[a]13 Consortia and 2 unclassified awards not included.

If we use the total percentage of students enrolled as the criterion for the proportion of awards to be given to each category of institution, it seems to be the case that liberal arts colleges are a bit over-represented, having received 22% of the awards with only 5% of the students, while two-year colleges, with 37% of the total student population, have received only 27% of the CAUSE awards.

Minority institutions, as portrayed in Table 8, have consistently been awarded CAUSE grants at about the same rate of success as non-minority institutions.

Table 8

Minority Institutions

CAUSE 1977-1979

Year	No. of Proposals		Success Ratio	
	Received	Awarded	Minority Inst.	All Proposals
1977	27	4	14.8%	14.1%
1978	26	6	23.1	22.1
1979	29	7	24.1	23.5

All physical and social science disciplines are eligible for CAUSE monies. As shown in Table 9, the most frequent type of proposal submitted has been multidisciplinary, with proposals from biology a distant second. The least frequently submitted proposals have been from earth science followed closely by proposals from physics.

Table 9

Proposals Received/Awarded by Science Discipline

CAUSE 1976-1979

	FY 1979 No. of Proposals			FY 1976-1979 No. of Proposals		
Discipline	Received	Awarded	Success Ratio	Received	Awarded	Success Ratio
Multiple Discipline	178	43	24.2%	1165	162	13.9%
Biology	29	7	24.1	231	39	16.9
Chemistry	16	5	31.3	99	16	16.2
Engineering	23	5	21.7	101	15	14.9
Earth Science	5	2	40.0	30	4	13.3
Mathematics	28	6	21.4	104	15	14.4
Physics	8	0	0.0	53	7	13.2
Social Science	20	4	20.0	113	15	13.3
TOTAL	307	72	23.5	1896	273	14.4

History and Background of CAUSE

Origins

CAUSE is a fairly young program; it is the youngest of the three NSF programs now aimed at improving college science programs (the other two are ISEP, Instructional Science Equipment Program and LOCI, Local Course Improvement Program). However, CAUSE has its origins in the College Science Improvement Program (COSIP) which began in 1967. This was a program whose goal was to broaden the availability of superior science programs in all regions of the United States. Specifically, COSIP was responsive to the needs of 2-year, 4-year and minority institutions to improve their science programs at a time when most grant programs were aimed at the great research universities. In 1973, however, cuts in NSF's budget forced a discontinuation of the COSIP program.

Congressional Mandate for CAUSE

When the National Science Foundation presented its Fiscal Year 1976 budget to Congress in the spring of 1975, no mention was made of any broad undergraduate science program. CAUSE resulted from hearings on the NSF budget by the Subcommittee on Science, Research and Technology, U. S. House of Representatives. The specific instigation was public testimony in which the need for support for the improvement of undergraduate science education was stressed. The 1976 NSF Authorization Act, Public Law 94-86, contains this section pertaining to CAUSE:

> The National Science Foundation is authorized and directed to conduct a Comprehensive Assistance to Undergraduate Science Education program, referred to hereinafter as CAUSE. CAUSE shall have the purpose of strengthening the science education capabilities of predominantly undergraduate educational institutions and departments or groups of departments thereof through awards to four-year colleges, two-year colleges, to the undergraduate component of advance degree institutions, and to groups of such institutions. . .

Purposes and Objectives of the Program

The Committee Conference of the two Houses reviewed the purpose of CAUSE and its potential role within the overall NSF science education program. The Conference Report includes this statement describing congressional intent as it related to CAUSE:

> The CAUSE program, initiated by the committee for the coming fiscal year, will provide a means of strengthening undergraduate science education in the Nation's colleges. This program will provide specialized science teaching equipment, science teaching materials, and will offer opportunities for the implementation of new methods of teaching science developed elsewhere, and will permit departments and institutions to develop their own approaches to science teaching.

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> CAUSE will also provide funds for the further training of science faculty and for the addition of new science faculty. Grants will be made on a competitive basis . . . Interdisciplinary approaches to teaching of science will be encouraged. Particular emphasis will be placed on encouraging the teaching of science in minority institutions and in two-year colleges.

In the final NSF Appropriations Act of 1976, $2.3 million out of a total budget of $10 million was set aside for 2-year institutions.

The Conference Report does not explicitly define the term "comprehensive". NSF has offered this definition in contrast to its other programs:

> . . . CAUSE, however, offers a comprehensive approach to the improvement of an institution's instructional programs by support of broader, more integrated projects. Therefore, a CAUSE proposal must be built upon the application of a set of coordinated activities . . . These activities are expected to improve science education in a particular department or a larger unit within the institution. (CAUSE Program Announcement, 1978)

In summary, the Congressional intent in establishing the CAUSE program was to: (1) strengthen undergraduate science education; (2) provide integrated and broadly-based science improvement programs at the institutional level; (3) provide for faculty development; (4) encourage interdisciplinary approaches to the improvement of science programs; (5) place particular emphasis on improvement of science education at minority and 2-year institutions.

Description of the Evaluation of CAUSE

History and Background of the Evaluation

In the summer of 1977, the Office of Program Integration at the National Science Foundation invited interested organizations to submit proposals for the evaluation of CAUSE and several other programs. The proposal competition was organized in two phases. The first phase was the awarding of three planning grants of $10,000 each for six months to develop evaluation designs. The second phase was the awarding of funds to support the execution of the evaluation by the group which produced the most promising design in the first phase. By issuing a general program solicitation rather than resorting to the RFP mechanism, NSF hoped to encourage more imaginative evaluation designs.

In its Program Evaluation Solicitation, NSF defined the purpose for the evaluations as helping to ". . . generate information on the need, scope, impact, and conduct of the programs in addition to indicating possible future implications, trends, policies, and theoretical issues." The primary audience for the evaluations was to be the National Science Foundation and secondary audiences were to be Congress, the executive branch and academic and professional audiences.

The Solicitation listed 10 questions which were defined as "possible concerns that might be raised." These questions are:

1. What is the nature and scope of the need for the program?
2. What rationale can be constructed for program activities?
3. What are the characteristics that lead to success or failure for the program?
4. Is the program achieving its objectives?
5. How well does the program meet the needs identified?
6. What promising practices or products have been developed?
7. What are the indirect outcomes of the program?
8. What lasting effects has the program achieved?
9. What indications of causality are there?
10. What policy implications are indicated?

These questions were general to all the NSF programs to be evaluated. Specifically in reference to CAUSE, the Solicitation states: "As the CAUSE program is quite new, evaluation must necessarily focus on antecedents, program rationale, project activities and intermediate outputs." Specific questions listed in the Solicitation were:

1. Nature and scope of need for CAUSE:
   a. What evidence exists that 2- and 4-year institutions need Federal assistance to keep pace with advances in science knowledge or improvements in science teaching?
   b. What are the specific areas of undergraduate science education most in need of Federal assistance? Why?

2. Does the CAUSE program adequately respond to these needs?
   a. Do eligible institutions consider the CAUSE program a viable and efficient mechanism for improvement?
   b. What impact (direct or indirect) might the present CAUSE program have on the target populations? On funded institutions?

3. Project outcomes
   a. What are the factors within projects that lead to success or failure?
   b. What preliminary innovative or promising practices can be found in CAUSE projects?
   c. What baseline information should be collected for later evaluation comparisons?
   d. Given the early nature of these projects, is there evidence to suggest the projects are meeting the program objectives?

4. Are there policy changes and program modifications the CAUSE program should consider?

NSF's thrust in these questions and issues was to elicit information about the needs, implementation strategies, outcomes and potential program modifications as these were relevant at the institutional level. They were not concerned that the evaluation focus on NSF's internal decision-making, policies, procedures or selection of awards since these were the purview of external oversight activities. Dr. Richard Atkinson, Director of the National Science Foundation, wrote a memorandum in 1977 which differentiated between the external oversight function then being established and program evaluation. He said, in part:

> Evaluation deals with the results of NSF research, science education, and other support activities. It is expected that program oversight and program evaluation will provide information that will be helpful in setting priorities and in assuring accountability and effective program management at all levels of organization.

The DEA Evaluation

In responding to the needs and priorities identified by NSF, Development and Evaluation Associates, Inc., designed an evaluation which would: (1) be responsive to the wide diversity in CAUSE projects at the institutional level; (2) be formative in nature, facilitating the refinement and improvement of the CAUSE program; (3) be comprehensive in its scope and at the same time provide detailed examination of a few CAUSE projects.

Out of the issues identified by NSF, we formulated six which we believed would potentially yield the most useful information:

1. To what extent are high priority institutional needs being met by local CAUSE projects?
2. How are the CAUSE projects being implemented? What are their strengths and weaknesses?
3. To what extent is the improvement of the quality of instruction occurring as a result of CAUSE?
4. What is the nature and quality of the evidence and the evidence collection and analysis procedures being used to determine the strengths and weaknesses of individual CAUSE projects?
5. What are the relative costs of the design, implementation, and operation of activities within CAUSE projects, and how do they relate to post-CAUSE institutional support?
6. What policy changes and recommendations should be implemented in the CAUSE program?

In seeking ways to be both comprehensive and provide detailed examinations of some CAUSE projects, we designed a three-pronged evaluation (see Figure 1).

The broad focus evaluation. This component of the evaluation provided information on all CAUSE projects funded between 1976 and 1978. It included an examination of proposals submitted to NSF and subsequently funded and a survey of all project directors.

The medium focus evaluation. This component consisted of one-time only site visits to 17 CAUSE projects in order to provide a look at the projects from the participants' point of view and provide some insight on how CAUSE projects were being implemented.

The narrow focus evaluation. This component of the evaluation provided an in-depth view of eight CAUSE projects with multiple site visits to each. A detailed understanding of these projects was made possible by this approach. The cost issue was explored in connection with these case studies.

This evaluation was thus designed around three independent studies using methods appropriate to the three levels of focus. Data was collected and analyzed separately. The data and results of the medium and narrow focus evaluation efforts are reported in Volume II of this report. The findings and analysis of the broad focus activities are presented in Volume III. Chapters Three and Four of this volume present conclusions and recommendations derived from all three foci of the evaluation. The design and conduct of this evaluation is explained in detail in the next chapter.

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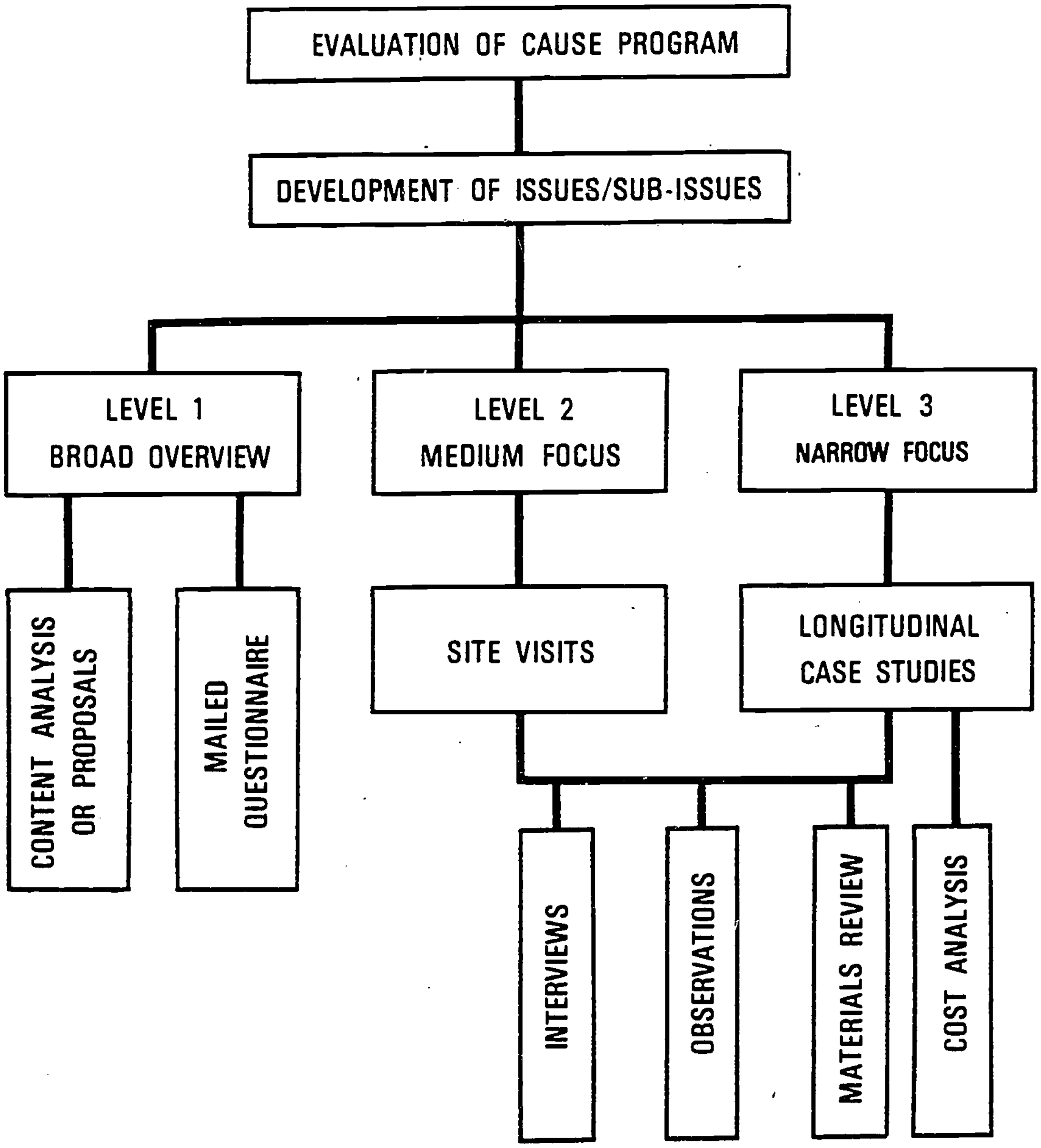

Figure 1. Profile of the Evaluation Design

CHAPTER TWO
METHODOLOGY OF THE EVALUATION

This chapter describes the methodology of the evaluation. The elements of the design of the evaluation include the issues, the evaluation framework, data collection techniques and activities, and data analysis. The part of the chapter which focuses on the data collection techniques and activities describes site selection, site visits, case studies, survey of project directors and analysis of proposals.

Issues

Source of the Issues

Six issues serve as criteria to focus this evaluation. The primary purpose of the evaluation is to provide NSF with a description of the CAUSE program in terms of:

1. To what extent are high priority institutional needs being met by local CAUSE projects?
2. How are the CAUSE projects being implemented? What are their strengths and weaknesses?
3. To what extent is improvement to the quality of instruction occurring as a result of CAUSE?
4. What is the nature and quality of the evidence and the evidence collection and analysis procedures being used to determine the strengths and weaknesses of individual CAUSE projects?
5. What are the relative costs of the design, implementation and operation of activities within CAUSE projects, and how do they relate to post-CAUSE institutional support?
6. What policy changes and program modifications should be implemented in the CAUSE program?

The issues were derived from the original NSF solicitation to conduct this evaluation, an examination of documents about the program, and site visits to a small number of projects. Informal site visits were made to eight CAUSE projects during the planning phase of this evaluation by an educational evaluator or a science educator. Each interviewed project directors and staff, students, administrators, and non-CAUSE science faculty. Interviewees were asked to describe their knowledge of and experiences with the project at their institution. Project staff were asked to describe project successes and failures, to suggest ways to improve CAUSE, and to recommend the types of information most important to gather in an evaluation of CAUSE. The site visitors prepared reports of their visits which summarized the interviews and analyzed the site visitor's perceptions of the project.

We, DEA staff, then distributed the reports and other information on CAUSE to an evaluation advisory panel assisting us in designing the evaluation. Panel members included educational evaluators, instructional technologists, and science educators. Each read the documents and we met to discuss the CAUSE program. Our goal was to select a focus and framework for the evaluation. Together we generated a list of more than a hundred issues we thought related to the CAUSE program and individual CAUSE projects. We made no attempt to judge the significance of each potential issue during our discussions. Each issue was just listed as it was generated in order to explore as widely as possible the characteristics of the CAUSE program.

