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ABSTRACT

This program is the result of efforts made to develop a preparation model for elementary teachers. The science component of the program is referred to as SODIA-Science which is derived from the first letters of descriptive words: Self, Others, Discipline, Implementation, and Associate teaching. These words describe the emphasis at each level of the program. About 250 students per term are served by this project with about 50 in each of four required content courses and a science methods course. A practicum component and student teaching are also experienced by the methods course students. The sample for this project consisted of more than 500 students with at least a 2.7 grade point average. An expanded Discrepancy Evaluation Model (DEM) was used in developing the design of the science methods course and assessing the impact of the science content courses. The basic design includes: (1) what is going to happen (activities--process); (2) what should result (objectives--outcomes); (3) what is needed (resources--input). The National Science Teachers Association's external evaluation confirmed that this project was one of the best elementary science teacher preparation programs in the country. In all dimensions measured, student performance had been improved. Seven references are included. (RT)

Final Report
Part 2
Program Assessment Report

Utah Elementary Science Improvement Project

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MAJOR QU 'STIONS

Project Outcomes

1. Can an effective elementary teacher preparation program be designed to meet NSTA standards for elementary science?

2. Can an effective elementary teacher preparation program be designed based on what previous research has to say?

3. Can the Discrepancy Evaluation Model be used to design and evaluate an elementary science teacher preparation program?

4. What role does collaboration play in effective program development?

5. What impact did the project have on student performance and attitude?

6. What are the innovative components of the project and how do they operate?

PROGRAM/COMPONENT DESCRIPTION

SODIA-Science is the science component of the SODIA Elementary Teacher Preparation Program at Utah State University. The present program has evolved since 1971, when initial efforts were made to develop an elementary teacher preparation model that met the needs of students and had a sound basis in theory. The acronym SODIA is derived from the initial letters of descriptive words (Self, Others, Discipline, Implementation, and Associate Teaching), which describe the emphasis placed at each level of the program.

This project serves about 250 students per term, about 50 in each of four required content courses and the same number in a science methods course. The methods course students also experience a practicum component and student teaching.

Science component innovations include a strong science content foundation, pretesting with remediation, computer mediated instruction, flexible completion times, a convocation, and a strong practicum. Students are pretested upon entry into the science methods course. Subcomponents of the pretest include life, earth/space, and physical science content knowledge, science process skills, and science attitude. Students scoring less than 80% competency in any subcomponent must undertake remediation in that area. Remediation procedures are individualized and include video tapes with study guides.

Practicum experiences are coordinated with computer-mediated curriculum resources. The procedure acquaints students with CMI technology and provides resources for teaching science in their practicum.

SAMPLE

The sample for this project consisted of college students admitted to the elementary teacher education program at Utah State University. They must have a GPA of 2.7 for admittance into the program. Total number of students is more than 500.

METHODOLOGY AND INSTRUMENTATION

An expanded Discrepancy Evaluation Model (DEM) was used in developing the overall design of the science methods course, and indirectly in assessing the impact of the science content courses (Yavorsky, 1976). The DEM procedures which were followed resulted in a program design including a structured description of the program. In DEM procedures, information on program components is organized to constitute an operational map. The basic design includes: what is going to happen (activities—process), what should result if the activities are caried out (objectives—outcomes), and what is needed to carry out the activities (resources—inputs). The basic design was expanded to include evaluation questions and sources of data.

In discrepancy evaluation, performance is compared to a standard. The program design serves as a formal representation of that standard and is stated in a form which makes the standard readily subject to evaluation (Yavorsky, 1976 pp. 7-10).

A program design should:

1. facilitate clarification of program goals
2. facilitate the total planning process
3. form a basis of analyzing costs in time and money
4. facilitate assessment of the program plan before implementation
5. provide an implementation guide
6. provide a sense of the whole.

Design may be thought of as a system utilizing inputs (teachers, students, desks, paper, etc.) in processes (classes, practica, testing, etc.) to produce certain outputs (knowledge, skills, attitudes, etc.). Inputs (I), processes (P), and outputs (O) can be conceptualized at different interacting levels. For the purposes of this project, concentration is on the IPO's of the science methods course.

