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ABSTRACT

School districts were identified that were involved in implementation of recent National Science Foundation (NSF) elementary school science curricula and in corresponding in-service work. Questionnaires sent to 6 school districts, selected somewhat randomly from across the 50 states and the District of Columbia, compiled information regarding practices employed in the implementation of the NSF curriculum and their recommendations for more successful implementation. Responses revealed that schools using NSF materials were moderate or larger in size, having some departmentalization in science, teaching science in a class-size group, having some instruction assistance (e.g., aids), having become aware of curriculum in use through NSF awareness conferences or college/university consultants, and having selected the curriculum through a local curriculum committee or by a science consultant/supervisor. Recommendations for successful implementation of NSF curricula are listed, including conditions for teacher training, evaluation, equipment and materials, facilities, and pilot programs. The two highest rated recommendations were: (1) teachers should receive training in the teaching strategies of the curriculum; and (2) teachers' understanding of learning theories and intellectual development should be coupled with the implementation efforts. (CS)

ELEMENTARY SCIENCE CURRICULUM IMPLEMENTATION: AS IT WAS AND AS IT SHOULD BE*

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Introduction

The implementation of recently developed elementary science curricula and the corresponding in-service work thought to be essential for a successful effort are well known among science educators, the National Science Foundation, science consultants and, most recently, the public via the news media. NSF's first effort to assist elementary school teachers in the area of science has been historically recalled by Wailes (1968). The effectiveness of implementation has been demonstrated in many ways, i.e., number of teachers trained, amount of financial support from local districts, and testimonials from in-service participants. Others (Anderson and Horn, 1972) have measured changes in teaching style, and Porterfield (1969) showed changes in questioning behavior by teachers after receiving training for using SCIENCE CURRICULUM IMPROVEMENT STUDY (SCIS) materials. The problems related to past in-service activities, including science education and other disciplines, are discussed by Horn (1975).

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The patterns and practices involved with implementation have not been as often addressed. This study was designed to identify the districts that have been involved in an implementation effort and compile the practices that they employed and, if they were to do it again, how it should be done. Although the sample, described later, was drawn from across the fifty states and the District of Columbia, it was not intended to be a random sample nor should the results be viewed in such a light.

Procedures and Sample Selection

A letter was sent to a state science supervisor from each state and the District of Columbia informing them of the study and requesting (1) the names of school districts in the state that use one or more of the National Science Foundation curricula (ESS, SCIS, SAPA(AAAS), COPES or USMES); (2) the name of a contact person within the districts and/or; (3) the name of another person within the state who might be contacted to gain the information requested. A questionnaire was then sent to the school district contacts to determine how NSF curricula were introduced and the method(s) of in-service used.

From the state supervisors' responses (42), 43% of the respondents knew of districts within their states that were using NSF curricula. In 17% of the responses, district names were included, but the information as to the use of NSF curricula was unknown and therefore not indicated. Combining the above information, 60% of those responding did give the names of school districts and contact names within their respective state.

Selection Process

From the lists generated through the state departments, where more than six districts were on the list, six school districts were randomly selected. In those instances where fewer than six districts were indicated, all identified were sent a questionnaire. A total of 106 questionnaires was sent and 62 were returned, yielding a 58% response rate.

Results

The questionnaire completed by the respondents was essentially composed of four parts. The parts were designed to assess:

1. curriculum used and organizational structure of elementary science instruction (Table I)
2. patterns of instructional assistance available for teachers (Table I)
3. sources of information about the curriculum and patterns for selection (Table I)
4. practices and recommendations for potential implementers (Tables II-VII)

As found in Table I, one could describe the "typical" school providing data for this study as:

1. being moderate or larger in size (81% had 22 or more elementary science teachers)
2. having some departmentalization in science, particularly at the upper grade levels (39% at the sixth grade level)
3. teaching science in a class size group, 10 - 30 students (79%)