From our discussions we created a list of issues which we circulated to the advisory panel. Each panel member was asked to rate each issue according to the following guidelines:

1. The likelihood that an investigation of the issue would lead to improvement of the CAUSE program.

2. The importance of the issue, as likely to be perceived by the major audiences of this evaluation.

3. The specificity of the issue (i.e., would its investigation yield information focused enough to inform decisions?).

4. The likelihood that an investigation of the issue would contribute to an accurate and comprehensive description of the CAUSE program.

5. The availability of resources to address the issues.

Based on the ratings, we sorted and analyzed the issues. Ones which received low ratings from a majority of the panel were deleted. Ones which received high or mixed ratings were analyzed according to the focus of the issue. Similar or related issues were grouped and assigned category headings. Then we discussed the issues again and reorganized them slightly.

The resulting categories became the six issues which have provided the structure for this evaluation. The issues generated by the advisory panel became sub-issues to explain, clarify, and extend the meaning of the six issues. Our intention was that the sub-issues be changeable throughout the evaluation. In this way we planned for findings to be organized at the same time as they informed the evaluation. We wanted to allow the evaluation enough scope in order to explore new sub-issues which might emerge during the course of the study. The sub-issues with which we started are listed below according to which issue they were originally assigned during the planning phase.

A List of the Six Issues and Sub-Issues

Issue #1: To what extent are high priority institutional needs being met by local CAUSE projects?

Sub-Issues

1.1 What are the needs for undergraduate science education today?

1.2 Can the institutional needs claimed in the proposal be verified?

1.3 To what extent are CAUSE project goals integrated with institutional goals?

1.4 What evidence is there that CAUSE projects would not have come about without NSF support?

Issue #2: How are the CAUSE projects being implemented? What are their strengths and weaknesses?

Sub-Issues

2.1 What are the proposed objectives of the project?

2.2 How do they compare with the present objectives?

2.3 Are the objectives being met?

2.4 How do the projects "operate?" What activities are involved in each?

2.5 Within the larger institutions, what types of people are awarded the CAUSE grants? The best? The worst?

2.6 What is the evidence that individual CAUSE projects have institutional support, both vertically and horizontally

2.7 How are projects most successfully integrated into their respective institutions? To what extent is integration evolutionary?

2.8 What is the nature of CAUSE project planning? How carefully is it being done?

2.9 What is the role of management, administration and communication in CAUSE projects?

2.10 What are the critical attributes of successful and unsuccessful CAUSE projects?

2.11 Who might be labeled as "change agents" in the project? What did they do? What are critical attributes of change agents in the CAUSE context?

2.12 What are the most common constraints on change in the CAUSE context? How are they overcome?

2.13 What evidence is there that CAUSE serves as a catalyst for change?

2.14 How does the CAUSE project respond to the instructional needs of various student populations? (Science majors, non-science majors, ages, ability levels, etc.)

2.15 To what extent is access to traditional and non-traditional student populations being changed as a result of CAUSE?

Issue #3: To what extent is improvement of the quality of instruction occurring as a result of CAUSE?

Sub-Issues

3.1 What general impact is the CAUSE program having upon undergraduate science programs?

3.2 What evidence is there that the quality of instruction has improved as a result of CAUSE?

3.3 What are the affective outcomes of CAUSE (student attributes, faculty morale, provincialism, etc.)

3.4 What unexpected outcomes have occurred especially across projects?

3.5 Are processes, materials, products of instructional development efforts of high quality?

3.6 Are the faculty/instructional developers given adequate materials and consulting resources to do their job?

3.7 To what extent are the materials/products developed actually utilized?

3.8 What events/incidents are seen as critical to project successes and failure? Which, if any, of these are common across projects?

3.9 What evidence is there that the effects of the CAUSE grant will continue after the funding runs out? What are the impacts over time?

3.10 What preliminary innovative or promising practices can be found?

Issue #4: What is the nature and quality of the evidence and evidence collection procedures being used to determine the strengths and weaknesses of individual CAUSE projects?

Sub-Issues

4.1 What role does evaluation play in individual CAUSE projects and within the CAUSE program as a whole?

4.2 How do CAUSE project directors perceive the role of evaluator?

4.3 To what extent are the capabilities of institutions for self-assessment and evaluation being improved through the CAUSE program?

4.4 What are the side-effects, the costs and benefits of the process of project evaluations?

4.5 How can project evaluation be improved?

4.6 What baseline data should be collected for later comparisons?

Issue #5: What are the relative costs of the design, implementation and operation of activities within CAUSE projects, and how do the relate to post-CAUSE institutional support?

Sub-Issues

5.1 What are the costs of design, implementation and operation of CAUSE projects?

5.2 How do design, implementation and operational costs relate to post-project institutional support?

5.3 How are capital expenditures used? What are the returns?

5.4 What is the effect of an institution's fixed funds being appropriated as matching funds for a CAUSE project?

5.5 What are the implications of CAUSE's requirement that one-third of the total project costs be borne by the requesting institution?

5.6 Are there any consistent differences in the objects of expenditures of the two funding sources?

Issue #6: What policy changes and program modifications should be implemented in the CAUSE program?

Sub-Issues

6.1 How can program administration be improved?

6.2 How can communication with and support of project monitors be improved?

6.3 How can CAUSE project evaluation procedures be improved?

6.4 How can the documentation and reporting of CAUSE projects be improved?

6.5 What are the strengths and weaknesses of the sampling of individual projects?

6.6 What are the policy implications of the feedback concerning the previous five issues?

Description of the Issues

Institutional needs. One of the major objectives of the CAUSE program is to promote projects which meet high priority local needs of institutions. The first part of a CAUSE proposal is a local review statement from an institution's chief officer or chief academic officer. The program announcement for CAUSE projects states:

> A requirement for CAUSE support is that the proposed activity not only contribute to the improvement of instruction in science, but that it do so through projects that are consistent with the local environment, i.e., the individual institution's overall science education objectives (CAUSE Program Announcement, 1979)

It goes on to specify that an institution should commit itself to a project which will fit in the institution; and which can be supported during and after the project. Institutions are cautioned to consider priority of science education needs.

Following the Local Review Statement proposals usually address the characteristics of the institution, science education needs, and the choice of project objectives to meet the needs. Proposers are also expected to describe specifically how the project will be supported after NSF funding is over.

The intent of the Local Review Statement and the discussion of institutional needs and project objectives is to identify projects most likely to improve science education at the local level. The assumption that projects which meet high priority needs are more likely to succeed is not discussed outright.

During the planning phase of this evaluation the validity and priority of local science education needs, as addressed by CAUSE, were examined. We assumed at the beginning that institutional needs statements were not always sincere and that institutional support might be less than complete. Planning phase site visits indicated that CAUSE projects might be primarily designed around individual faculty or departmental concerns with little regard for institutional concerns. It was because of this preliminary evidence and the relative importance given institutional need and commitment in proposal review criteria that we selected Issue One.

During this evaluation we have sought to clarify needs described in proposals and judge the degree to which project designs match their stated needs. We have tried to determine the extent to which actual institutional support for projects exists; where support was lacking we sought to uncover the reasons and the consequences of the lack. We also studied whether or not a project influenced institutional needs or caused them to be examined further.

Project implementation. The carrying out of a project is supposed to be described in project proposals. Review criteria of the proposal include completeness and clarity of the project plan; the relationship between objectives and activities; and the sequence of and time allowance for project activities. Management of projects is also considered important. Proposals should describe management procedures, staffing, and monitoring of the project. The program announcement recommends that:

> Proposals should be as specific as possible in the discussion of how the various proposed activities will be carried out so that the feasibility, practicality, and potential gain of the project can be assessed by reviewers.

We selected project implementation as an issue to be studied in this evaluation because proposals are often scanty in their descriptions of proposed-project activities. A major emphasis of this evaluation has been to describe local institutional responses to science education needs. We sought to compare proposed objectives and activities with those actually carried out and to examine the reasons for discrepancies when they occurred. We assumed that while successful project implementation strategies would differ from site to site, some strategies would be shared. We focused specifically on planning, communications, and management as potential sources of useful strategies. We thought that future projects might benefit from information about such strategies.

Quality of instruction. Two primary objectives of the CAUSE program are to strengthen the nation's undergraduate science education resources and to improve the quality of undergraduate science instruction. We recognize that these are long-term goals but chose to study as carefully as possible the impact of projects on the quality of instruction. As the program announcement points out:

> Since the ultimate target is the undergraduate student, proposals should indicate how the project will have an impact on the student's understanding of science.

The data from the planning phase of the evaluation indicated a wide range in the quality of instructional materials and strategies being developed on projects. We thought quality might be affected by resources, such as instructional development expertise, or special materials available to CAUSE faculty for instructional improvement. We knew we would have difficulty exploring this issue since assessment of quality of instruction of a project is dependent on the evaluation practices of that project. We did not intend to make independent assessments or examinations of projects or even to conduct secondary analyses of already available data. We have examined improvement of science education resources and of quality of instruction by studying the processes used, the improvement over what was replaced, the probable longevity of the improvement, and the unanticipated outcomes.

Evaluation. A major objective of the CAUSE program is "to enhance the capability of institutions for self-assessment, management, and evaluation of their science programs (CAUSE Program Announcement, 1979)." The guidelines suggest that up to 10% of the total project budget may be expended on evaluation activities. In 1976, 1977, and 1978 the program announcement described the roles evaluation can play in a project and offered an extensive bibliography on current evaluation theory and methods. In 1979 the bibliography was deleted, but prospective project staff are encouraged to include two forms of evaluation in their projects:

> The first should be designed to provide the project's staff with whatever information is needed to monitor and adjust the project's progress toward its stated goals and objectives. The primary beneficiaries of this evaluation are the project's staff . . . . The second form of evaluation should be designed to provide the project and other interested parties with an overview of project outcomes. (CAUSE Program Announcement, 1979.)

Evaluation has thus been highly recommended as an important project activity for both its formative and summative roles.

Because institutional capacity for evaluation is a goal of CAUSE and because evaluation is considered an important project activity we chose to study evaluation as our fourth issue. During the planning phase we gathered conflicting data on project evaluation. CAUSE documents placed a heavy emphasis on it while the projects we visited varied greatly in conduct of evaluation activities. We speculated that the conflicting evidence might have come from a lack of familiarity with social science techniques or from a mistrust of the validity or utility of such procedures. We also considered that we were not recognizing the fact that most science educators routinely collect evidence about the success of their teaching activities. However, it seemed to us that some project directors were more concerned about project activities other than evaluation. During our evaluation we have examined evaluation strategies used on projects, staff perceptions and knowledge about evaluation, impact of evaluation data on projects, and the general nature of problems with evaluation.

Project costs. Projects are funded with resources from both NSF and their own institutions in a two-thirds/one-third match. The program announcement notes that:

> Since CAUSE is intended to provide assistance to institutions in improving their own programs of science education, or in enhancing their own capabilities to conduct such improvement activities, recipients of NSF support under this program will be required to contribute to overall project costs. (CAUSE Program Announcement, 1979.)

Institutions have great leeway in selecting which budget items they will support. Types of items supported by an institution are not factors judged in reviewing proposals. Institutional contributions may include indirect costs at the standard rate for the institution. The institutional contribution gives evidence to the institutional support promised in the local review statement.

We selected an examination of project costs and resources as Issue Five because we believed that costs are closely tied to understanding institutional support and continuation of the project after CAUSE. Investigations during the planning stage at one site indicated that institutional support could be far greater than that promised and allocated in the budget. It seemed possible in some cases that NSF funds generated, during the project, additional resource allocations directly to science education at an institution. On the other hand, institutional financial support promised in the proposal might only be for indirect costs with no other resources forthcoming from the institution. We wondered if allocation of resources was a real indicator of institutional support, evidence for which is sometimes difficult to track down.

Continuation costs were also of interest to us because the program guidelines seemed to emphasize the need for institutions to continue support of a project once CAUSE funding was complete. We assumed this meant that many CAUSE projects were aimed at providing new and more expensive-to-operate

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instructional resources. Therefore we chose to study the costs of project activities in terms of where the costs were incurred and for what purpose. Such an analysis we thought might provide information on recurring and non-recurring costs and their relationship to project continuation costs. A functional cost analysis of project budget, activities, and objectives was selected as a way to describe the distribution of costs across projects. We have studied three phases of a project which include: the design phase, when planning and development of project activities take place; the investment phase, when hardware and commercially-produced instructional materials are purchased or facilities are renovated; the operational phase, when the development activities are complete and any expenses are for maintaining use. Our goal has been to describe the nature of costs within a variety of types of projects.

Issue Five was selected as an important area for study for obvious reasons, but it was also a highly speculative area for study. The cost analysis of the kind of instructional improvement activity funded by CAUSE is a relatively new and difficult aspect of program evaluation endeavors. Furthermore, with projects and institutions as diverse as those funded by CAUSE it can be particularly difficult to avoid misleading, invalid or overly simplistic examinations of project costs. We therefore decided to limit the conduct of cost analysis to the eight sites chosen as part of the narrow focus evaluation, and to conduct each cost analysis with a primary concern for the accurate description of an individual project's utilization of its resources and less of a concern for cross-project comparisons. As a result of these design decisions, relatively less data is available to address Issue Five than for the other issues, but a concern for project cost variables ultimately figured in our understanding of aspects of Issues Two and Three concerns.

Policy recommendations. We viewed policy recommendations not so much as a separate issue, but as the overriding concern of this evaluation. We selected it as Issue Six but, in fact, we did not treat it as an issue to be investigated at each site. Our focus has been that the data for this issue would come from the other five issues rather than from any kind of direct data collection on policy recommendations. In this sense the issue of policy recommendations is a second order issue of the evaluation.

Use of the Issues

The issues have remained the same throughout the evaluation. At one point after the conduct of the first phase of the survey and the first visits to projects we seriously considered whether or not they would continue to be useful. At that time many new issues were emerging which did not seem to fit in topic or in scope with either our issues or our sub-issues. We decided without the issues the evaluation would lose all structure and coherence so we recorded and discussed the emerging topics. We then put them aside and continued to use the issues to focus our data collection and analysis activities.

As the evaluation progressed and we began analysis of data from each source we returned to the issues and the emergent topics. The topics, for us, had merged into the issues. They were important and visable but had found a space under the umbrella of one or another of the issues. In the meantime the sub-issues had changed. Some merged together. Others moved from the issue of quality of instruction to project implementation or to the issue of institutional need. Several were changed to better reflect the CAUSE program--the focus was similar but the perspective had changed.

Specific tracking of sub-issues across the span of the evaluation is difficult or impossible to do. For us the sub-issues served to bring us back to the specific evidence and detail needed to clarify each issue. We did not seek to maintain the sub-issues themselves as categories for findings and conclusions. A careful reader, however, should be able to see some influence of the sub-issues listed above in the discussions of findings in Volumes II and III. The six issues are the same.

Evaluation Framework

In order to conduct an evaluation based on issues we needed to select a framework to structure the evaluation itself. Stufflebeam describes the use of a framework in this way:

> An investigatory framework specifies the conditions under which data are to be gathered and reported, and the assumptions to be made in interpreting the findings. In all evaluation studies evaluators must choose either implicitly or explicitly among a number of alternative investigatory frameworks, e.g., experimental design, survey, case study, and site visitation.
>
> No one investigatory framework is superior in all cases. None is always best in serving the criteria of technical adequacy, utility, and efficiency. Also different frameworks work differentially well under different sets of feasibility constraints. Thus evaluators may choose different investigatory frameworks depending on the evaluative purposes to be served, the priorities assigned to the different criteria for judging evaluation reports, and the unique conditions under which evaluations are to be conducted. The task is to choose the framework that will optimize the quality and use of results under realistic constraints. (Stufflebeam, 1975, p. 47.)

Criteria for Selection of an Evaluation Framework

Our overriding concern was to provide NSF with a useful evaluation of a complex, multidimensional funding program. Our professional bias was for the evaluation to take a formative role with respect to NSF policy-making. In selecting a framework we specified four criteria to guide the selection process:

1. The methods should be capable of providing both a broad picture of the overall CAUSE program and in-depth portrayals of a sample of individual projects.
2. The methods should emphasize both redundancy and multiple perspectives.
3. The methods should be capable of refining the evaluation as it proceeds.
4. The methods should produce data that are policy-relevant and capable of being used by policy-makers.