METHODOLOGY, INSTRUMENTS, AND FINDINGS

The methods, instruments, and findings are discussed in categories related to the major questions posed earlier.

Program Effectiveness-NSTA Standards

One of the goals of this project was to design a program that met recommended National Science Teachers Association standards for the preparation of elementary teachers. The test for this goal was in the form of a submission for consideration under the NSTA Search for Excellence in Science - Preservice Elementary Science Awards Program. The result of this evaluation was an award and an indication that the project met all NSTA standards. A brief discussion of these criteria follows:

An NSTA position statement (1983) recommended standards for the preparation and certification of elementary science teachers. Much of the rationale for the stated NSTA standards is similar to the rationale for the USU methods course. The NSTA statement indicated that there is universal agreement that elementary teachers should have reasonable knowledge of science content. The first recommended standard reads as follows:

> All colleges and universities should require a minimum of 12 semester hours or 18 quarter hours of laboratory or field-oriented science including courses in each of these areas: biological science, physical science and earth science.

This standard is exceeded by the SODIA Science program in that all students are required to take 5 credits each of biology, geology, chemistry, and physics. These courses all have laboratory components. Furthermore, AAAS guidelines (AAAS, 1970) indicate that courses should be related to the science the students teach. This goal is accomplished in that all Elementary Science State core objectives are covered in the four required content courses.

The second NSTA recommended standard relates to science teaching methods. The recommendation is achieved in all aspects by the new methods course. The recommendation reads as follows:

> Preservice elementary teachers should be required to complete a minimum of one separate course of approximately three semester hours in elementary science methods. This course should be scheduled after the science content courses have been completed and just prior to student teaching.

This recommendation is expanded to include the following related to methods course content:

> The elementary science methods course should develop instructional skills designed to assist preservice teachers to teach science processes, attitudes, and content to elementary school children, grades K-6. The course should include experiences such as hands-on activities to promote process skill development, the selection of science content appropriate for the elementary school, the design of classroom environments that promote positive attitudes, the selection and use of a variety of instructional strategies and materials, and the development of techniques for evaluating pupil progress in science.

There is considerable emphasis in the methods course on teaching content, processes, and attitudes as components of scientific literacy. The process skills are related to "hands-on" activities and content is directly coordinated with curricula judged appropriate for elementary grade children. Specifically, the following course components relate to this recommendation:

Topics 2.1, 2.2, 2.3	Content, Process and Attitude Assessment
6.1	Scientific Literacy
7.1, 7.2	Curriculum Materials

The third area of emphasis is related to field experiences, emphasizing the need for experiences with children.

> Preservice elementary teachers should have opportunities throughout their undergraduate years to teach science to children in schools. These field experiences in science should begin with observations and tutoring and proceed through small and large group instruction. Student teaching must include experiences in planning and teaching science.

The initial exposure to students in Level II of the SODIA program may or may not include science experience. The classroom exposure at that level is unstructured to the extent that students may not be assigned at a time that science is taught or with a teacher who is teaching science. The exposure during the practicum component of the methods course provides every student the opportunity to teach science. This is followed by Level

III, a full quarter methods related practicum, during which every student is required to teach science. Final classroom exposure is a full quarter of student teaching that normally includes science teaching.

Recommendation four relates to faculty preparation. Faculty for both the content and methods courses meet NSTA standards. Content course faculty have a high interest in teacher preparation. Methods course faculty are well versed in content and in teaching methodologies.

Recommendation five emphasizes the need for an atmosphere in which students can explore, investigate, and discover. Preservice teachers should have an appreciation for the nature of scientific inquiry, the assumption being that teachers prepared in environments that invite and support curiosity, investigation, and inquiry are more likely to provide similar situations for their students.

> Preservice elementary teachers should be instructed in science laboratories and educational facilities that include equipment, instructional materials, and library holdings that promote science learning and exemplify outstanding school science programs.