TABLE I

SUMMARY OF INSTRUCTIONAL ORGANIZATION
AND CURRICULUM SELECTION PROCESS BY CURRICULUM

		ALL N/%	ESS N/%	SCIS N/%	COPES N/%	S-APA N/%	USMES N/%
Teachers of Elem. Science							
1-7		7/12	2/40	3/14		2/11	
8-14		2/3		1/5		1/5	
15-21		2/3	1/20			1/5	
22 or more		47/81	2/40	18/82	1/100	15/79	5/100
Departmentalization in Science							
Yes		37/62	4/67	12/57	1/100	12/60	4/67
No		23/38	2/33	9/43		8/40	2/33
Level of Departmentalization							
K-3	Yes	8/13		2/9		4/20	1/17
	No	53/87	6/100	20/91	1/100	16/80	5/83
4	Yes	17/28	3/50	2/9	1/100	5/25	3/50
	No	44/72	3/50	20/91		15/75	3/50
5	Yes	25/41	3/50	6/27	1/100	8/40	3/50
	No	36/59	3/50	16/73		12/60	3/50
6	Yes	37/39	4/67	12/55	1/100	13/65	3/50
	No	24/39	2/33	10/45		7/35	3/50
Knowledge Source of Curriculum							
NSF Awareness Conference		9/18	1/17	4/22		2/13	2/33
Commercial Advertisements		3/6	1/17			1/7	1/17

TABLE I (cont'd)

	ALL N/%	ESS N/%	SCIS N/%	COPES N/%	APA N/%	USMES N/%
Knowledge Source of Curriculum (cont'd)						
Curriculum Representative	6/12	1/17	3/17		2/13	
College/Uni. Consultant	10/20		5/28	1/100	4/27	
Neighboring District	1/2		1/6			
News Media						
Administrator's Organization	4/8	1/17	2/11			1/17
College Course	3/6	1/17	1/6		1/7	
Other	15/29	1/17	2/11		5/33	2/23
Instructional Group Size						
Individualized	3/5	1/20		1/100		
Small Group (< 10)	6/10	1/20	1/5		2/11	
Class Size (10-30)	46/79	1/20	19/90		17/89	6/100
Large Group (> 30)	3/5	2/40	1/5			
Assistance for Science Instructor*						
Paid Aides	15/25	2/33	3/14		5/25	1/17
Volunteer Aides	6/10		2/9		2/11	
H.S. Student Aides	9/15	1/17	1/5	1/100	3/14	1/17
College Student Aides	7/12		2/9		4/21	1/17
Consult/Resource Teacher	27/45	1/17	10/45		10/53	4/67
Curriculum Selection						
Local Curric. Committee	15/28	3/50	4/21	1/100	4/25	2/33
Total Faculty	6/11				6/37	
State Adoption						
Local Administration			5/26		2/12	1/17
Sci. Consult/Supervisor	10/19	1/17	5/26		1/6	2/33
Genr'l Curric Consult/ Super	5/9	2/33	3/16			
Other	8/15		2/11		3/19	1/17

*Respondents checked all that applied; therefore, totals may sum to more than 100.

TABLE I (cont'd)

	ALL N/%	ESS N/%	SCIS N/%	COPES N/%	S-APA N/%	USMES N/%
Recommended Curric. Selection						
Local Curric. Committee	27/51	4/67	13/68	1/100	6/37	1/17
Total Faculty	9/17		1/5		7/44	1/17
State Adoption						
Local Administration	1/2		1/5			
Sci. Consult/Supervisor	8/15		3/16		2/12	2/33
Genr'l Curric Consult/ Supervisor	1/2	1/17				
Other	7/13	1/17	1/5		1/6	2/23

TABLE II
IMPLEMENTATION--PERSONNEL/EVALUATION

As It Was			As It Should Be		t
$\bar{X}$	SD	Condition	$\bar{X}$	SD	Value
.2982	.4616	Teacher training was a prerequisite for a teacher to use the curriculum.	.7719	.4233	-6.96**
.6842	.4690	College/University personnel were actively involved in one or more phases(selection, pilot, training, adoption, utilization, evaluation) of the local implementation effort.	.8148	.3921	-2.19*
.3929	.4928	State Department of Education personnel were actively involved in one or more phases (selection, pilot, training, adoption, utilization, evaluation) of the local implementation effort.	.7091	.4584	-5.17**
.4138	.4968	A formal evaluation program of the curriculum in your district conducted after at least one year of operation.	.9322	.2536	-7.89**
.6964	.4640	Neighboring districts have visited and/or formally communicated with you about the curriculum.	.9434	.2333	-3.71**