Each of these criteria is explained below.

Broad picture and in-depth portrayal. Cronbach (1970) has discussed what he calls the "bandwidth-fidelity dilemma" in terms of psychological testing. The dilemma is that there is always a trade-off between breadth of coverage and precision of information; i.e., it is possible in a given investigation to obtain a wealth of information about a few things, or a paucity of information about many things. An analogy may be drawn to the microscope. The highest powered lens will provide great detail but a narrow field of vision. The lowest powered lens will provide a wider field of vision, but some precision will be lost. This evaluation was designed to provide a comprehensive view of the CAUSE program through a combination of broad coverage/low precision techniques to provide an overall picture of the program, and narrow coverage/high precision techniques to provide a detailed understanding of its more important facets.

Redundancy and multiple perspectives. Redundancy refers to the repeated gathering of information from similar sources. This technique is used in physical, social and psychological measurement to increase reliability and to check validity. Multiple perspectives refer to the varied points of view of different observers. As in the story of the blind men and the elephant, reliance on the perceptions of one or two persons, whether they be site visitors or project staff, is likely to provide a distorted view of the CAUSE program. We chose data collection strategies which would maximize redundancy and minimize distortion caused by a limited number of perspectives.

Refinement during the evaluation. This evaluation was designed to be a responsive evaluation in that the issues which were investigated were not limited to those identified in the planning phase. Stake's (1973) description of the portrayal process illustrates this principle:

> To do a responsive evaluation, the evaluator conceives of a plan of observations and negotiations. With the client's help he prepares brief narratives, portrayals, product displays, graphs, etc. He finds out what is of value to his audiences. He gathers expressions of worth from various individuals whose points of view differ. Of course, he checks the quality of his records. He gets program personnel to react to the accuracy of his portrayals. He gets authority figures to react to the importance of various findings. He does much of this informally--iterating, keeping a record of action and reaction.

We chose methods which would permit an iterative process of issue definition and redefinition, based on imput from both NSF and individual projects.

Policy-relevant data. Evaluation data are notoriously under-utilized. Some of the reasons for the neglect of policy studies, according to Agarwala-Rogers (1977), include "lack of administrators' participation and involvement in the evaluation process, conflicting interests of program officials and evaluators of the program, lack of mutually agreed upon 'problem' definitions and 'needs' delineation between evaluators and users of the research findings . . ., lack of emphasis on providing solutions to problems . . ., overemphasis on negative aspects of the program . . ., and problems of feedback and timeliness of evaluation results."

We chose a framework to involve NSF administration in the selection and definition of issues, to maximize NSF-DEA communication, and to focus on program successes as well as failures. These strategies were intended to maximize the utility of this evaluation for the development of NSF policy.

Methods for the Framework

To meet the criteria for selecting a framework for this evaluation we chose methods at three levels of specificity and focus. The first perspective, gained from case study methods, is a close-up and in-depth view of 8 out of 25 selected projects. The second perspective, from site visits, is a detailed examination of the remaining 17 of those 25 projects. The third perspective, gained from surveys of project directors and analysis of proposals, provides a broad view of all projects from 1976-78 (N=201).

The three perspectives were selected as ways to emphasize redundancy in data collection from multiple perspectives in order to increase reliability and validity of the data. The issues provided the structure by which multiple perspectives could be investigated. Emphasis on different characteristics of the CAUSE program, at the program level and at the project level, could be shifted among the three levels. With three levels of methods to study a multidimensional program. the issues would have to be investigated in a way that would provide redundancy in the data. Otherwise there would be no way to understand the relationship among levels or among the characteristics and dimensions of the CAUSE program.

Accuracy of data can be examined by asking the same questions of different types of people and different sources. Redundancy could be achieved through use of complementary data sources and collection techniques. These range from the survey of project directors' opinions and experiences to the site visitors' observations over time of one site, from pre-planned interviews with project staff to informal conversations with students, and from investigation of specific sub-issues to exploration of unanticipated outcomes. The pursuit of multiple perspectives was chosen to lead to a more complete understanding of the issues.

Strengths and Weaknesses of Methods

Each data collection method had some strengths and weaknesses in its contribution to the evaluation. We chose methods to complement each other and to match the intent of the framework to provide redundancy and multiple perspectives. For example, the survey asked a wide range of questions of all project directors. Since the survey was conducted by mail and required written responses, the choice of questions was limited to those whose meaning could be conveyed to all project directors in written form. No opportunity existed to probe individual responses to clarify or extend their meaning. Validity and reliability of results was further affected by the fact that responses are based on self-report. The superficiality of the survey on some issues was balanced by the detail and depth of data that was provided by the case studies. Through the case studies, team members had the opportunity to ask the same question of several CAUSE faculty and staff members and to repeat the question during return visits. However, the case study data are limited by the fact that they were collected by a team of people who, because they visited a project several times, may have lost some of their perspective or objectivity with respect to a project. The two-day site visit, on the other hand, afforded teams the opportunity to ask similar questions from a wide variety of projects. The questions covered the same issues at each site but were tailored to each specific project. However, because these projects were only visited once, the data were not as reliable as those modified by repeated visits and repeated questioning. The sites, as a group, add more breadth to the data than do the case studies and more detail than the broad view methods. Strengths and weaknesses of the methods are summarized in Table 10.

Data Collection Activities

Visits to 25 CAUSE Projects

The following section describes the data collection activities of the evaluation with respect to the narrow and medium focus methods. Since the 25 sites were selected as one sample of 1976-78 projects with the eight case study sites as a subset of the larger sample, site selection is discussed first. Following the discussion, site visits, case studies, and cost analysis are described.

Site selection. Site selection was a complicated and difficult decision to make. The problem was due to the great diversity in CAUSE project and institutional characteristics, limited resources for site

Table 10

Strengths and Weaknesses of Data Collection Methods

Perspective, technique method and sample	Strengths	Weaknesses
Broad focus: Mailed survey and Analysis of proposals N = 201[a]	Broad coverage; requires less time; inexpensive, substantial redundancy across projects; opportunity to investigate feasibility of program-wide baseline data collection; opportunity for all directors to air opinions; proposal analysis provides a comprehensive summary of the public face of CAUSE	Relative superficiality of data collection techniques; inability to probe deeply; surveys limited to the single perspective of project directors; possibility of being perceived as bureaucratic meddling
Medium focus: Two-day site visit, including interviews, observasation, and materials and document review N = 17	Opportunity to probe face-to-face on selected issues; to understand the project in its context; for visitors to interact with project staff on a professional level; cross-validation of subjective judgments from multiple perspectives; a significant sampling of project population	Possibility of visitors being "snowed" on a single visit; danger of over-generalization from single visits; lack of time to probe deeply into all important issues; possibility of missing some important projects; reliance on subjectivity of visitors; limited redundancy
Narrow focus: Case study including multiple site visits, emphasis on progress of project, in-depth examination of some issues, and cost analysis N = 8	Opportunity to understand issues in the context of an ongoing project; to look at the progress of a project over time; potential for establishing the rapport necessary for subtleties to be understood; multiple perspectives with substantial redundancy within sites; opportunity to study expenditure of project resources	Difficulty of generalization from small sample; substantial cooperation from sites necessary; time consuming; expensive; educational cost analysis is a relatively new technique and not well understood or well developed

[a] Because of the timelines of this evaluation, 1976, 1977 and 1978 projects were surveyed (N = 201). Proposals were analyzed for the years 1976, 1977, 1978 and 1979.

visiting, and the importance of representatives of the sample of sites. Diversity of projects is very great across variables such as the year funding began, duration of the project, type and size of institution, amount of funding, discipline focus, etc. Initial understanding of the importance of certain variables was confused by the brevity of project proposals and the complexity of project design.

We selected the most important variables to consider and ranked them in terms of priority. We then selected a sample that was representative of the 201 projects from 1976-78. Because we were concerned about a number of different variables each had to be considered independently of the others. The sample of 25 represents several different distributions of variables. If the variables are considered simultaneously, the resulting sampling matrix has a great many cells, too many cells to be used as a guide to site selection.

We distributed sites across two variables first: type of activity and funding level (see Table 11). We then checked the distribution of the other five variables across the sample. When we found an imbalance in some variable we "fiddled" with the sample by replacing some cases in order to even out the distribution. Eventually, we ended up with a fairly representative distribution of sites on each variable taken individually. The distribution across other variables is shown in Table 12.

The variables we used in order of high to low priority are: type of activity, funding level, institutional involvement, year, institution type, discipline, and duration. "Type of activity" refers to the substantive nature of the project and has six categories: use of computers, equipment and facilities, instructional materials revision, individualized

Table 11

Distribution of the Sample (Population) Funding Level by Type of Activity

Funding Level	Use of Computers	Equipment/ Facilities	Materials Revision	Individualized Instruction	Remediation	Other
	Types of Activity					
Low Cost (less than $100,000)	1 (6)	3 (21)	1 (1)	1 (5)	1 (2)	1 (11)
Medium Cost ($100,000 to 150,000)	2 (10)	1 (15)	0 (3)	1 (6)	0 (1)	1 (6)
High Cost (more than $150,000)	3 (33)	2 (12)	1 (5)	3 (27)	1 (11)	2 (26)
TOTAL	6 (49)	6 (48)	2 (9)	5 (38)	2 (14)	4 (43)

Table 12

Distribution of Sample Across Other Site Selection Variables

I.	Institutional Involvement:	Single Department		Across Departments	
		28%		72%	
II.	Fiscal Funding Year:	1976	1977	1978	
		32%	44%	24%	
III.	Type of Institution:	2-yr.	4-yr.	Ph.D.	Consortium
		28%	40%	24%	8%
IV.	Duration:	1 year	2 years	3 years	
		12%	16%	73%	
V.	Disciplines:	Life Science (16%)	Chemistry (12%)	Earth Science (4%)	
		Computer Science (4%)	Engineering (8%)	Physics (4%)	
		Social Sciences (4%)	Mathematics (4%)	Multi-discipline (44%)	

instruction, remediation, and other. "Funding level" is a variable, based on NSF funding, which was created by dividing the range of awards from $0 to $300,000 into three levels of $100,000 increments. "Institutional involvement" is based on whether the project involves only one department at an institution or goes across departments. "Project year" is the fiscal year in which the project was awarded its grant: 1976, 1977, 1978. "Type of institution" is based on a distinction used throughout the CAUSE program of two-year colleges, baccalaureate degree-granting institutions (which may grant Masters degrees, too), Ph.D.-granting institutions, and consortia of institutions. "Discipline" is the academic field which is the focus of the project and again is taken from a designation used by NSF. The categories cover a broad range for each discipline and include: life sciences, chemistry, earth sciences, social sciences, physics, mathematics, computer science, engineering, and multi-discipline projects. Finally, "duration" of projects refers to their length as one year, two year or three year projects.

One of the twenty-five sites we originally selected was not visited. The project had been scheduled to be completed during the period of our case studies. When we telephoned the college to speak to the project director we discovered that she had retired. We called her at home and found out that the project had been completed a year ahead of schedule. Although we intended to study some completed projects we decided that this particular project would be too difficult to study. We thought that with the project director gone from the institution the main source of information about the project was missing from the institution. We replaced the project in the sample with another (and it has been included in Tables 11 and 12).

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Site visits. To prepare for site visits, consultants and staff met for a two-day orientation session. The purpose of the meeting was to explain CAUSE, the overall evaluation, the place of the site visits in the evaluation, and site visit procedures. We tried to build a shared understanding of the evaluation issues and the goals of the evaluation. Together we reviewed and discussed site visit procedures as described in a site visit resource manual and an individual site visit guide.

The site visit resource manual contained: the names and addresses of the evaluation staff and consultants; a summary of the evaluation plan; some information on interviewing, materials review, and cost analysis; a statement of confidentiality of site visit data; a CAUSE program solicitation, statistics on CAUSE projects, 1976-78; and guidelines for travel expenses. The manual provided background material for the individual site visit guide. A separate copy of the guide was prepared for every site visit. It was taken on a site visit by both team members and used as a tool for preparing for a visit and as a place to record data. The individual site visit guide contained a checklist for all procedures; a schedule for the visit; interview planning guides; an interviewing focusing guide to the evaluation series; a form for recording the focus of the visit; a form for planning each interview; de-briefing procedures for between team members; and specific directions for report preparation. Forms for giving feedback on the visit to DEA were included and were completed by the project director and by the science educator.

The site visits were conducted by two-person teams, composed of a science educator and an evaluator, in order to represent two points of view. The viewpoints were unique in some respects and overlapping in others. The science educator represented discipline expertise and knowledge of current practices in science teaching. The educational evaluator represented expertise in current instructional improvement practices in higher education and, as a full-time DEA staff member, consistency with the rest of the evaluation activities. Science educators were assigned to sites based on their discipline and their expertise.

Activities related to a typical site visit began two or three months in advance of the visit. Project directors were notified of our interest in having them participate in the evaluation and a time was set for the visit. The project director was asked to set up a two-day schedule of interviews, observation and group meetings. The science educator and the evaluator read the project proposal, discussed it, selected a focus for the visit, and wrote questions on issues via telephone in advance of the visit.

The site visitors met on site the morning of the first day. They made final plans for the visit before going to the institution. In advance of the teams' arrival project directors set up group meetings and/or individual interviews with CAUSE faculty and staff, students, non-CAUSE science faculty, and administrators. The team usually met first with the project director to discuss their schedule and to make additions or changes.

Each day on site included extensive interviewing, touring of facilities, observing classes and reviewing materials and project documents. At the end of the first day the two team members went over their observations, discussed them, and selected questions which had been missed or were still unclear. At the end of the second day they met with the project director for a debriefing session.

Reports of the visit were the responsibility of both team members. The science educator followed a specified format which covered a description of the site visit and an analysis of the issues with respect to the project. The evaluator wrote informal field notes summarizing each activity of the site visit and then later rewrote the science educator's report. Then the report was sent to the project director for corrections and comments. Based on the comments, the site visit reports were revised. In a second round of revisions the site visits were rewritten to include more information on the institution, the techniques used for the site visit, a better description of the project, and fictional names of people and institutions.

Case studies. The data collection activities of the case studies were essentially the same as those of the site visits. What differed was the addition of multiple observations over the period of a year. The issues were explored in more depth, specifically in respect to how the project progressed and evolved over time. Between visits the team members and other DEA evaluation staff read the reports, commented on them, and identified topics to examine in more detail. The team had time to obtain and to study project documents and instructional materials carefully.

Reports were written, in most cases, after the first visit and after the last visit. The interim visits were documented with field notes. The first reports were sent to project directors for comment and, generally, elicited many corrections.

The relationship between the visiting team and the project, especially the project director, was different from that of the site visits, and it altered over time. The relationship differed because the projects knew the teams would be visiting again. It might be described as a tension which existed between wanting to be friendly and hospitable and feeling threatened by being evaluated. In all cases, however, project directors and staff were very cordial and cooperative.

Reporting format for case studies was not specified as rigidly as it was for the site visits. Teams were given more leeway to design a report which described the project and the casing process as they decided best fit the situation. The focus of the case studies was always on the evaluation issues. However, at each institution themes, or additional issues, developed as the team investigated further. The reports, in general, and the prefaces and summaries of the reports, in specific, are intended to describe the special themes of a project in addition to the issues.

Cost analysis. Each case study has a component which explored project costs. A cost analyst visited the case study site and gathered data independent of the rest of the case study team's data collection activities. The analysts were kept abreast of the results of visits to the sites, and no analyst went to a site until the case study team had visited at least once. The analyst interviewed project staff to gather data about the expenditure of time, money and other resources which were used to accomplish the objectives of the project.