The combination of science course laboratories, the science society and technology methods course component, and the Edith Bowen Lab School facilities collectively satisfy the requirements of this recommendation. The one area of deficiency lies in that there is no annual budget for supplies and equipment.

The final recommendation defines conditions relative to professional development. These skills range from positive attitude toward science to an appreciation for the position of science in the total elementary curriculum.

> The professional orientation of preservice elementary teachers should include experiences that (a) instill positive attitudes toward science and science teaching, (b) foster an appreciation for the value of science in the total curriculum and in the lives

of the children, and (c) develop a commitment to continue their education as teachers of science through reading, participating in professional organizations, and furthering education, including inservice experiences.

Item "c" above has not been evaluated, but items "a" and "b" are integral parts of the philosophy and objectives of the methods course.

Program Effectiveness - Research Base

The entire foundation of the project was built on the premise that research had something to say about what should be included in an effective elementary science methods course. The overall success of the project speaks in favor of accepting that the foundation (Daugs, 1986) was sound.

Utility of the Discrepancy Evaluation Model

An expanded-modified Discrepancy Evaluation Model (DEM) was used in developing the overall design and in evaluating components of this project (Yavorsky, 1976). The procedures followed contributed to an overall picture of the entire project which included impact of prerequisite science courses and more specifically, the science methods course itself. The DEM procedures which were followed resulted in a program design including a structured description of the program. In DEM procedures, information on program components is organized to constitute an operational map. The basic design includes: what is going to happen (activities—process), what should result if the activities are carried out (objectives—outcomes), and what is needed to carry out the activities (resources--inputs). The basic design was expanded to include evaluation questions and sources of data.

In discrepancy evaluation, performance is compared to a standard. The program design serves as a formal representation of that standard and is stated in a form which makes the standard readily subject to evaluation

(Yavorsky, 1976 pp. 7-10).

A program design should:

1. facilitate clarification of program goals
2. facilitate the total planning process
3. form a basis of analyzing costs in time and money
4. facilitate assessment of the program plan before, during, and after implementation
5. provide an implementation guide
6. provide a sense of the whole.

Design may be thought of as a system utilizing inputs (teachers, students, desks, paper, etc.) in processes (classes, practica, testing, etc.) to produce certain outputs (knowledge, skills, attitudes, etc.). Inputs (I), processes (P), and outputs (O) can be conceptualized at different interacting levels. This report concentrates on the IPO's of the science methods course.

Program Design for SODIA-Science

This section of the paper includes parts of the program design in the form of a flow chart and IPO's. The purpose of this section is to illustrate the format of IPO's and how they were used to specify outcomes.

Figure 1 illustrates all methods course components.