* $p \leq 0.05$
** $p \leq 0.001$

TABLE III

IMPLEMENTATION--EQUIPMENT & MATERIALS/FACILITIES

As It Was			As It Should Be		t
$\bar{X}$	SD	Condition	$\bar{X}$	SD	Value
.6842	.4690	Equipment and materials were provided for each teacher.	.8571	.3531	-3.47**
.7586	.4317	Teachers shared equipment and materials.	.6727	.4735	1.53
.1897	.3955	Remodeling and/or significant purchases for classroom furniture was accomplished because of the curriculum.	.5000	.5045	-4.34**
.7241	.4509	An unusually large appropriation (50% more than usual) for purchases of equipment and materials was made by the local district.	.8246	.3837	-1.99
.4211	.4981	A procedure for reimbursement of teachers for incidental expenses related to the science curriculum has been developed.	.7818	.4168	-5.58**

* $p \leq 0.05$
** $p \leq 0.001$

TABLE IV

INSERVICE TRAINING--CONTENT

As It Was			As It Should Be		t
$\bar{X}$	SD	Condition	$\bar{X}$	SD	Value
.8621	.3478	Teachers received training in the use of the teaching strategies of the curriculum.	.9818	.1348	-2.44*
.6897	.4667	Teachers' understanding of learning theories and intellectual development was coupled with the implementation efforts.	.9825	.1325	-4.71**
.5345	.5032	Teachers received training in science content around which the curriculum is centered.	.8725	.3363	-5.61**
.6102	.4919	Teachers received training in classroom management for using the curriculum.	.9643	.1875	-5.34**
.5862	.4968	Techniques for student evaluation were developed /learned by the teacher for the curriculum.	.9074	.2926	-4.59**

TABLE IV (cont'd)

INSERVICE TRAINING--CONTENT

As It Was			As It Should Be		t
$\bar{X}$	SD	Condition	$\bar{X}$	SD	Value
.3750	.4885	Tuition for any college course work associated with the inservice training was paid by the participants.	.4118	.4971	0.0
.3158	.4690	Tuition for any college course work associated with the inservice training was paid by the local district or state (non-federal) funds.	.6000	.4949	-4.21**
.4340	.5004	Travel and/or living expenses for any inservice training was paid for by participants.	.3600	.4849	0.63

* $p<0.05$
** $p\leq 0.001$

TABLE V

INSERVICE TRAINING--SUPPORT

As It Was			As It Should Be		t
$\bar{X}$	SD	Condition	$\bar{X}$	SD	Value
.5893	.4964	The commercial distributor of the curriculum provided inservice for teachers.	.7778	.4196	-3.55**
.6897	.4667	The local district provided (funded) inservice training for the teachers.	.9423	.2354	-4.12**
.4737	.5037	The local district provided release time for inservice training.	.9091	.2901	-6.27**
.5636	.5005	Inservice training was provided through a project funded by the National Science Foundation.	.8704	.3390	-5.00**
.2364	.4288	Instruction for inservice training was provided by local teachers salaried by a college/university.	.4600	.5035	-3.14*

* $p \leq 0.05$
** $p \leq 0.001$

TABLE VI

INSERVICE TRAINING -- ORGANIZATION

As It Was			As It Should Be		
$\bar{X}$	SD	Condition	$\bar{X}$	SD	Value
.7500	.4367	Key teachers or resource teachers received training for leadership roles in the implementation.	.9444	.2312	-3.05*
.5789	.4981	Administrators were given training for assisting in the implementation effort.	.8772	.3311	-4.93**
.3158	.4690	District business officers were oriented to the needs of the curriculum.	.6964	.4640	-5.19**
.6491	.4815	The curriculum was piloted in half or less of the total classrooms for one or more years before being implemented district-wide.	.8364	.3734	-3.47**
.5714	.4994	Summer teacher training was provided.	.9107	.2877	-5.36**
.6607	.4778	Academic year teacher training was provided.	.8364	.3734	-3.48**
.7931	.4086	Inservice training was provided in the local district or within one hour's drive of the local district.	.9057	.2951	-2.33*

* $p \leq 0.05$
** $p \leq 0.001$

TABLE VII

INSERVICE TRAINING -- INSTRUCTION

As It Was			As It Should Be		t
$\bar{X}$	SD	Condition	$\bar{X}$	SD	Value
.6786	.4713	College credit was available for inservice training.	.9091	.2901	-3.90**
.2456	.4343	Instruction for in-service training was provided by state department of education.	.5283	.5040	-4.55**
.6786	.4713	Instruction for inservice training was provided by a college/university.	.8868	.3199	-3.27*
.4737	.5037	Instruction for inservice training was provided by local teachers not salaried by a college/university.	.6154	.4913	-2.19*
.6000	.4944	The inservice training program, if any, was for 30 or more actual instructional hours.	.7736	.4225	-2.63*

* $p \leq 0.05$
** $p \leq 0.001$

4. having some instructional assistance, most often found as paid aides (25%) and consultant/resource teacher (45%)
5. having become aware of curriculum in use through NSF awareness conferences (18%) or college/university consultants (")
6. having selected curriculum through a local curriculum committee (28%) or by a science consultant/ supervisor (19%) and would recommend that a local curriculum committee have this responsibility (51%).