Typically, total project costs were first analyzed by conventional budget categories for an established fiscal period and displayed on a standard budget form. This chronological compilation of costs by categories did not show information useful in understanding some project characteristics. For example, traditional budget categories by fiscal year did not show the distribution of costs for instructional improvement projects which have three distinct phases of activity: design, investment, and operation. Thus, a second, functional analysis of project costs was conducted which arranged project costs according to project objectives or activities. While the analysis based on traditional budget categories was useful in examining continuation costs, the functional analysis was useful in examining the nature, sources, and allocation of contributed resources (particularly those not listed in the original proposal).

The cost analysis methods were not utilized in any uniform manner across the case study sites. The objectives of the projects varied greatly and the sample is small. So the cost analysts chose, as a team, to select methods for each case study site which would best illustrate the type of costs for that project. Further discussion of the selection of methods is continued in the section in Chapter One, Volume II which summarizes findings on project costs.

Broad View of CAUSE Projects

Survey of CAUSE project directors. A survey of virtually all project directors for 1976, 1977, and 1978 projects was conducted in two stages. One-half of the project directors received the first survey and the other half received the second survey. The survey results provide a broad overview of CAUSE projects from the perspective of the project directors. They reflect the project directors' experience with project activities and their opinions about their projects and the CAUSE program. A complete description of the rationale, procedures, and results from the survey appear in Volume III, Chapter One.

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Analysis of proposals. A content analysis of proposals for 1976-79 CAUSE projects was conducted as a second broad focus data collection activity. The original intention of the content analysis was to examine science education and institutional needs described in proposals. The analysis was to provide an overall description of the various types of science education needs being served by CAUSE and the relative emphasis the needs were given in the proposals. The analysis was expanded to include an examination of problems and needs, audiences for CAUSE projects, goals and objectives, and outcomes of projects as proposed. The additional categories fitted easily into the content analysis data collection and paralleled an earlier analysis conducted by NSF.

What did not work which was proposed was analysis of unfunded proposals. We took a sample of 20 unfunded proposals from 1978. The sample was too small to be meaningful for comparison purposes to funded proposals for 1978. There were too many "empty cells" or categories of variables which did not have any cases. We dropped the unfunded proposals from further comparison. A complete report of the analysis of proposals including procedures, data analysis, and results appears in Volume III, Chapter Two.

Data Analysis

Data analysis was accomplished through use of an iterative process of discovery and verification. The discovery phase was the expansion of the sample of observations using the methods of site visiting, casing, surveying, and content analysis. The verification phase was one of reduction of observations into categories and relationships among categories. We used this two-phase process over and over again during the evaluation.

The derivation of the six issues during the planning stage of the evaluation was the first round of iterations and is explained above in the section on the issues. Once the evaluation was underway, observations were gathered from the first survey, the analysis of proposals, and about one-fourth of the visits to projects. The evaluation team then got together to analyze the first group of findings. Since these observations had been gathered with instruments and interview protocols based on the six issues and the sub-issues, they were easily organized into categories which matched the issues. However, we had many findings which did not fit. We debated elimination of the issues or the sub-issues. We tried to explain the meaning of the uncategorized findings. We proposed new categories but those could not incorporate all the findings, just the ones which were outside the issues. Eventually we decided on some rather weak new categories and planned to investigate them as well as the issues in the next round of data collection.

After completion of the second survey and about two-thirds of the visits we met again to analyze findings. The new categories proposed in the previous interaction had lost their ability to explain findings in a meaningful way. The issues were useful in explaining all the old and the new observations taken together but many of the sub-issues did not work too well.

At the end of all of the data collection, findings were analyzed again. We worked with the science education consultants to select categories to explain and reduce the observations. The conclusions

(Volume I, Chapter Three), the analysis of findings from the case studies and site visits (Volume II, Chapter One) and the results of the survey and the content analysis (Volume III) represent the outcome of our final round of analyses. The issues remained viable throughout the evaluation as categories for reducing the data. The sub-issues were less useful and new categories or sub-issues were generally employed in analyzing the results as treated in the respective chapters.

The validity of the issues and the categories of findings under each issue can be tested by examining them with respect to the data reported in the site visit reports, the case studies, and the tables from the survey and the analysis of proposals. The issues and categories should explain the meaning of the findings and should not be able to be contradicted. No counter-examples to the categories should exist if our analysis was adequate. The analyses and conclusions based on the issues should bear a generalizable relevance across the data as reported here.

Summary

The methodology of the evaluation has been built across six issues: institutional need, project implementation, quality of instruction, evaluation, project costs, and recommendations. The evaluation framework emphasized redundancy and multiple perspectives. The methods were selected at three levels of focus: broad, medium, and narrow. Site visits, case studies, surveys, and content analysis were chosen as data collection techniques. The data analysis process was a naturalistic one which utilized the iterative process of discovery and verification.

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Results were analyzed and reported by level of focus: The findings from medium and narrow-focused efforts are presented in Chapter One of Volume II; Chapter One of Volume III reports the outcomes of the broad-focused investigations; and, the remaining chapters of this volume report conclusions and recommendations based upon all three levels.

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CHAPTER THREE

CONCLUSIONS

Introduction

This chapter presents the evaluation's overall conclusions. The conclusions are organized around the issues whose choice and definition is explained in the preceding chapter. Various conclusions are presented relevant to each issue. An explanation of each conclusion is provided along with a series of references to some of the specific evaluation findings which led to the conclusion. The reader is encouraged to use these references as a bridge to the more detailed findings and evidence presented in Volumes II and III.

The contents of this chapter represent the ultimate level of refinement for the evidence gathered through the evaluation's various activities. Other analyses of findings are presented in the first chapters of Volumes II and III, but these analyses are solely at the level of the study's narrow and medium, or broad focused methods respectively. The conclusions presented in this chapter are based on all aspects of the evaluation. Chapter Four, then, goes one step beyond findings themselves to offer recommendations for the future conduct of the CAUSE program.

Finally, before considering the conclusions it should be noted that all projects selected for site visits and case studies have been treated anonymously in this report. Fictitious names have been used for every institution and person involved in the study.

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Issue One

To What Extent Are High Priority Institutional Needs Being Met by Local CAUSE Projects?

Conclusion 1.1: Most CAUSE Projects Would Not Have Occurred Without CAUSE funding.

This is perhaps the most basic conclusion of the evaluation. It confirms the fact that the NSF funds are necessary to establish projects of the type sponsored by CAUSE. (This, of course, implies nothing about the importance or appropriateness of the projects themselves, which will be dealt with in later conclusions.)

Approximately half of the project directors surveyed and visited reported that they would have "given up on their projects for lack of funds" if CAUSE money had not been available. The reports of the site visitors confirm this perception. It appears, further, that those who would have proceeded without CAUSE funds would have had to do so at an extremely reduced capacity and in almost all cases with a drastically different project.

The major reason for this is that most universities are facing or will soon face decreasing enrollments and are operating under fixed or shrinking budgets. A project funded internally must be viewed in terms of other internal functions that must be cut back for its support. There are few loose dollars anywhere in higher education.

A related reason is that most of the projects funded by CAUSE require an up-front investment of relatively large amounts of dollars. Facilities and equipment for science on a per student basis are expensive. When money is available for new resources science must compete with other departments and science may not be a high priority of the institution.

The need for relatively large amounts of dollars is in part due to the need to acquire or renovate facilities or equipment, but it is also due to the comprehensive nature of CAUSE projects. Most projects which require the cooperation of faculty and administration have to represent a wide variation of interests and concerns. The resources necessary to coordinate and integrate the various aspects of the projects with related components are substantial compared to normal day-to-day activities. Moreover, in order to obtain a unified effort, it is necessary to involve and coordinate the expenditure of these resources fairly simultaneously. Otherwise, the project runs a strong risk of being lost in the shuffle.

Finally, another reason for believing that the CAUSE projects we reviewed would not have occurred without external support is that there often is an uncertain commitment to the improvement of instruction in science education, particularly in terms of curriculum revisions and additions, and faculty development. Just over half of the project directors reported that no incentives were provided by their institution to work on CAUSE. Visitors to sites often had the impression that project staff were fighting an uphill battle to maintain institutional commitment from fellow faculty as well as from the administration for the improvement of instruction. Faculty who devote their available professional time to research are rewarded with promotion, tenure and prestige. Those who choose to concentrate their efforts on instruction are often looked down upon by their colleagues and rarely receive any sort of credit toward promotion and tenure. We observed a few instances in which faculty involvement in instructional improvement may have hindered promotion.

The lack of available internal funds as well as the lack of strong institutional commitment for instructional improvement led us to believe that CAUSE funding was necessary for these projects to have come into existence.

Example references to the evaluation findings. The following points represent some of the specific observations which gave rise to this conclusion. These points are offered to help the reader understand how this conclusion was reached. For a more complete understanding, the reader is encouraged to refer to the material in Volumes II and III.

1. Forty-six percent of project directors reported that they would have given up their projects without CAUSE funding. Most of the rest identified other sources of external funding. Only 6% reported that they would have sought funding from within their institution.
2. Over one-half of the project directors surveyed reported that they received no incentives for working on CAUSE. Of those, over one-half reported that administrative recognition and release time would have been helpful in achieving project goals.
3. Maples CCC and Saints University are good examples of projects that could not have occurred at all without CAUSE funds. Sands College, Elms College, and College of the Mountains provide examples of projects that probably would have occurred without CAUSE funds, but at a much lower level or over a much longer period of time.
4. Although shortages of funds are a problem everywhere, Springs University and Forestview College provide clear pictures of the role CAUSE projects can play in institutions where budgets are restricted.
5. Cedar State University illustrates the need for intensive front-end efforts to bring about a successful project; Sands College, Elms College, and Willows University illustrate the need for front-end equipment and facilities purchases.
6. Ivy University and University of the River provide examples of the tension which can arise between the research and instruction responsibilities of faculty at some institutions.

Conclusion 1.2: CAUSE Projects Fill Needs Perceived as Important within Institutions which Receive the Grants.

The CAUSE program stresses a focus on locally defined needs as opposed to more general, nationally defined needs. The hope expressed in the legislation is that the CAUSE program ". . . will permit departments and institutions to develop their own approaches to science teaching.' The CAUSE program guidelines require a statement from the institutional administration (usually signed by the president or academic vice-president) describing the project's relationship to institutional goals and stating the institution's commitment to and support of the project's implementation and post-grant continuation. This description and justification of local needs is seen as one means of insuring the necessary institutional support for project implementation and the eventual continuation of project improvements in post-grant years.

In and of itself, the fact that a given institution took the efforts necessary to pursue a CAUSE project suggests at least some level of concern for the need(s) addressed by the project. Evidence gathered in the conduct of this study indicates that this assumption is an appropriate one. The more important question, however, is whether there is a broad-based perception of the importance of the need(s) throughout the institution. This question is a more difficult one to answer.

Primarily from the evidence collected as part of the site visit and case study methods of this evaluation, it is our judgment that the needs served by CAUSE projects are generally of high priority for the institution. In a few cases, the need being addressed was of crucial importance to the successful maintenance of any kind of viable science education program. In a few cases, it appeared that the needs addressed by the projects were of only tangential importance to the institutions. Most projects addressed needs which fell somewhere in between these extremes.

From both visits to the sites and the survey data, two important variables relating to the relationship between CAUSE projects and institutional needs have been identified. First, there sometimes was reason to challenge the assumption that simply because the administration of the institution "signs off" on a proposal there is broad based agreement that the needs addressed are of high priority. In some cases it might have been that some members of the institution simply saw the project as a means of obtaining external dollars; in other cases, it might have been that the institutions saw the primary benefit of the CAUSE project as an increase in institutional prestige. In short, the reasons for local support of a CAUSE project are not always as simple as they appear in the proposal.

A second variable affecting the relationship between CAUSE projects and institutional needs involves the intra-institutional resolution of competing plans for CAUSE projects. CAUSE guidelines specify that only one project within an institution can be funded during a given time period. Evidence collected suggests that where there are competing proposals within an institution, decisions about which one the institution will commit itself to are not always made totally on the basis of the most important institutional needs. Instead, these decisions are sometimes made on the basis of the ability of various departments or divisions to handle institutional politics, or on the basis of which proposal has the highest probability of being funded. Increased attention to the ways in which institutional needs are identified and the relative priority of these needs appears warranted.

Example references to the evaluation findings. The following points represent some of the evidence which gave rise to this conclusion.

1. Surveyed project directors reported in large numbers that such activities as "efforts to win support for our project at our institution" were important for project success, while "reluctance of important department or school administrators to commit themselves to the project" and "communication problems within our institution" were two of the most frequently cited difficulties.
2. An outcome noted by several project directors on the survey was that the CAUSE project sometimes acted as a catalyst to other departments or units on campus to initiate activities similar to those carried out on the CAUSE project.
3. Sands College and Saints University have CAUSE projects which have a very broad base of support within their institutions.
4. The project at Ivy University may face some difficulties because of a lack of a broad base of support within the institution.
5. At College of the Mountains, the chemistry department's CAUSE proposal was chosen for support by the administration over biology's in part because chemistry's proposal had a higher likelihood of success.

Issue Two

How Are the CAUSE Projects Being Implemented? What Are Their Strengths and Weaknesses?

Conclusion 2.1: CAUSE Projects are Being Implemented As Proposed.

The relationship between the project as described in the proposal and the project as implemented generally was an initial focus of the site visitors, not as an assessment of compliance but as a means of becoming quickly acquainted with the nature of the ongoing project. The survey of project directors also asked several questions on this point. In the opinion of the project directors as well as the site visitors, there was a very close match between projects as proposed and projects as implemented.

This generalization, however, should be qualified on two counts.

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First, there frequently were some variations from original plans, usually in terms of emphasis and occasionally through the dropping of one or two original objectives. Sometimes this was done through a formal amendment to the grant, but more often it simply occurred during project implementation. The variations were rarely significant in terms of the project's overall goals and often represented reasonable judgments on the part of the project director. The need for modifications usually resulted either from an initial lack of understanding of the resources necessary to carry out the proposed tasks (this was especially true with respect to materials and curriculum design activities) or from a mid-project decision to de-emphasize the project's relatively unsuccessful aspects and emphasize its more successful aspects. Occasionally changes had to be made due to changes in project personnel.

A second qualification to the conclusion that projects are implemented as proposed relates to the clarity with which project plans and objectives were originally stated. Projects differed widely with respect to the specificity of goals and objectives; those with clearly specified goals and objectives were more easily assessed in terms of the degree to which they accomplished their original intents. Project directors in these projects also tended to monitor the progress of the project more closely than those in projects in which goals and objectives were defined ambiguously, possibly because the specification of goals and objectives made such monitoring possible. However, even those projects without specifically defined objectives appeared to conform to the spirit and general intent of their proposals.

Finally, it should be noted that almost all projects had to make changes in their original timelines. This was often due to delays in receiving equipment purchases and/or to unfamiliarity with the amount of time activities and processes take. Plans for project expenditures were also frequently modified. This usually occurred formally through the institutions contributing more than was originally intended. Occasionally, formal renegotiations with NSF were required. Evaluation plans also were frequently modified for reasons to be discussed later.

Example references to the evaluation findings. The following points are offered to help the reader understand how this conclusion was reached. For further information, the reader is encouraged to refer to material in Volumes II and III (particularly Volume II).

1. The survey showed project directors reporting that goals and objectives, activities, management and impacts have been very much as proposed. Budget, evaluation plans and timelines are reported as frequently changed from the original proposal.
2. University of the River's project is an example of a modification of one objective - purchasing some commerically-produced materials for the learning center instead of developing all materials locally - and a modification in timeline due to university scheduling.
3. Saints University and Cedar State University are examples of projects which followed their objectives very closely as they were specified.
4. Clay College and Valley University are examples of projects which had delayed timelines because of unexpected delays in start-up activities.

Conclusion 2.2: CAUSE Projects Serve as Catalysts in Focusing, Motivating and Coordinating Instructional Improvement Activities of Science Faculty.

High quality projects are characterized by high quality project staff. While these people generally were present at the institution before the award of the grant, due to various institutional constraints, they may not have worked together previously on a major instructional improvement effort. The CAUSE project acts as a catalyst and overcomes some of these real or perceived constraints and brings these people together. Typical constraints which CAUSE funding can help to overcome include lack of time, opportunity (and often precedent) to work with people other than immediate colleagues, and a general lack of substantive support for the improvement of instruction within the institution.