El. Ed. 401 Science Methods (5 cr.)
Component Flowchart

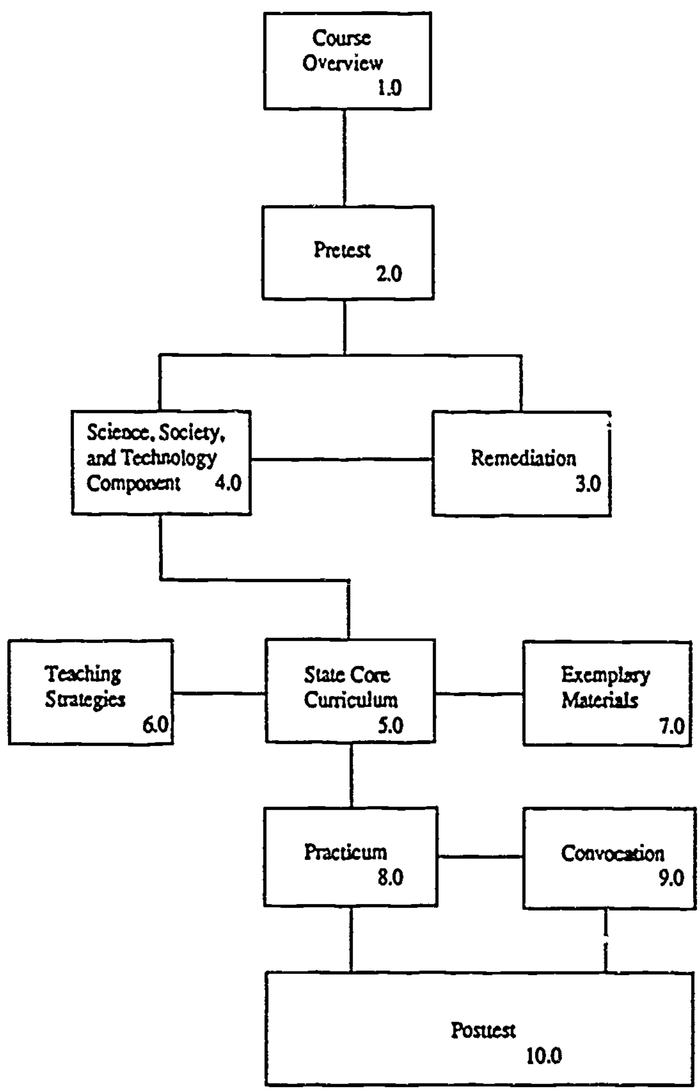

Figure 1

Initially, a program goal was generated for each major course component. Student objectives were then stated for each topic considered under a given goal. This process resulted in a total curriculum framework for the course. IPO's were then written for each objective.

To illustrate the IPO format and how a component was evaluated over the project's implementation, the section that follows includes the original IPO for component 5.Ø, some of the feedback that was used for evaluation, and the final product.

Component 5.Ø

Program Goal 5.Ø **To provide background on the origin and requirements of the Utah Elementary Science Core.**

Topic 5.1 Elementary Science Core Overview

Objectives: The student should:

5.11 be familiar with the State Core numbering system in order to use it as an aid in a computer-managed curriculum.

5.12 be familiar with the hierarchal arrangement of standards and objectives as stated in the Utah State Science Core.

5.13 examine across-the-curriculum relationships as presented in the Utah Elementary Science Resource Guide.

5.14 identify and explain how all aspects of the Utah Elementary Science Resource Guide relate to the State Elementary Science Core.

INPUTS	PROCESS	OUTPUTS
All students Instructor Classroom	In a lecture-discussion situation the instructor will introduce the students to the Utah Elementary Science Core.	Students will be aware of the numbering system, hierarchal arrangement of standards and objectives, and general content of the Utah Elementary Science Core.
State Science Core Utah Elementary Science Resource Guide Discs Apple IIe Computers/printers	The Apple IIe computer will be used to introduce the Utah Elementary Science Resource Guide. The instructor will explain how the various aspects of the guide relate to the total elementary curriculum.	Students will understand how the Utah Elementary Science Resource Guide is tied to the Core curriculum.

EVALUATION QUESTIONS	SOURCES OF DATA
Are students able to use the technology?	Course evaluations
Does the process adequately introduce the Utah Core Curriculum and the Elementary Science Resource Guide?	Test data
Do students use the resources on their own?	Student interviews
How well does the process relate to the Edith Bowen Lab School Project TINMAN objectives?	Lab school principal interviews

Discussion and Recommendations

This component was an innovative success. Student response was very positive, as evidenced by course evaluations, and their performance on related exam items has been excellent.

The component is now team taught by the Edith Bowen Lab School principal and the course instructor. The inclusion of the principal was made to provide an introduction to Project TINMAN, a computer-mediated curriculum management system utilized in the lab school in which methods course students do their practicum. The inclusion of the total management system expanded the original intent of using the computer as a resource for science curriculum materials to a more relevant total picture.

The use of computer-mediated videodisc was also added to the presentation.

Over half the students reported using the above described resource during their practicum. None reported negative feelings about the process.

Final Form for Component 5.0

Program Goal 5.0 To provide background on the origin and requirements of the Utah Elementary Science Core.

Topic 5.1 Elementary Science Core Overview

Objective: The student will utilize the Utah Core Curriculum and the Elementary Science Resource Guide as examples of computer-managed curriculum.