A finer differentiation presented by curriculum in use is found in Table I. When interpreting the data by curriculum, one is cautioned about the sample distribution. Also, since these districts were specifically identified by a person at the state level, they would have obviously been brought to the attention of others for non-random reasons. These reasons could include geographic location, personalities, exemplary programs--among others.

In any implementation effort there are many factors to consider, and often one does not have total control of the resources and/or the means necessary to accomplish the objective. Regardless of this problem, knowledge of the experience of others provides data that are invaluable to a successful effort. This study gathered data from previous implementers and grouped them for ease in interpretation as shown below. Recommendations for potential users are provided later.

Table II	Implementation--Personnel/Evaluation
Table III	Implementation--Equipment and Materials/ Facilities
Table IV	In-service Training--Content
Table V	In-service Training--Support
Table VI	In-service Training--Organization
Table VII	In-service Training--Instruction

A series of questions was asked the subjects and they were to respond once "As It Was" and once "As It Should Be" for each condition. A condition was in the form of a statement, such as "college credit was available for in-service training." In Tables II - VII the means and standard deviations for the "As It Was" and "As It Should Be" questions for each condition are presented. Also, the t-value and probability of significant difference between the means of the two questions based on this value are listed. The t-test for dependent samples was used (Glass, 1970). The options were "yes" scored as 1 and "no" scored as 0; therefore, a mean of 0.3900 could be interpreted as 39% of the respondents marked this item "yes."

It is interesting to note that in only two cases was the mean for a condition in the "As It Should Be" category less than in the "As It Was" category. These two exceptions deal with sharing of equipment and materials by teachers and travel and living expenses by participants during in-service training sessions. Generally, there seemed to be a great difference between what had been done and what should have been done in each of the six groups of conditions. One must interpret this with some degree of caution. As an example, a significant difference ($p \leq 0.05$) was computed relative to the condition

that specifies "teacher training in the use of the teaching strategies of the curriculum," but 80% of the respondents indicated that this was present in their in-service effort. It simply means that more (98%) think it should be a part of the preparation for implementation.

The results of this study can best be utilized in the context of the local needs, and a potential user of the information should consider each condition while reflecting on his own available resources and educational personnel.

Recommendations

As persons interested in the design of in-service programs to facilitate implementation, these writers recommend the following selected conditions for a successful effort.

1. Teacher training should be a prerequisite for utilization.
2. Teacher training should include:
   a. teaching strategies of the curriculum,
   b. learning theories and intellectual development,
   c. science content pertinent to the curriculum,
   d. classroom management for using the curriculum,
   e. techniques for student evaluation.
3. Instruction should be provided by college/university personnel.
4. College credit should be available for in-service training.
5. Summer and academic year training should be included, and it should be available within one hour's drive.

6. Key or resource teachers should be trained for leadership roles.
7. Administrators and business officers should be oriented to and/or receive training to facilitate implementation.
8. Funding for in-service training should be provided by local districts and the National Science Foundation.
9. State Department of Education personnel should be involved in the effort.

As a local school district person interested in developing an implementation project, the following selected conditions IN ADDITION to those identified above are recommended:

1. A formal evaluation of the effectiveness of the curriculum should be conducted after at least one year of operation.
2. Every effort should be made to provide equipment and materials for each teacher with a minimal amount of sharing equipment.
3. Attention should be given to some facility needs of the curriculum.
4. Larger than usual appropriations for equipment and materials will be necessary. (NOTE: None of these curricula require the usual expense of student textbooks.)
5. Some procedure for reimbursement to teachers for incidental expenses may be necessary.

6. Tuition costs for required teacher participation should be the responsibility of local districts.
7. The curriculum should be piloted for one or more years before district-wide implementation.
8. Release time for in-service training should be provided.

In conclusion and to emphasize a point, after having undertaken an elementary science curriculum implementation effort, the two highest rated recommendations (98% in both cases) by the respondents are that:

1. Teachers should receive training in the teaching strategies of the curriculum; and
2. Teachers' understanding of learning theories and intellectual development should be coupled with the implementation efforts.

SP2

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