The results of the survey of project directors indicate the importance to the projects' success of a committed staff working collaboratively. Responses to these surveys and the case study data also indicate that the opportunity to collaborate with other science educators is an important benefit of participating in the project. It was evident at many of the site visits, particularly at the more successful projects, that faculty who had not previously worked collaboratively were now working as a team, often providing substantial encouragement and support to each other with the result that the team's combined efforts were often substantially greater than the sum of the individuals' efforts could ever have been.

The collaborative nature of CAUSE projects provides benefits in addition to the support of colleagues. The presence of a single large project provides each participant with more prestige and recognition than would be provided faculty members if they performed the same activities on their own. The visibility of the projects also facilitates the mobilization of other institutional resources in its support. Most importantly, the collaborative and often interdisciplinary nature of CAUSE projects encourages the weaving of instructional improvements into the fabric of science programs at the institution. The coordination of an institution's already existing personnel resources into effective teams committed to instructional improvement is perhaps one of the CAUSE program's more important contributions to science education.

Example references to the evaluation findings. The following points represent some of the specific observations which gave rise to this conclusion. See Volumes II and III for further details.

1. The survey results show an overwhelming majority of project directors reporting that "working collaboratively with project staff" is important to project success.
2. The survey also suggests that improved morale and a sense of community are unexpected benefits of a well functioning CAUSE team.
3. The negative effects of changes in staff and/or of unproductive staff members were also reported by project directors on the survey.
4. Saints University's CAUSE faculty mentioned as a "best aspect" of the project the opportunity to work together with faculty from other departments to attack attrition problems in entry-level science courses. The project director there promoted dissemination of information about the CAUSE project and, thereby promoted recognition of individual faculty efforts.
5. At Central City JC, several faculty mentioned that increased communications and collaboration among faculty from different science divisions was not only unexpected, but also one of the most important consequences of the project.
6. Cedar State University provides an outstanding example of the benefits of a collaborative relationship among faculty.

Conclusion 2.3: Projects Are Generally Adequately Managed, but Project Directors Often Do Not Have Access to Areas of Expertise Important to Project Implementation.

While it was found that most projects are achieving (sometimes surpassing) their proposed objectives, it also is the case that these achievements are frequently limited by or require more effort than necessary due to a lack of the required expertise. Generally, this lack of expertise is not in the area of project management since project directors tend to be experienced faculty who have the respect of their colleagues and are effective leaders. Instead, the lack of expertise generally involves some specific activity of the project itself. Such deficiencies were often recognized in the proposal and plans were made to compensate for the missing expertise by hiring consultants. Sometimes, however, the need for certain kinds of expertise had not been adequately recognized in planning the project.

The area in which expertise was most frequently lacking was instructional development. Although most project directors and staff have had extensive previous experience in teaching and often in the design of their own instructional materials, few have had experience with (or sometimes recognize the need for) a systematic approach which stresses the clarification of needs to be served, the identification and choice of instructional options, the development of the selected options and the use of feedback information to improve their implementation. The evaluators felt that CAUSE dollars could have been more efficiently used in general had instructional design expertise been available. The lack of adequate evaluation expertise is a related problem to be discussed under the conclusions related to Issue Four. Other types of expertise that were not always accessed when appropriate include hardware selection (particularly with respect to computers), computer programming, and the production of instructional television.

In general, project directors seem to have a good grasp of general project management skills such as planning, budgeting, monitoring, communication and allocation of responsibility. However, some did not and their projects suffered accordingly. Timelines were often unrealistic and project directors and staff were frequently surprised by the amount

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of time various tasks consumed. The time required for project management activities themselves was usually underbudgeted.

An important and potentially valuable source of expertise that project directors expressed strong interest in was the group of present and previous CAUSE project directors themselves. When asked to make one suggestion to NSF in an open ended question on each of the surveys to project directors, 40% and 43% of the suggestions related to more and better communication and dissemination among CAUSE projects and with NSF staff. Based on the site visitors' observations, it is undoubtedly true that the staff of the various CAUSE projects could learn a lot from each other's experiences.

Example references to the evaluation findings. The following points suggest some of the observations which gave rise to this conclusion. Volumes II and III provide further evidence.

1. On the survey, the most frequently mentioned areas of expertise that project directors thought would have been helpful were evaluation, computer applications and project management. Interestingly, less often mentioned was instructional development.
2. It seems likely that some of the computing modules developed on the CCHEI project could have been made more instructionally effective if an instructional designer had assisted faculty. Some faculty specifically mentioned difficulties they had with organizing the content for instructional purposes.
3. The project director at Maples CCC had developed a comprehensive system for monitoring the progress of a project which spans a multi-campus college.
4. The projects at Willows University and Sea University provide examples of how persons with expertise in computer programming can be integrated into a project team. The project director at Cedar State University was adept at capitalizing on the technical skills of others within the university.

Conclusion 2.4: Effective Project Directors Tend to Possess Several Common Characteristics.

The need for project directors who are able to effectively direct and administer project activities is critical to the successful culmination of CAUSE projects. Most project directors at sites visited appeared to be generally effective in their roles. Several appeared to be outstanding. Some of the characteristics which seem to be related to project director effectiveness are outlined below.

In most cases, project directors who are effective are senior faculty members and had primary responsibility for writing the proposal. Their involvement in the proposal writing meant that they were the ones primarily responsible for formulating project objectives and implementation plans. Thus they had thorough knowledge and understanding of the rationale of project activities from the inception of project implementation. In most successful projects which span departments or divisions of the institution, the project directors hold administrative positions such as department chairperson. Presumably, senior faculty are more able than junior faculty to weather the political implications of administering across organizational units and are, in addition, less susceptible to "publish or perish" pressures.

Good project directors provide strong personal leadership and are innovators at their institutions. Generally they are among the first at their institutions to urge adoption of local innovative activities, typically in the guise of a CAUSE project. Most are well respected among colleagues and administrators and set examples of hard work and enthusiasm for the project. A related characteristic is that effective project directors are frequently adept at handling institutional politics. This appears to be most important when projects cross organizational lines within the institution.

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Some of the most successful project directors appear to be those who are experienced at and knowledgeable about the relevant substantive areas and tasks of the project. There are several notable exceptions to this, however, where project directors are adept at utilizing the expertise of others at critical project points.

Example references to the evaluation findings. The following points are offered as examples of the evidence relevant to this conclusion.

1. When we asked, on the survey, whether project directors had had previous experience in managing externally-funded projects in a higher education setting, 42% reported having managed at least one instructional improvement project prior to CAUSE; 39% reported having managed at least one research project prior to CAUSE, and 31% reported that CAUSE was their first experience in managing a project.
2. Project directors at Maples CCC, Saints University, Central City JC, Willows University and Coastal University have strong personal leadership styles and are all quite adept at institutional politics.
3. The project director at Cedar State University was extremely skilled at project management and also adept at capitalizing on the skills of others within the institution.
4. The project director at Central City JC was adept at encouraging the active participation of administrators in project activities, thus promoting their ownership of project goals and their support.

Conclusion 2.5: The Use of Release Time Is a Critical Factor in the Efficient and Effective Use of CAUSE Dollars.

The use of release time appears to be of extreme importance in the successful completion of CAUSE projects. CAUSE projects represent work for faculty which is in addition to their normally assigned responsibilities. Thus, either the faculty member must be released from his/her usual responsibilities in order to devote time and effort to project activities or the faculty member must complete project tasks during his/her personal time in addition to normal responsibilities. Most CAUSE proposals specify the use of release time for faculty to work on projects. In implementing the projects, however, it is sometimes very difficult to allocate or administer release time effectively.

Problems involving the effective allocation of release time generally stem from a number of sources including the nature and size of the institution, the accuracy of the planned-for level of effort, institutional policies, and the willingness of institutional administrators to live up to commitments made. The most effective utilization of release time was when faculty were directly released from a percentage of their teaching responsibilities. At some institutions, however, this proved to be difficult either because the size of the institution did not provide the flexibility necessary for other faculty to cover the course(s) from which an individual was released or because adequate replacement faculty could not be found. At some institutions, faculty were released from non-teaching responsibilities (such as committee assignments), but in most cases this turned out to be release time more in theory than in reality. In at least one case among the sites visited, the release time commitments made by the institution were simply ignored. Several projects allocated release time as overload pay (a dubious practice given NSF guidelines). For some projects, the timing of release time and the intensity of project activities proved to be a problem.

In most cases it was found that whatever release time was made available was generally insufficient. Most project plans underestimated the time required for critical project tasks such as development of instructional materials. Almost all projects underestimated the time required for the project director to administer the project.

Problems associated with the insufficiency of release time resulted in several observed and reported negative consequences to project operation and to the potential for project continuance. Chief among these were the "burn out" of project faculty (most notably project directors) and the fact that project timelines in many cases needed to be extended because not enough "real time" was available to work on project tasks.

Example references to the evaluation findings. The following points suggest some of the observations which led to this conclusion. A number of the case studies (and particularly the cost analyses) provide further detail on this area.

1. The survey shows that "lack of sufficient time to complete planned activities"; and "conflicting commitments on the part of project staff", two items added to the second version of the survey, were perceived by project directors to be the most serious difficulties in their projects. The survey also shows that only 44% of the project directors reported that incentives for working on CAUSE were provided by their institution.
2. The most extreme example of problems with release-time is CCHEI where none was initially built into the project implementation.
3. Project directors at Saints University and University of the River all could have benefited from more release time.
4. At Bay College release time which had originally been allocated never materialized for the project director or other project staff.
5. At Cedar State, conflicting responsibilities for research and teaching made the effective use of release time difficult.

Conclusion 2.6: Institutional Support Is Critical to Successful Project Implementation.

Horizontal and vertical support for CAUSE projects appears to be generally adequate for project success. However, there does seem to be definite room for improvement, and for some projects, lack of support is a serious problem. This lack of support is sometimes due to a lack of skills, abilities, and political power of the project director and project faculty. At other times it is due to a lack of a clear understanding and definition of what institutional needs are being served by the project and why they are of high priority.

It is very important that sufficient institutional support be obtained prior to the submission of the proposal. In some cases, written documentation of such support has been used to hold administrators or faculty to earlier commitments once the project was funded. It is also critical that projects generate sufficient institutional support during project execution so that adequate vertical and horizontal support will continue to exist for project activities in the post-grant era. Those projects which have never gained either the support of faculty or administrators at their institutions tend to have a lower probability of successful continuation.

Faculty reward structures are related to the notion of institutional support. In addition to providing project staff with adequate time to accomplish the tasks of the projects, it is also important that adequate reward structures for faculty participation in the project be provided. This can be an especially severe problem in larger institutions with strong research orientations. Typically, time and effort spent on instructional improvement projects do little for the faculty member when questions of promotion and tenure arise. This problem seems related to the fact that most successful project directors are senior faculty members who are substantially insulated from such pressures. In many cases, the only apparent reward available to faculty who work on the project is the satisfaction of knowing that the facilities and/or resources for science instruction at their institution have been improved and presumably that science instruction itself has been improved.

Example references to the evaluation findings. The following points suggest some of the evidence which gave rise to this conclusion.

1. The survey shows that a large majority of project directors agree that efforts to win support for the project at their institution is important to project success. They also reported that leading causes of difficulty are communication problems within the institution.
2. The survey also shows that conflicting commitments on the part of project staff present a serious difficulty.
3. At Bay College lack of institutional support in the form of allocation of "real" release time had a severe impact on the ability of the project to continue past CAUSE funding.
4. Hilltop University, Ivy University and Cedar State University provide examples of the key role institutional support plays in project success.

Conclusion 2.7: CAUSE Projects Often Represent Innovations Within Their Respective Institutions Which Are Not Usually Innovations to Science Education.

The large majority of project directors (94%) responding to the first survey reported that their projects were either very innovative (52%) or somewhat innovative (42%) as compared to the regular activities of the department(s) involved in CAUSE. Observations of the site visitors confirmed this report. Project directors are in general viewed as innovators within their departments and most often the project activities are unlike activities occurring in related departments.

In general, however, the projects cannot be characterized as innovative with respect to science education as a whole since most of the projects we visited had counterparts occurring somewhere else in the country under the auspices of the CAUSE program. In fact, there are strong similarities among projects even within the sample of 25 we observed. Although certain aspects of some of the projects do represent a unique approach or a unique application of a certain technology, there tends to be a substantial overlap among projects with respect to the problems grappled with and in the solutions found.

This overlap is not always clear to project directors and staff. Most project directors reported on the survey cited above that they believe that their projects are in fact innovative with respect to science education. On the other hand, there is often relatively little awareness about what others are doing in related areas of instructional improvement. (There are a number of important exceptions to this, as some project directors and staff were extremely well informed.) Although there were many cases where it was obvious to site visitors that communication among directors of similar projects would be particularly useful, relatively little such communication occurred.

It is not necessary to be innovative nationally to be successful. It is not even necessary to be innovative locally if the needs are legitimate and of high priority. It is important to recognize, however, that many projects that are innovative locally could benefit substantially from investigating the present and previous efforts of others attempting similar projects so that something might be learned from the successes and failures of others.

Example references to the evaluation findings. The following points suggest some of the bases for arriving at this conclusion. Further evidence can be found in Volumes II and III.

1. The survey shows a substantial number of project directors spontaneously recommending more communication among project sites.

It is clear that they believe in the potential benefits of sharing information and "lessons learned". Forty-two percent of project directors report that science projects at other institutions similar to theirs have not been useful sources of information primarily because project directors have not located such projects elsewhere.

2. At Blue Meadows State College an audio-tutorial approach to the teaching of science was regarded on campus (and locally) as a major innovation.

3. Sands College and Marigold College provide examples of projects that were not innovative but which meet legitimate institutional needs.

Conclusion 2.8: Comprehensive Projects Have Stronger Potential for Overall Lasting Improvements to Undergraduate Science Education.

In reviewing project implementation and impact at the 25 projects we visited, one overall theme emerged: the best projects were those which were most comprehensive. The CAUSE program guidelines encourage the conduct of comprehensive projects. Such projects are described as "those which are broader and more integrated, and which include a set of coordinated activities".

In practice, however, the concept of comprehensiveness has sometimes come to imply inclusivity, specifically in regard to the number of academic areas affected or involved. Some projects have faltered in their attempts to be comprehensive and, instead, have been somewhat scattered and disparate. Projects such as these are characterized by multiple and unrelated mini-projects occurring where the staff of each remains relatively unaware of what the staffs of the others are doing. Although these individual projects have been sometimes of high quality, as a group they have lacked cohesiveness.

A more appropriate approach to the concept of comprehensiveness would emphasize the importance of taking a holistic or systematic approach to the identification of local science education needs and problems. Those projects which have considered all of the elements of an instructional system as it relates to some problem are the most truly comprehensive and the most outstanding projects we visited. These projects have been characterized by the development of a consensus among project staff regarding the needs to be served and the means to serve them. Careful attention has been paid to the relationship of the project to all facets of the institution, and efforts have been made to coordinate the various project components with each other and with ongoing institutional plans and activities. It is this integration with the institution which marks comprehensive projects.

Example references to the evaluation findings. Evidence presented in Volume II provides support for this conclusion such as the following points.

1. Forestview College and Cedar State University provide examples of comprehensive projects.
2. Springs University and Ivy University are examples of projects which are considerably less comprehensive.

Issue Three

To What Extent Is Improvement to the Quality of Instruction Occurring as a Result of CAUSE?

Conclusion 3.1: Science Education Resources Have Been Improved.

CAUSE projects generally have strengthened science education resources with respect to instructional materials, laboratory and instructional equipment, instructional facilities, and the development of faculty skills in instructionally related areas. The improvements wrought by the projects are likely to provide, in most cases, long-term benefits to institutions in terms of their capability to provide quality science programs. Particularly in those projects which have involved the acquisition of equipment and/or the acquisition/renovation of institutional facilities, more or less permanent improvement in science education resources have been made. Of course, there are exceptions, especially in those cases where project activities have primarily consisted of "one time" occurrences and where there appears to be little institutional support for the continued pursuit of project goals.