INPUTS	PROCESS	OUTPUTS
Students Instructor Lab School Principal State Science Core Elementary Science Resource Guide Computer Facilities and Resource at Edith Bowen Lab School	The Utah Elementary Science Core will be introduced in a lecture-discussion session. This will then be tied to a computer-mediated curriculum resource which includes the Elementary Science Resource Guide, the Edith Bowen Lab School hard disc facilities and a computer-mediated videodisc. Time: 1 1/2 hrs.	Students will understand the relationships between the State Elementary Science Core and the Elementary Science Resource Guide. Students will utilize a computer-managed curriculum process to obtain science teaching resources.

Outputs

The word "output" has various meanings. The discrepancy evaluation procedure specifies two types of outputs: terminal objectives and enabling objectives. The design was initiated with the program goals which specified those changes or products which were to result from program-controlled processes. These program goals were then expanded to include objectives that specified what was intended to be fed into the external environment. These objectives were further expanded into outputs, as part of the IPO statement, for which the program is accountable. For example, above final form of component 5.Ø, the program goal was "to provide background on the origin and requirements of the Utah Elementary Science Core". This goal served as an organizer for the curriculum developer. In the creative curriculum development process, an important question was: Can this goal be reached in a way that will incorporate innovative technology?

Though the Utah Core Curriculum had value in and of itself, the above question expanded the process to include computer-managed curriculum procedures. These factors were further spelled out in a second level of objectives called outputs. The outputs had direct relationship to the evaluation questions and sources of data. Though this matrix may sound complicated, it and the processes involved constituted a very workable procedure for designing and evaluating the program.

Some outputs could be classified as enabling outcomes. These outputs help facilitate achievement of previously stated higher level objectives. In terms of the DEM system, an enabling objective may be both the output of one process and the input of another. For example, the specified output under objective 1.11, "students will have an understanding of course goals, objectives, and procedures" is an enabling objective for Topic 1.2, grading. Understanding of the course goals, objectives, and procedures is a required input that enables the student to put grading procedures in a meaningful framework.

Outputs generally fall into three categories: individual change, institutional change, or products. The program design specifies the change variable, and also specifies how the output is to be evaluated.

The above example relating to understanding of course goals, objectives, and procedures in an example of measurable individual change as evidenced by course evaluations and instructor discussion with students. The formation and functioning of the advisory committee was an example of institutional change. Product outputs vary from teaching notes to tests.

In a broader perspective, the terminal total-program objectives related to providing a sound science content foundation through the process of requiring specified courses in biology, chemistry, geology, and physics, became inputs for the science methods course. These factors are specified in very general terms in course Component 2.Ø. The input "students" infers inclusion of all that is stored in their heads.

In the section that follows, the original program design for Topic 2.1 of Component 2.Ø is stated in its original form. Then some of the complexities of assessment.are explored.

COMPONENT 2.0

Program Goal 2.0 To provide a means of determing student level of scientific literacy.

Topic 2.1 Content Area Assessment

Objectives: The student must:

2.11 achieve a score of at least 80% in each of four (biology, geology, earth science, physics) content area assessments.

INPUTS	PROCESS	OUTPUTS
Students Personal record disc Content area assessment disc Computer facilities	Students will utilize a computer-mediated assessment procedure to self-preassess content area competencies in biology, geology, chemistry, and physics. Time: TBA	Students performing at below the 80% level will be identified.

EVALUATION QUESTIONS	SOURCES OF DATA
How well does the testing procedure operate? Has the pretest been validated? What is the reliability of the pretest? Are the prerequisite courses properly preparing the students?	Instructor feedback Course evaluations Validation process Test data Advisory Committee

The major goal of the prerequisite science content courses was to produce a scientifically literate student. A major issue in this process was defining the term scientific literacy. The advisory committee suggested that three major areas be considered in assessing scientific literacy: comprehension (content/knowledge), application (process skills), and attitude.

A scientific literacy test was constructed modeled after items from the British Columbia Science Assessment (1982). Validity considerations were covered in the 1982 British Columbia report. Test items were also compared with the standards and objectives stated in a field trial version of the Utah Core Curriculum (1987). All test items had comparable core components; therefore, it was inferred that the pretest covered topics appropriate for Utah elementary teachers.