In addition to the obvious improvement in science education resources such as equipment, facilities and materials, the improvement of faculty skills should not be overlooked. Due to participation in project activities, faculty development has occurred both in those projects which have primarily focused on faculty development and in those projects where faculty acquisition of new skills has not been a primary focus but a spin-off of project activities. Some of the improved skill areas have been in the systematic processes of instructional development and in the application of computer technology to instructional purposes.

In some cases, the capital investment in science education which the CAUSE project represents has increased the visibility and viability of an institution's science education programs. This seems especially true at smaller institutions where resources of the magnitude required were not available from alternative sources and science education needs were severe and basic in type (e.g., no adequate lab facilities). In some cases, the award of the CAUSE grant itself was used as evidence of viability and in turn served as a catalyst for the acquisition of additional resources for science education from other sources external to the institution.

Both human and material resources in science have been demonstrably improved due to the CAUSE program. It is unlikely that these improvements could have taken place without CAUSE.

Example references to the evaluation findings. The following points suggest some of the findings which led to this conclusion. See Volumes II and III for further details.

1. The survey shows the improvement in faculty skills running through many of the questions like a leitmotif. Project directors reported spontaneously that faculty have learned new skills and new competencies because of the CAUSE program.
2. The survey also shows that 54% of project directors expect to acquire or upgrade equipment, materials, facilities, or computers through their CAUSE grant.
3. The projects at Sands College and Forestview College provide examples of the improvement of instructional facilities.
4. Sycamore CC, Sea University and Hilltop University are examples of projects focused specifically on faculty development.
5. Cedar State University, Willows University and Clay College provide examples of faculty development occurring as a spin-off of their projects.

Conclusion 3.2: Institutional Capabilities for Self-Assessment, Management and Evaluation Have Not Been Substantially Changed.

One of the primary charges of the CAUSE program is to improve the capabilities of institutions to perform self-assessment, management, and evaluation. On the basis of the evidence collected during the course of this study, however, it appears that this goal has fallen short of the mark. This is not to say that the CAUSE projects have not had some impact on the capabilities of individuals within the institutions with respect to these areas. Indeed, many projects have provided a powerful means of professional development for faculty (especially project directors), particularly in the area of management.

In some cases, the processes which occurred during the proposal development phase of projects to some extent have increased the ability of institutional staff to think through their needs and to prioritize them. It is difficult to judge, however, how general this effect is and, given the evidence we have gathered, we suspect that the effect has occurred only in a minority of the projects. Furthermore, it may well be the case that the institution's capability for self-assessment was high prior to the CAUSE grant in those cases where the proposal development process involved a true and thorough analysis of institutional needs.

As discussed more fully in the section on Issue Four, evaluation activities on the CAUSE projects have generally been disappointing. Although there are exceptions, it is difficult to see how institutional capabilities in this area could have been improved given the generally inadequate and inappropriate attention given to evaluation in the projects themselves.

Example references to the evaluation findings. The following points suggest some of the evidence which led to this conclusion.

1. Saints University has a capability for self-assessment, management, and evaluation which was used to plan their project.
2. Coastal University has a well-known center for evaluation on campus but center staff were not utilized on the CAUSE project, and capabilities for self-assessment and management were in place before CAUSE.
3. At Maples CCC the skills of the project director may have been sharpened due to his participation in CAUSE but the institutional capabilities were not.
4. Willows University provides an example of an improvement made to the institutional capacity for self-assessment.

Conclusion 3.3: The Quality of Science Instruction Has Been Improved Within Most Institutions Funded by CAUSE.

This conclusion is based primarily on the judgment of the site visitors after consideration of the instructional processes and products developed and being developed under the auspices of CAUSE. It relies only slightly on data directly reflecting changes in student behavior, knowledge or attitudes since, as discussed in the following conclusion, there is very little of such data available. We also have relied on survey data in which project directors report improvements in student performance attitudes. This, of course, cannot be considered as direct evidence since it is based on self-report.

The strongest evidence for the improvement of the quality of instruction is the expansion of instructional opportunities for students. Many of these opportunities have been designed into courses as required activities and many others have been designed to be supplementary to existing course materials and used at the students' option. In many cases the CAUSE projects have made available educational experiences that simply were not available previously (e.g., through the acquisition and development of laboratory facilities, both self-study and traditional, computer hardware and software, revised curricula and the like). Although instructional materials prepared under CAUSE grants vary widely in terms of normal instructional design criteria (clarity, organization, specification of goals and objectives, readability, appropriate use of the medium, etc. most are being used by faculty and students who generally report them to be useful.

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on the argument that providing support to qualified and dedicated science faculty to address local instructional needs will in itself lead to improved instruction, provided that resources and personnel are well managed and legitimate needs are being addressed. Whether the provision of support will actually result in improved instruction depends upon the skills and abilities of project staff. Project staff capabilities have been discussed in previous conclusions and have been found to be generally quite high, notwithstanding the lack of certain specific areas of expertise previously discussed.

A final evidence of instructional improvement may be in improved teaching effectiveness. A majority of project directors reported in the survey that faculty have improved their teaching and have developed better relationships with their students. Again, this is based on the perception of project directors and is not direct evidence of improved teaching effectiveness.

Example references to the evaluation findings. The following points suggest some of the specific evidence for this conclusion.

1. An overwhelming majority of project directors responding to the survey reported that students are performing better and have developed more positive attitudes toward science.
2. Saints University, Coastal University, and Maples CCC are examples of projects where learning opportunities for students in required courses have been expanded.
3. CCHEI and University of the River are examples of projects which have improved supplemental instructional resources.

Conclusion 3.4: The Direct Impact of CAUSE Projects on Students Cannot Generally Be Documented.

Very little evidence exists at most CAUSE projects which shows a direct impact of project activities on students' knowledge, attitudes and behaviors. When such evidence does exist, as in the form of test scores or feedback on student questionnaires, it is difficult if not impossible to determine from available data whether or not the impact is more, less or different from impacts that could have been expected from participation in non-CAUSE or pre-CAUSE educational experiences.

There are a number of reasons for this lack of evidence. One reason is that most of the projects involve long-term efforts which are still in progress or have only recently ended. The real impact of many of these projects is yet to come. Another reason is that the relationship between many of the project activities and impact on students is necessarily indirect, particularly in the case of faculty development and facilities development efforts. In these cases the impact of the project on students must be ascertained through a logical analysis of ends and means as much as through the collection and analysis of empirical data. Finally, as will be discussed more completely in conclusions related to evaluation, the evaluation strategies used within CAUSE projects have generally been inadequate. The data collected has been insufficient to provide meaningful information on projects' impacts on students.

There are a number of important exceptions to this conclusion, as a number of projects have systematically collected meaningful data relating to the impacts of project activities on students. However, these are in the minority and cannot provide a basis for reaching any conclusions about the CAUSE program in general.

This conclusion should not be taken to imply that we believe CAUSE projects are not having a significant impact on students. We believe they are, as do the majority of faculty, staff and students interviewed at the sites. However, our belief is based primarily on our subjective judgments and a reasoned analysis of the evidence collected during the site visits and reported in the site visit reports and case studies. Stronger empirical data could be obtained, in many cases, and would enable stronger conclusions to be made both within and across CAUSE programs.

Example references to the evaluation findings. Some of the evidence which led to this conclusion is listed below.

1. As was noted in the preceding conclusion, the survey data strongly supports the belief that there have been direct impacts on students as a result of CAUSE activities but these data cannot be taken as conclusive since they are self-reported.
2. Cedar State University and Saints University collected convincing data on their projects' impact on students.
3. Sea University provides an example of maintaining computer usage data as indirect evidence of impact on students.
4. Although there is little documentation of direct impact on students of the Forestview CAUSE project, it is clear to the observer and reader that important impacts will occur.

Conclusion 3.5: A Range of Secondary and Unintended Effects Have Occurred As a Result of the CAUSE Projects.

Several outcomes of the CAUSE projects have occurred which might best be classified as secondary or unintended since they are not within the scope of the original intentions or goals of the project. Nevertheless, these effects probably have important implications for the quality of the science programs at the institutions at which they have occurred.

One apparent and pervasive outcome, as evidenced by discussions with project staff during visits to sites and by a large minority of project directors reporting the outcome in an open-ended question in the survey, has been increased cooperation and communication among faculty. This is particularly true among faculty from different departments or divisions who prior to the CAUSE project had little if any interaction. The CAUSE projects have apparently served as an opportunity for increased professional interaction among faculty.

At several of the sites visited, staff reported that the CAUSE project has increased what had been a sagging staff morale. These reports are supported by open-ended and closed responses by project directors on the survey. Many project staff apparently have gained new self-confidence and self-esteem about their ability to have an impact. In some cases, the CAUSE project sparked a general revitalization of additional course and curricula which were not originally within the scope of project activities.

In many cases, the impact of the CAUSE project has been felt in science areas not officially connected with the CAUSE project and in other non-science areas at the institution. In addition, it has been reported that in some cases the impact was felt outside the institution itself, either in the community at large or in other area educational institutions.

Example references to the evaluation findings. The following points suggest some of the evidence for this conclusion. Further evidence can be found particularly in Volume II.

1. At Forestview College the CAUSE project provided a major boost to sagging faculty morale at an institution in a state of crisis.
2. At Central City JC, faculty and administrators from throughout the institution participated in inservice courses on instructional applications of computers as did faculty from other educational institutions in the area.
3. At Sea University the establishment of an instructional computing center led to an orientation program for all university students on how to access the computer.
4. At Saints University a course redesign process was expanded and became much more comprehensive than originally proposed.

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Issue Four

What Is the Nature and the Quality of the Evidence and the Evidence Collection and Analysis Procedures Being Used to Determine the Strengths and Weaknesses of Individual CAUSE Projects?

Conclusion 4.1: CAUSE Has Resulted in Increased Awareness of Evaluation in Undergraduate Science Education.

A major goal of the CAUSE program is to "increase institutions' capability for self-assessment. . . and evaluation of their science programs." The present study found that the CAUSE program has resulted in an increased awareness of the role of evaluation in improving undergraduate science education programs. While an increased awareness is short of an actual increase in capability and application, increased awareness is an important initial step to increased capability and usage.

Most project directors and project staff interviewed professed to be ignorant of evaluation technology. Many spoke of having to go to the library to review the evaluation literature cited in the early solicitation or of having to ask the local evaluation expert to help respond to the RFP. Given that a large proportion of the proposal writers went through this procedure each year for the last four years, it is reasonable to say that awareness has been increased among this group. In addition, because project evaluation has been a component designed into each project it has had to be at least addressed with respect to the activities of the five to 20 faculty involved with each active project. Because it tended to be a new experience, and because some perceived it as a negative experience, CAUSE projects usually stimulated discussions about evaluation.

Finally, a few of the more successful projects published their results in professional journals. If nothing else, the CAUSE program has caused a large number of science educators to grapple with the concept of evaluation.

Example references to the evaluation findings. The following points suggest some of the bases for this conclusion.

1. Eighty-five percent of project institutions agreed with the statement on the survey, "Evaluation plays a more important role in our CAUSE project than it does elsewhere in our institution's science programs."
2. In the open-ended questions on the survey, several project directors used technical evaluation terms knowledgeably.
3. Seventy-three percent of project directors reported on the survey that "project staff have acquired additional expertise in evaluation as a result of the CAUSE project".
4. At Bay College, the project director expressed great interest in discussing the place, role, and techniques of evaluation in science programs.
5. The project director at Maples CCC talked to the director of institutional research at his college about evaluation and got help designing an evaluation plan.
6. At Ivy University the project director designed a guide to evaluation in instructional improvement efforts and distributed it to faculty in several departments.

Conclusion 4.2: There Is Widespread Uncertainty Among Project Staff About the Nature and Purpose of Evaluation.

While many project directors, in fact the vast majority, agree with statements from the survey like, "It is important that CAUSE guidelines require evaluation as part of projects", and "Evaluation is important at our institution in monitoring the effectiveness of projects of this type", there is also a strongly held feeling that precious project resources should not be used for evaluation when they are needed for implementation activities. The agreement with statements affirming the importance of

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evaluation suggests that some project directors are likely to verbally support evaluation while also feeling that evaluation is the least important of all project priorities. Consequently, there is a lack of clarity and focus in evaluation activities at CAUSE institutions. Sometimes the evaluation proposed initially has not been done or has been modified. Sometimes data are not utilized effectively.

The site visitors, evaluators and science educators alike believe very strongly in the validity of this conclusion. While project personnel easily spoke about most of their project activities, interviewers found they had to probe substantially to understand the role of evaluation on the project. More often than not, the project director was the only person who knew what was happening in terms of evaluation of the project. Even then, questions were often deferred to "the evaluator". Evaluation activities were begun most often late in the project, sometimes not until the project was completed. Very few project staff ever gave the interviewers a sense that they had ever received any evaluation data that they found helpful, or that they were even curious about what evaluation data would have to say about their work. The apparent reason for this was that project staff saw little relationship between what they were trying to accomplish and project evaluation activities.

The project directors' generally positive regard for evaluation and its utility as reported on the survey surprised us at first. Upon further reflection we believe it is not contradictory for two reasons. The first is that project directors as a group seem to be more conscious of the utility and worth of evaluation than their project staff. The second is that project directors' self-reported support for evaluation reflects an acceptance of evaluation in principle that they actually find difficult to apply in practice. This difficulty, we believe, results from a limited understanding of the nature and purpose of evaluation, an understanding that emphasizes accountability to others somewhat to the exclusion of decision-making within the project. It is this limited understanding of the nature and purpose of evaluation that limits evaluation's utility to project staff in fulfilling their goals and objectives.

Example references to the evaluation findings. The following points represent some of the specific evidence which supports this conclusion. Further details can be found in Volumes II and III.

1. In contrast to the agreement with positive statements on the survey already noted, fully 25% of project directors also agree that evaluation activities probably require more time, money and effort than they are worth, and 27% agree that project funds allocated for evaluation activities could be better spent on other project activities.
2. The survey shows that the most frequent aspects of the project to be evaluated are student reactions to the project, instructional materials and student performance and that the most common types of evaluation data collected are multiple choice and essay examinations of student achievement and student opinions of project activities or outcomes.
3. Project staff at Clay College and the project director at Blue Meadows State College claimed scientists really don't know too much about evaluation.
4. The project director at Springs University reported that project staff were generally uncertain about "what NSF wanted" with respect to evaluation.

Conclusion 4.3: Evaluations as Implemented Vary Considerably in Substance from Evaluations as Proposed.

The majority of project directors responding to the survey reported that evaluation plans were being carried out as proposed. However, survey results also showed evaluation to be one of the activities which, in practice, most frequently deviated from the proposal's plans. This finding was generally confirmed during the site visits: evaluation plans were often being followed in name only with relatively little attention to the role evaluation activities could play in conducting or improving project activities.

Almost all of the proposals dealt explicitly with evaluation. Some included quite detailed plans for quasi-experimental designs, followup studies and other data collection strategies. Others merely described who would be responsible for the evaluation. Almost all described evaluation as being an integral part of the project, many going so far as to include evaluation as one of the project's objectives. Some mentioned the use of formative evaluation to inform ongoing design decisions, but most stressed its role in determining project success.

In practice most of the more detailed evaluation plans were carried out less extensively than proposed, sometimes because the initial plans were not practical, other times because evaluation concerns were superceded by other project concerns. The summative-oriented evaluations were carried out but it was very difficult for site visitors to locate anyone in the project who seemed to be interested in the results, or who was waiting to make any sort of decision based on the data. Even in those cases in which numerous evaluation activities occurred, the resulting data were rarely referred to or discussed by project staff or administrators.

Not all the variations from proposed evaluation plans were necessarily bad. Some projects increased or added formative evaluation activities to their original plans. In general, the added evaluation strategies which focused on improving developing products seemed to be more successful, particularly when they were carried out in close coordination with the faculty involved in the development effort. In some cases a conscious decision was made by project staff to increase improvement-oriented evaluation activities. More often, these decisions simply manifested themselves in the day-to-day activities of the project. In a number of instances the conduct of activities designed to assess the quality of developing products had always been planned but had not been written into the proposal because it was not considered to be evaluation. In some of these cases the utility and effectiveness of these evaluation activities appeared to be quite high.

The reason for the discrepancies between proposed and implemented evaluations seems clear. The CAUSE guidelines are quite explicit in their emphasis on the importance of evaluation. In order to respond, proposal writers typically went to the library or turned to their local evaluation consultant to help put together a credible evaluation plan. In this sense, evaluation plans were often prepared somewhat blindly and without careful tailoring to the proposed project activities, necessitating adjustments being made during project implementation.

Example references to the evaluation findings. In addition to the survey results in Volume III, the reports of the projects at Coastal University, Willows University and Springs University in Volume II provide clear examples of projects whose actual evaluation activities differed in important ways from their original plans.

Conclusion 4.4: CAUSE Has Had Little Impact on Institutions' Capabilities for Self-Assessment.

Because evaluation has not played an important or prominent role in the individual projects and has had little effect on them, it has not been possible for the CAUSE projects to have any real impact on an institution's capability for self-assessment or evaluation of their science education programs. The project directors who already knew something about evaluation pretty much administered the evaluation activities themselves, resulting in no institutional change. Those who knew little about evaluation either retained the services of an evaluation consultant or an expert from a relevant science discipline from within the institution or from some other institution. In either of these cases very little interaction occurred between evaluator and project staff which would increase the staff's capabilities in evaluation. In the case of evaluation consultants, efforts were focused on the collection of data. In the case of discipline experts, efforts focused on a review of course content.

There were some important exceptions to this generalization. The increase in awareness of evaluation that was discussed in an earlier conclusion is a step toward increased capabilities, although it is a rather small step. More specifically, a number of institutions did improve the evaluation capabilities of project staff and of the institution through the inauguration of evaluation procedures that did not previously exist. These projects provide useful models, but are not sufficient in number to be considered as evidence of the CAUSE program's impact on science education institutions' capabilities for self-assessment.

Example references from the evaluation findings. The following points suggest some of the bases for this conclusion.

1. Eighty-five percent of project directors reported on the survey that evaluation pays a more important role in their CAUSE project than it does elsewhere in the institution's science programs, while only 43% reported that "Our CAUSE project has helped science faculty members to integrate evaluation into ongoing science programs at our institution."

2. The Willows University CAUSE project has impacted on the University's capacity for self-assessment in a meaningful way. This may also be true, to a lesser extent, at Cedar State University and at Hilltop University.

Conclusion 4.5: Evaluation Has the Potential to Improve CAUSE Projects in Important Ways.

In spite of the relatively ineffective role evaluation has played in most observed CAUSE projects, we feel that evaluation has an important role to play in future projects. The strongest evidence supporting this conclusion is the key role evaluation has played in selected areas of some of the more successful projects.

The improvement-oriented or formative role of evaluation has the most potential for improving projects in that it relies heavily on the already existing expertise of project directors and staff and can have a direct impact on the achievement of their own objectives. While there are specific data collection and analysis techniques useful to formative evaluation, we saw several instances in which project staff with no training in evaluation were conducting extremely useful formative evaluations. The evaluation activities, sometimes not labeled as such, were characterized by explicit consideration of desired outcomes and careful observation of interim products (and the initial use of these products) to determine the extent to which the outcomes were being achieved. Sometimes these observations were formal and sometimes they were informal. However, they were always conscious and directed toward collecting information useful to the improvement of project activities or outcomes.

There were also examples of useful evaluations which focused on the quality and/or success of final products. While these types of evaluations were typically not very useful because of their lack of bearing on any real decisions to be made, there were some exceptions.

Some of these evaluations resulted in publications useful to others involved or considering involvement in similar activities; others were used to document the worth of the project to the institution in order to argue for post-project maintenance. Given that there are many projects attempting to accomplish similar objectives through similar means, it seems important to document the success of these methods to help others to avoid common problems.

Another sort of evidence of the potential for evaluation of CAUSE projects was found at the many projects where evaluation could serve a useful role but did not. Many instructional improvements are being adopted with very little knowledge of their effectiveness. Many individual units or modules are being produced one after the other without any improvements being made in later products based on information about the earlier ones. This is clearly resulting in a lot of wasted effort and decreased overall efficiency (and probably quality) of product development efforts.

The potential for evaluation is most likely to be achieved through the use of evaluation techniques and strategies which utilize the already existing observational and conceptual skills of practicing scientists and which are supported by the judicious use of professional evaluators who are willing to assist project staff in the design and implementation of evaluations which are useful and meaningful to the conduct of the project.

Example references to the evaluation findings. The following points outline some of the specific evidence relevant to this conclusion.

1. Saints University used informal and formal formative evaluation and did summative evaluation activities as planned. Maples CCC and the University of the River had formative evaluation activities planned in their proposals which they carried out. These activities appeared to be affecting the projects' outcomes.

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2. The formative evaluation activities of the project staff at Elms College led to greatly improved audio-tutorial laboratory materials.
3. The arrival of the formative evaluator at Willows University was termed a "turning point" by the project director.
4. The instructional materials developed at Springs University could have benefited from a stronger formative evaluation component in the project.

Issue Five

What Are the Relative Costs of the Design, Implementation and Operation of Activities Within CAUSE Projects, and How Do They Relate to Post-CAUSE Institutional Support?

Conclusion 5.1: Most CAUSE Projects Support Design and Implementation Expenditures for Instructional Improvements with Low Recurring Costs for Post-Grant Continuation of the Improvements.

Overall we found that CAUSE funds generally have supported the design and investment expenditures necessary for capital improvement projects. Whether they have been primarily instructional development efforts or additions to equipment or facilities, most projects have represented a one-time allocation of resources to accomplish a specific kind of improvement that would continue to provide benefits in the future with little or no marginal recurring costs for their operation.

Although this conclusion has grown out of the cost analyses of the eight case studies, the science educators and evaluators have come to similar, although less well-documented conclusions about the majority of the remaining 17 sites not visited by the cost analysts. In most cases the visitors have concluded that the improvements generated by the projects would continue past the grant's expiration. An important factor the site visitors took into account in judging the likelihood of continuation was the demand for additional resources to support the improvement in post-grant years.

This conclusion, in conjunction with the earlier conclusion that institutions cannot fund CAUSE-like projects on their own, points to the important function the CAUSE program has served in the improvement of undergraduate science education. CAUSE has provided higher education institutions with otherwise unavailable targeted funds necessary to bring about capital improvements in science education, improvements that once made can be continued with minimal drain on institutional resources.

Example references to the evaluation findings. The reader is encouraged to read the cost anlysis sections of the case studies in Volume II. A few specific points follow.

1. Saints University and CCHEI are examples of projects with one-time expenditures of resources for instructional development of redesigned courses and computing modules respectively. One component of the Saints' project was a capital investment in facilities.
2. Saints University's CAUSE project might have higher than average post-grant operating costs; however, it appears that these costs replace other recurring costs prior to the grant.
3. Ivy University may face difficulties with post-grant continuation because of the relatively high recurring operation costs of its center for instructional development.
4. Forestview College, Sands College and Marigold College provide examples of projects in which the major focus was on capital improvement of facilities for science instruction.

Conclusion 5.2: Institutional and Personal Contributions to CAUSE Projects Almost Always Exceed the Contributions Originally Proposed.

In most cases the local CAUSE projects have served to coalesce and focus local resources for the improvement of science education beyond the extent originally proposed. This was observed and documented most clearly in the cost analyses at the institutions described in the eight case studies, but it was frequently noted by site visitors to the remaining 17 institutions as well. Sometimes the additional institutional contributions have been quite obvious as when the institution covered the extra cost of additional or higher quality equipment than originally proposed. At other times these additional contributions have been less obvious, although just as real, as when the presence of the project has served as a means of attracting a variety of other institutional resources in the form of donated administrative time, or the use of additional university facilities or services for project-related purposes. The increase in visibility and reputation of a given department has also sometimes been reported as providing additional leverage to local science departments during institutional budget negotiations.

Substantial personnel resources have also been donated to the projects, most often by individual project faculty, in the form of evening and weekend hours. While at times the necessity for this extra time has been caused by inadequate planning or management, it often also has been the result of the motivational impact of a good project on the faculty. Good projects have generated excitement among faculty which has led in turn to a very strong personal and professional commitment among project staff to the project's goals and objectives. This capability of motivating, exciting and focusing the efforts of faculty interested in increasing the quality of instruction is one of the important ways CAUSE has resulted in increased resources for the improvement of science education, resources beyond those initially proposed in terms of NSF and institutional budgetary contributions.

Example references to the evaluation findings. The reader is encouraged to see the cost analysis sections of the case studies in Volume II for in-depth analyses of contributed resources. Some examples follow.

1. Saints University and CCHEI are examples of projects which received large amounts of donated time from project personnel.
2. Coastal University is a good example of a project which generated a sizable additional contribution from the institution for project activities.
3. Cedar State University provides an example of how a CAUSE project can be used as leverage to procure additional institutional resources and as a means of capitalizing on existing university facilities.
4. The existence of CAUSE projects at Forestview College and Sea University was used as evidence of viability and commitment in obtaining additional funds from sources external to the institutions.

CHAPTER FOUR

RECOMMENDATIONS

Introduction

A question asked of project directors and staff during the course of the various site visits and also on the two surveys was "If you had one thing to recommend to the National Science Foundation regarding the CAUSE program, what would it be?". This question was often asked among the site visitors themselves during the course of the evaluation, and was asked again in writing of each of the site visitors before final deliberations regarding the conclusions and recommendations were conducted. Many more recommendations have been suggested over the course of the evaluation, most of which have been discussed or at least implied in the various levels of analysis included in Volumes II and III of this report. The recommendations presented here are those which emerged most frequently during these discussions and which appear to have the greatest potential for strengthening the CAUSE program.

Recommendation One
The CAUSE Program Should Be Continued and Strengthened

The CAUSE program has been effective in improving the nation's science education resources. Institutional needs for improvement of instruction in science education are real and institutional budgets are unable to support the initiation of the sort of comprehensive projects brought about by the CAUSE program. Projects have been effectively implemented and are meeting institutional needs as perceived by local science faculties. Through the CAUSE program's requirement of matching funds as well as through the catalytic effect of many funded projects within their respective institutions, the CAUSE program has encouraged the targeting of institutional and human resources toward the improvement of undergraduate science education. The CAUSE program is effective.

Although the basic organization and intent of the CAUSE program is sound and no significant weaknesses have been identified as inherent in its general approach, we believe that the CAUSE program can be strengthened significantly through an increase in emphasis in a number of critical areas.

Recommendation Two

The CAUSE Program Staff Should Be Enlarged, or Other Means of Providing Additional Personnel Support to the CAUSE Program Should Be Provided

There were very few complaints voiced by project directors about NSF's administration of the CAUSE program. Quite the contrary, comments on the surveys as well as those made during site visits were quite positive. Although contact between CAUSE program staff and individual projects was infrequent, the contacts that did occur were well regarded.

However, it was clear from observations made during the site visits that a number of problems could have been avoided and projects often could have been more effectively implemented had the expertise of fellow scientists experienced in the improvement of instruction through large-scale development efforts been available. We feel the advice and support that is presently being given to project directors by program staff is appropriate and useful and that an increase of such advice and support would result in a more effective CAUSE program.

Recommendation Three

Project Directors Should Be Encouraged and Assisted in Obtaining Specialized Expertise When Needed

There are a number of specific areas of expertise useful to directors of large-scale instructional improvement projects. Comments made by project staff on survey forms and during the course of site visits as well as observations made by the site visitors themselves indicate that expertise in many areas is often unavailable to given projects. Specific types of expertise noted to be lacking most often include expertise in evaluation, instructional development, project management, hardware acquisition and instructional computer programming.

Possible ways in which obtaining assistance in these areas could be encouraged, when the need exists, include suggesting the use of outside experts through program guidelines or during negotiations, supplying project directors with lists of sources of available expertise in each of these areas, and sponsoring targeted workshops for project directors needing assistance.

Recommendation Four

Communications and Collaboration Across the Country Among Project Staff and Others Involved In and/or Experienced With Similar Instructional Improvement Efforts Should Be Encouraged and Supported

Improvements in the communication and collaboration between CAUSE project directors could greatly improve the efficiency and effectiveness of many projects. Among the 25 projects visited as part of this study, many were quite similar in nature and intent. Many more similarities undoubtedly exist among all CAUSE-funded projects, not to mention other instructional improvement efforts not funded by CAUSE. As the site visitors went from project to project, they frequently saw project staff addressing and solving many of the same problems, but usually only after considerable time and effort had been expended. In those few projects where project staff had access to similar projects elsewhere, they seemed to benefit greatly from the experience of others. Unfortunately, most project directors are either unaware of other projects similar to their own, have little means of access to those projects, or do not understand how their project might benefit from another's experience.

This situation exists in spite of efforts by the CAUSE program to disseminate information on funded projects and to bring the project directors together to meet one another. While these efforts are appropriate, they are insufficient. The kind of information that most project directors would benefit from has more to do with the process of conducting project activities than with the products of those activities. New project directors need to hear the stories of how other projects have been conducted. They need to be able to talk to someone about the minutiae of project activities.

It seems clear that the more that can be done to foster communication and collaboration among CAUSE project directors the better. In addition to the CAUSE program's existing efforts in this area, it is recommended that CAUSE encourage or foster further opportunities for project directors to meet and talk with one another. Specifically, the role of the present project directors meeting should be clarified and extended. All project directors should attend one such meeting a year. This meeting should be longer than it is at present, provide more opportunity for project director to project director interaction, and (to accommodate the needs of new projects) should be held in the summer rather than in the fall. The conduct of such a meeting could represent an unrealistic burden for CAUSE program staff; however, the meeting could be organized and largely conducted by any of a number of external groups or organizations familiar with the CAUSE program. Much of the cost of these meetings would be underwritten by stipulated allocations in project budgets. Furthermore, it is recommended that proposal guidelines stress the desirability of establishing budget allocations for other kinds of project-related professional development activities. In addition to the project director meetings, most projects would benefit from opportunities for their faculty to attend workshops, professional association meetings and other events related to their projects' activities.

A number of other steps could be taken as well to further project directors' access to information on the process of conducting CAUSE projects. Careful descriptions of projects, such as the case studies presented in Volume II of this report, should be disseminated to the project directors. Proposals, interim reports and evaluation findings of selected projects could be gathered together in a kind of lending library for project directors. (It would also clarify the role of project interim reports and final reports if project directors understood that these reports were being written to inform future project directors.)

Other ideas along these lines can be generated and these need more refinement. The important thing to understand is that to be successful most CAUSE projects require some professional development of project staff in such areas as instructional development, instructional technology, and so on. The CAUSE program should devote further attention to facilitating the professional development aspects of the projects in order to maximize their efficiency and effectiveness.

Recommendation Five

A Project Directors' Reference Manual Should Be Created to Provide Support and Direction to Project Staff, Particularly in the Areas of Project Management, Evaluation and Instructional Design

There are a sufficient number of problems faced in common by most project directors and staff to justify the creation of a reference manual describing these potential problems and alternate means of attacking them. Included in such a manual would be descriptions of various management, evlauation and instructional design strategies used by successful project directors, and criteria to aid in the selection of the appropriate strategy for a given situation. Of particular use would be hints, guidelines, and forms useful for the monitoring and control of project activities. The selection and use of outside experts would also be covered, as would be hints on the successful use of formative evaluation strategies. References to additional sources of information would also be included. The availability of such a manual, which would rely primarily on the experience of project directors of past CAUSE programs, would greatly decrease the present problems due to each project tending to start anew with little awareness of the progress already made by others.

Recommendation Six

The CAUSE Program's Present Emphasis on Local Need and Institutional Support Should Be Continued, If Not Increased

Effective CAUSE projects are based on high priority local needs. Although this statement is somewhat obvious, its implications for the planning and implementing of projects are not. It is relatively easy to construct a statement of institutional need that does not contradict the institution's general goals and which directly supports whatever instructional improvement project a creative faculty member would like to implement. However, it is extremely difficult to identify, clarify and articulate a consensus on local instructional needs in a way that drives and focuses project planning, design, implementation and evaluation. However, without a clear, common and meaningful understanding of what needs are to be filled and exactly how project activities are to meet those needs, the filling of the needs will depend more on chance than on design. Because it is so easy for institutional administration and project staff to climb aboard the bandwagon of an intuitively appealing solution and so difficult to clearly and meaningfully articulate the concept of high priority institutional need, it is critical that project staff be encouraged and assisted with respect to recognizing the importance of local institutional needs as the driving force of their projects.