The pretest was administered to 249 methods course students over a period of two years. Faulty items were identified and revised. Hoffman's efficiency indicies were used to assess item effectiveness.

A reliability coefficient was determined for the entire pretest, using subjects over a two-year time period using the Livingston criterion-referenced adjustment of Kuder Richardson 20. Passing score was 80% or better. Test statistics as well as the unadjusted and adjusted reliability coefficients are displayed below.

N	Mean	Variance	KR20	Rcr	SEM
249	67.85	56.15	.84	.87	2.70

Table 1. Pretest Reliabilities

Other data which contributed to test acceptance was a correlation between passing the pretest and having completed the prerequisite content courses.

In an initial analysis of data, students were grouped for each content subsection of the test on the following criteria: Group 1, who reported having an equivalent course in the area measured by the subsection of the test; Group 2, students who reported not having had an equivalent course. The T-test was used to assess differences, if any, between the group means of students who had completed an equivalent course and those who had not. Results indicated that both the physical science (chemistry/physics) and earth science scores showed significant differences between group means. There was no significant difference between group means on the life science section of the test at the P=.05 level. Results of the T-tests are displayed in Table 2.

					Pooled Variance Est.			Separate Varian.Est.		
Var.	# Cases	Mean	STD Dev.	STD Error	T-Val	Deg. of Freedom	2-tail Prob.	T-Val	Deg. of Freedom	2-tail Prob.
Grp 1=no course										
Grp 2=course										
BIOSC Biology Score										
Grp 1	45	13.44	1.501	0.224	0.67	247	0.503	0.68	66.19	0.496
Grp 2	204	13.27	1.545	.108						
PSSCR Physical Science										
Grp 1	127	8.9921	1.450	1.129	-2.28	171	0.024	-2.70	115.06	0.008
Grp 2	46	9.5217	1.005	0.148						
Earth SC										
Grp 1	78	11.8846	1.859	0.210	-3.31	247	0.001	-2.88	110.28	0.005
Grp 2	171	12.5497	1.256	1.096						

<u>Group Comparisons</u>

Table 2

Initial inference was that the earth and physical science subsections were doing what they were intended to do, discriminate among students prepared in those content areas, but that the life science subsection did not perform that function. Interviews with students revealed that the picture was more complex than had been covered in initial data collection. Four additional important factors emerged from the interviews. Not all students were honest in their reporting. Some students, particularly transfer students, reported taking equivalent courses that interviews determined as clearly not equivalent. Some students that reported not taking the prerequisite courses had passed College Level Program Examinations (CLEP) and had the requirement waived. Nearly all students reported having had high school biology, but not chemistry, physics or geology. Table 4 shows typical pretest performance of students on the old program. These students had an open 19 credit science requirement. They typically elected to take Nature Study rather than Biology 101, Conservation instead of Geology 101, and Astronomy rather than Physics 120 and Chemistry 101. It can easily be inferred by comparing data in tables 3 and 4 that present students are indeed more scientifically literate than students under the old program.

Table 3

	Taken Course		Not taken course	
	Passed test	Failed test	Passed test	Failed test
Biology	92%	5%	0%	3%
Earth Sci.	83%	11%	0%	6%
Physical Science	56%	17%	8%	19%

Pretest Performance of El. Ed. 401 Students (New Program)

Table 4

	Taken Course		Not taken course	
	Passed test	Failed test	Passed test	Failed test
Biology	83%	4%	4%	9%
Earth Sci.	70%	13%	4%	13%
Physical Science	48%	4%	4%	44%

Pretest Performance of El. Ed. 424 Students (Old Program)

In nearly every instance where test results were other than expected, there was a reasonable explanation. Those who had taken the prerequisite course, but did not pass the pretest had a variety of reasons. Often the reason was a low grade (D) or they had taken the prerequisite course as a pass/fail. Other reasons included transfer courses or substituting a transfer course for the required prerequisites. Other students had completed an earlier degree and had had the prerequisite waived or had very old credit.