A number of specific actions can be taken to make the present emphasis on institutional needs more meaningful to project planners and implementers. The statement of institutional support should represent the commitment not only of the institution's highest levels of administration, as is presently the case, but of the department chair(s) and dean(s) levels as well.

This statement of commitment should explicitly define the specific needs to be addressed by the project and should describe the institution's specific commitment to the project in terms of how faculty time will be reallocated, what responsibilities participating faculty will be released from (and how those responsibilities will be covered), and the incentives the institution will provide participating faculty to enhance their continued interest and participation in the project. Evidence of individual faculty members' personal and professional commitment to the project should also be emphasized in project proposals.

Recommendation Seven

A Greater Emphasis Must Be Placed on the Clarification and Improvement of Proposals Once the Proposal Review Process Is Completed but Before the Grants Are Formally Awarded

Some amount of negotiation between CAUSE program staff and selected grantees presently occurs as part of the formal award procedure and the modifications to original proposals recommended by proposal reviewers and CAUSE staff appear to have been generally sound. (Although pre-award negotiations were not a formal focus of our evaluation, documentation of these negotiations were often reviewed by site visitors.) However, we believe that it is this point in the project development process that NSF has the greatest power to positively affect the quality of CAUSE projects. Project staff will be more strongly motivated to put additional time and effort into the improvement of proposals because they know the probability of award is great. This is also an opportune time to require the institution's administrators and department faculty to become more precise about the nature of their commitment. In particular, it would be an ideal time to fully explicate the issues of release time, management and logistics, and evaluation.

Since the recommendations of the proposal review teams are an important source of information for CAUSE program staff during the pre-award process, it is important that each review team include at least one person knowledgeable and experienced in comprehensive instructional improvement efforts in higher education. We believe a number of problems within specific projects could have been avoided had they been identified during the proposal review process.

Recommendation Eight
More Emphasis Should Be Placed on the Relationship Between Development and Operation Costs Within Proposed Projects

The distinction between development costs (i.e., the costs required to bring about an instructional improvement) and recurring operation costs (i.e., the costs required to maintain an instructional improvement) is not usually addressed in project proposals, nor does it appear to be one consciously made by many project directors. However, the formal consideration of the cost structures of the eight case study sites as well as a more informal consideration of costs within each of the other sites visited strongly suggests that the distinction is extremely important in CAUSE, particularly with respect to its bearing on the post-grant maintenance of projects. The costs of most of the projects visited were primarily development costs. We believe that most of the instructional improvements brought about by these projects will continue to be maintained by their institutions upon completion of the grant. The relatively high recurring operation costs of a few of the projects raised some doubts as to these projects' continued viability within their respective institutions in post-grant years. During the solicitation and award process an explicit emphasis should be placed on determining the proportion of the project which is a recurring operation cost. Those projects with a high portion of recurring operation costs should be required to carefully justify the projects' plans in terms of long-term benefit to the institution and/or maintenance of the projects' improvements. The commitment and ability of the institution to continue the proposed instructional improvement in post-grant years should be examined very closely by the proposal reviewers and the CAUSE program staff.

Summary

The CAUSE program is meeting extremely important institutional needs for improved science education resources. Some strengthening of the program, as suggested by the above recommendations, would enhance the implementation and increase the impact of local projects.

BIOGRAPHICAL INFORMATION ON EVALUATION STAFF AND CONSULTANTS

Thomas Allen is presently an Associate Professor of Chemistry at Hudson Valley Community College. Over the past several years he has created over 10 module programs for use in introductory chemistry courses at the two-year college level. These modules were developed for both computerized and audio-tutorial instruction. In an article entitled "Computers, Anyone", Mr. Allen discusses integrating computer technology with classroom instruction. He has had extensive teaching experience at the two-year college level, and has also consulted with many two-year colleges to determine educational needs and the appropriateness of interfacing computer technology in instructional settings. Mr. Allen served as an evaluation team member, specializing in science education, on one site visit and one case study of the CAUSE evaluation.

Albert Beilby is the Assistant tc the Director for the Office of Library Services at the State University of New York in Albany, New York. Dr. Beilby has been working on the development of simplified and generalizable techniques for the collection and analysis of functional cost data. He has conducted cost studies in a variety of educational settings including universities, two-year colleges, small liberal arts colleges and U.S. Army officer training schools. At the present time he is working on efficient, generalizable cost modeling procedures for use in evaluating innovative post-secondary programs. He is also analyzing State University of New York library holdings in order to identify factors to be considered in the future development of SUNY library collections. Dr. Beilby served as a cost analyst on three of the case studies in the evaluation of CAUSE.

Jacquelyn L. Beyer is currently a professor in the Department of Geography and Environmental Studies at the University of Colorado, Colorado Springs. Her past teaching experience is extensive including work at Rutgers University, the University of Cape Town, Antioch College, Montana State University, Columbia University, and the University of Texas. Dr. Beyer has also been involved in developing and implementing PSI in several content areas. Her concern for excellence in teaching and instruction has led to the development of many innovative programs. One of her current interests as a recently licensed private pilot is to develop an interdisciplinary course on "Science from the Window of an Airplane". Dr. Beyer served as a content expert in science education on two of the site visits and one of the case studies for the CAUSE evaluation.

David Butts earned a Ph.D. from the University of Illinois in Science Education. He is currently Chairman and Professor of Science

Education at the University of Georgia. He has been the Director of the NSF Leadership Conference for College Educators (1969), the Director of the National Science Foundation Leadership Conference (1967), and has written 14 books and numerous articles in science and science education. He is actively involved in a variety of professional organizations. Dr. Butts participated as a science education consultant on one of the site visits and one of the case studies for the evaluation of the CAUSE Program.

Jane G. Cashell has served as the project co-director of the CAUSE evaluation for Development and Evaluation Associates, Inc. In that position, she has assumed various responsibilities. She has served as an evaluation team member and reporter for three site visits and two case studies. Her other responsibilities have included design and analysis of the Survey of CAUSE Project Directors, analysis of funded proposals, development of site visit and case study methodology and reporting, and analysis of results from site visits, case studies, and all data collection activities. She has managed the staff, activities, and budget for the evaluation.

For a DEA contract with the American Express Company she designed the evaluation component of a training system. Prior to working at DEA, she worked for two and a half years on the evaluation staff of the Center for Instructional Development at Syracuse University. Her next project, once the CAUSE evaluation is completed, is a conceptual analysis of some of the activities related to the activity of evaluating.

Ms. Cashell holds a B.A. from Antioch College in elementary education and a M.S. in instructional technology from Syracuse University. She is a doctoral candidate in the Instructional Design, Development, and Evaluation program at Syracuse. Just recently Educational Leadership and the Journal of Research in Science Teaching have accepted for publication articles for which she is co-author.

Terry Coleman, Research Associate with Development and Evaluation Associates, has served as a member of the primary evaluation staff on the study of the CAUSE program. His foremost responsibilities on the project have been to serve as evaluation team member for four site visits and two case studies. In addition, he has participated in staff deliberations regarding design, methodology, and analysis of data.

Several of Dr. Coleman's recent projects have included the design of a nationwide evaluation of a school health curriculum for the National Center for Disease Control, the development of a training evaluation system for New York State's Department of Social Service, and the development of training materials in evaluation for a foreign governmental educational television network. He holds a B.A. degree in English education from the State University of New York at Albany (SUNYA), an M.S. in Educational Communications from SUNYA, and a Ph.D. in Instructional Design, Development, and Evaluation from Syracuse University.

Esther Lee Davenport is currently a Research Engineer at the Georgia Institute of Technology. She is working on a Ph.D. from the same institution in Industrial/Organizational Psychology. Her past experience is diverse and includes the development and management of a program for women in engineering, and participation in several NSF program evaluation studies. Ms. Davenport's current interests are in the areas of program evaluation and applied research on learning and training. Ms. Davenport served as an evaluation team member with expertise in science education on two of the site visits and one of the case studies.

Philip L. Doughty conducted a cost analysis for the case study of Cedar State University in the CAUSE evaluation. He is currently an associate professor and chairman of the Instructional Design, Development and Evaluation program at Syracuse University. His graduate degrees and professional activities have emphasized the application of cost-effectiveness analysis and other management techniques to the design and operation of educational systems. In particular, he has designed and utilized cost-effectiveness models for teacher education, post-secondary education, and military training. Dr. Doughty has also designed and developed a computer-based test-development program and has engaged in numerous instructional design and development projects. He was project co-director on the development of evaluation protocols and procedures for biomedical communication directors under contract to the National Medical Audiovisual Center (NMAC) in Atlanta, and is currently developing the cost analysis procedures for the evaluation model for the New York State Department of Social Services.

Marvin Druger served as an evaluation team member on two site visits and one case study for the evaluation of CAUSE. He earned a Ph.D. from Columbia University in 1961. In addition to his scientific publications, he has written and lectured extensively on innovative techniques in science education. He has been the Chairman of the Education Committee of the Genetics Society of America for the past three years and was nominated for president of the National Association for Research in Science Teaching. He is the president elect of the Society for College Science Teaching. Dr. Druger has participated in the Advisory Panel and conducted a portion of the site visits during Phase I of this evaluation.

John D. Eggert has served as the project co-director for the evaluation of CAUSE. He was responsible for the original design of the evaluation and, with Ms. Cashell, has overseen its implementation. He has served as an evaluation team member and reporter on seven site visits and three case studies. Other responsibilities have included participation in the design of the site visit and case study methodology and in the analysis of the data across cases and sites, and across all data sources.

Dr. Eggert is Director of Development and Evaluation Associates, Inc. (DEA). Projects which he has co-directed include a feasibility study and plan for the evaluation of the Center for Disease Control's School Health

Curriculum Project and the design for a state-wide evaluation system for Title XX training for the New York Department of Social Services. He has also participated in a major staff development effort for the Government of Iran's educational radio and television network. Prior to his tenure as DEA's Director he served in the evaluation office of the University of Mid-America and also designed and implemented an evaluation of a Training of Teacher Trainers (TTT) project at the University of Wisconsin-Milwaukee. John received his doctorate from the University of Chicago's MESA program (Measurement, Evaluation and Statistical Analysis). In his dissertation he developed a model for emotional response to music and investigated that model in an academic setting.

James J. Gallagher received an Ed.D. in Science Education from Harvard University. He is presently Director of the Michigan State University Science and Mathematics Teaching Center. He has written extensively in the field of science education and has served as President of the National Association for Environmental Education Committee and as Director of Education for the American Society for Environmental Education. Dr. Gallagher is now president-elect of the Michigan Association of Science Education Specialists. During the CAUSE evaluation, Dr. Gallagher participated as the science education consultant for two of the site visits and one case study.

Ramesh Gaonkar served as an evaluation team member specializing in science education on one case study and one site visit conducted for the evaluation of CAUSE. He is a professor at Onondaga Community College, Syracuse, New York. He earned his Ph.D. from Syracuse University in 1974 through an interdisciplinary program in Instructional Technology in the School of Education and Electrical Engineering in the School of Engineering. He has taught physics in both the United States and in India. Dr. Gaonkar has participated in numerous curriculum development and evaluation projects and has presented several seminars and guest lectures.

Richard M. Lent is a research associate at Development and Evaluation Associates, Syracuse, New York. Dr. Lent's specialty is in the use of cost-effectiveness analysis as a means of planning and evaluating projects involving the use of instructional development and educational media. He has conducted a number of studies in this area and has written and taught on the subject both here and abroad. He has also served as a consultant on curriculum and instructional development projects in a variety of traditional and non-traditional post-secondary education settings. Dr. Lent came to DEA from the State University of New York where he was assisting one of its institutions in making the transition from a four-year to upper-division only college. He received his Ph.D. from Syracuse University in Instructional Technology.

Dr. Lent participated in a number of activities for the evaluation of CAUSE including the Forestview Case Study, three site visits, and three cost analyses. He also was responsible for managing the cost analysis team and had major responsibility for analysis of findings from all the case studies and site visits. His other projects at DEA have involved the creation of a training system for American Express and the design and conduct of staff development workshops for state and federal agency training departments.

John E. Penick earned his Ph.D. from Florida State University in science education. He is presently an associate professor at the University of Iowa. He has conducted a number of research studies in science education and is a member of a variety of professional groups including the Association for the Education of Teachers in Science, the American Educational Research Association, and the National Association for Research on Science Teaching. He has made many presentations and has conducted numerous workshops for school districts around the country. Dr. Penick served as an evaluation team member specializing in science education for one of the case studies and one site visit.

Kathleen Porter served as a graduate intern on the CAUSE evaluation project for Development and Evaluation Associates, Inc. Her responsibilities on the project centered on the broad focus evaluation activities, the content analysis of funded proposals and the surveys of project directors. She was involved in instrument development, data collection, data analysis and reporting.

Now, as a research associate with DEA, she is working on the development of an evaluation system for the Department of Social Services in the State of New York. She is primarily interested in evaluation in higher education settings and has much background in faculty development.

Dr. Porter earned her Ph.D. in English from Syracuse University and was an assistant professor of English at St. Lawrence University. She was responsible for editing the complete final report of the evaluation of CAUSE.

Peter A. Stace earned his doctorate in the Area of Higher Education and his masters degree in economics at Syracuse University. Presently, Dr. Stace is an Assistant Dean in the College of Arts and Sciences at Syracuse University where his major responsibility is to direct undergraduate services and advising in the College. A primary area of interest for Dr. Stace is that of cost-effectiveness analysis and its application as a tool for program evaluation. He has completed his dissertation and several other studies in this area and has conducted workshops on the topic. Dr. Stace served as a member of Development and Evaluation Associates' cost analysis team during the CAUSE evaluation and conducted the cost analysis for the case study of Willows University's CAUSE project.

Spencer Swinton served as an evaluation team member on one of the site visits conducted as a part of the CAUSE evaluation. He completed his undergraduate education at MIT and earned a Ph.D. from the University of Chicago in 1973 in the area of Measurement, Evaluation and Statistical Analysis. Presently, he is a research psychologist in the Division of Educational Research and Evaluation at the Educational Testing Service. He has been chairman of the Department of Mathematics at the Government Teachers' College, Dar es Salaam, Tanzania and an Assistant Professor of Child Development at the University of Wisconsin. Dr. Swinton served as the project director for NSF's PLATO Elementary Computer-Based Education Evaluation and has had experience in a variety of research, development, and evaluation projects. In addition to publications in the areas of cognitive development and evaluation, he holds a recent patent in the field of educational technology.

Jody Karen Witham served as a graduate intern on the CAUSE evaluation project for Development and Evaluation Associates, Inc. Her responsibilities on the project centered on the broad focus evaluation activities, the content analysis of funded proposals and the surveys of project directors. She was involved in instrument design and development, data collection, data analysis and reporting.

Ms. Witham holds a B.A. in Psychology and an M.A. in Education, both from the University of Vermont. She is a doctoral candidate in the Instructional Design, Development and Evaluation program at Syracuse University. She is primarily interested in "regular" education for "special" children, and the development of principles of motivation which can be applied in the design of instruction and classroom management.

Robert E. Yager earned his Ph.D. from the University of Iowa in 1957. He is presently director of the Science Education Center at the University of Iowa. He has directed over 70 different NSF sponsored programs and institutes, many of which involved the evaluation of innovative science education programs and activities. He has served as a consultant and an evaluator for proposals, accreditation, project evaluation, and synthesis studies. He has been president of a number of professional organizations including the National Association for Research in Science Teaching and the Association for the Education of Teachers in Science. Dr. Yager served on the Advisory Panel during Phase I of this evaluation. He also participated as an evaluation team member specializing in science education for four of the site visits conducted during the CAUSE evaluation.

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