It would appear that the foundation courses and the pretest are doing what they were intended to do. The issue of testing procedure is another matter. The computer mediated approach was fraught with problems, with sufficient substance for a masters thesis. Most of the computer testing procedures are beyond the scope of this paper, however, it may be of interest to highlight some of the problems involved to further illustrate the complexity of assessing the problem.

Allred (1988) dealt with the problem of presenting complex graphics utilizing the Apple IIe computer. This was a major challenge as there was no existing program to do the job. His work resulted in a program and procedure to achieve the desired product. Dazzle Draw (Snider, 1984), the software which led to the solution of the problem, had never been discussed in the literature as a means of integrating Dazzle Draw graphics for computer program applications. Allred's innovation resulted in a new application of this software. Designing a Dazzle Draw graphic was no longer an end product, but a means to an end. The importance of this innovation can only be fully appreciated when one considers how many "experts" could not provide any advice on how to achieve project goals.

In this instance, the specified Input in the original IPO's called for a computer-mediated pretest. This was a great idea that produced immediate and long-lasting discrepancies that required a knowledgeable, creative person two years to solve.

The Discrepancy Evaluation Model has been a very useful tool for evaluating SODIA-Science. Initially, it gave the Advisory Committee a picture of where the elementary science program might go. It has served the curriculum developers well in clarifying program goals and has proven valuable in planning the entire program. Costs in time and money were never really adequately considered. It was a job that had to be done.

The discussion in the previous section of this paper illustrates the complexity of gathering data and applying it to the model. This data must then be analyzed to identify any discrepancies in the model. With ten major course components and twenty three topics involved in the methods course, the amount of data needed to document effectiveness of each component becomes voluminous. Each component is unique.

Collaboration

Having the right people involved in the project was critical. If either the Dean of Education or the Dean of Science had not been committed to the project, it would never have succeeded. Department head commitment was also critical.

The initial task of the project director was to present a convincing case to the above persons. This presentation required not only a documentation of need, but some suggestions for solutions to problems. In the case of this project, everything just seemed to fall into place. We had the right people and a working atmosphere that greatly facilitated the project.

The need to share the goals of the project with the entire department faculty was always high priority. Before the project began, the department was consulted and their approval to proceed was obtained. Progress in the project was reviewed regularly in faculty meetings.

It was within the departmental framework that the only major difficulty occurred. Specifically this related to advisors' hesitation to share the new requirements with students. The increased science content and the change from a three-credit to a five-credit methods course did cause considerable student stress. Advisors were on the "front line" through the transition period and their general tone of response was apologetic and they accommodated many exceptions. This atmosphere may not have changed without a change in personnel.

The cooperation of public school teachers and administrators was very helpful. Their inputs, through the advisory committee, informally contributed to a broad sense of ownership in the program. Though not well documented, there is a general sense of preference for graduates from USU among Utah hiring agencies.

The general collaborative atmosphere of the project has enhanced the image of the department across campus in general and particularly in central administration. The State Office of Education has also recognized the quality of the program and continues to be very supportive of efforts to promote elementary education. Indirectly, the project's reputation has increased the probability of other funding.

Student Performance

The Scientific Literacy Assessment was designed in part to measure the effectiveness of the four required content courses in providing a sound science background for elementary teachers. Tables 3 and 4 compare the content performance of students under the old program and students under the new program.

Improvement can be noted in all areas. In nearly every instance where test results were other than expected, there was a reasonable explanation. Those who had taken the prerequisite course, but did not pass the pretest had a low grade (D) or they had taken the prerequisite course as a pass/fail. Other reasons included transfer courses or substituting a transfer course for the required prerequisites. Other students had completed an earlier degree and had had the prerequisite waived or had very old credit.

The effect of the four foundation science courses was further investigated spring term, 1988. This was the last term anyone without the prerequisites was allowed to register for the methods course. Students were divided into two sections: one with students meeting all prerequisites, and another with students having any deficiencies. Of the 23 students in the first group, only one did not pass one part of the pretest. Of the 13 students in group two, twelve did not pass some part of the pretest.

A fifty-item general science content assessment was administered to students in 1980 and to both sections of students spring term, 1988. These groups are identified as follows:

Group 1 — Spring 1988 - having all prerequisites

Group 2 — Spring 1988 - having one or more content deficiencies, not all prerequisites met

Group 3 — 1980 - students under old program.

As illustrated in Table 3, group 2 did little better than the 1980 group. Group 1 outperformed both other groups at the .01 level as measured by a t - test analysis. Group 1 performed better than group 2 at the .05 level.

Table 5. Content Performance

	Mean	SD
Group 1	34.68	6.32
Group 2	28.88	4.17
Group 3	26.22	0.36

It can be safely concluded that both the foundation content courses and the methods course are having a positive influence on the students.

Course Evaluation

Course evaluations were also used as an indicator of program success. Prior to the project, the course was already highly rated. Any increase in scores should be an indicator of improvement.

During the 1986-87 school year and the summer session, 1987, students in both the old program and in the new program registered for El. Ed. 424 (3 cr.) and El. Ed. 401 (5 cr.) respectively. Students in 424 were not required to have the prerequisite content courses and did not experience the STS component of the new methods course.

Student response fall term, 1986 resulted in a few minor course modifications, and also resulted in major changes in the evaluation form. The revised form was used to assess and compare student response winter term, 1986.

Fall term, 1986 data were used as initial indicators of project effectiveness. This data is summarized in Table 6. Data are listed as mean response to each item on a five point scale with 5=very positive, 4=positive, 3=neutral, 2=negative, and 1=very negative. Data are listed for both El. Ed. 401 and El. Ed. 424, the new and the old methods course. All students had identical experiences for the items listed, i.e. same time, same instructor, same instruction. Students in the new course had the additional 2 credit STS component.

Table 6. Initial Student Course Evaluation Data

ITEM	El. Ed. 424 Mean Rating n=46	El. Ed. 401 Mean Rating n=16
The course outline and instructor presentation explained what was going to happen in the course.	3.86	4.56
Grading procedures were adequately explained and followed.	4.36	4.81
PRETEST		
Manner of administration	4.22	4.00
Feelings about knowing your competencies	3.96	4.38
Feelings about knowing your deficiencies	3.46	4.06
REMEDIATION		
Procedure for informing of test results	3.63	4.20
Counseling process	3.33	4.11
Video-Study Guide quality (Leave blank if not required)	3.06	3.50
Video-Study Guide value	3.18	4.28
Remediation Posttest (Leave blank if not required)	3.31	3.50

Component 5.1 Elementary Science Core Overview	3.91	4.56
Component 5.1 Edith Bowen School Computer Systems	4.00	4.50
Component 6.1 Scientific Literacy Lecture and Applications	4.04	4.31
Component 6.2 Cognitive Processes Handouts	3.39	3.53
Component 6.3 Multidisciplinary Approach	4.50	4.50
Component 6.4 Lab Equipment Review	3.48	4.06
Component 7.1 Project Learning Tree	4.28	4.75
Component 7.2 Health Science Self Evaluation	3.67	4.12
Component 7.2 Silver Burdette Classroom Presentation	3.56	4.07
Component 7.3 Supplementary Science Materials (e.g. , Science and Children)	3.67	4.25
CONVOCATION Planning Sessions	4.02	4.31
Adequacy of Resources	4.06	4.25
Children	4.56	4.44
Teacher	4.37	4.38
Time	4.14	4.50

Follow-up	3.98	4.31
Overall Impression	4.28	4.56
TESTING Items covered = materials taught	3.20	3.93
Fair	3.30	4.27
Appropriate Length	3.74	4.53
Adequate in Scope	3.37	4.20
MEAN	New Course 4.25	Old Course 3.80

With the means consistently higher for students in the new course, it was concluded that the new program was in general an improvement.

Data were also summarized over the four terms when both the old course and new course were offered. The data were based on ten student evaluation form items that were not changed over the time period. The mean response for all comparison items for the old course was 3.97 and for the new course, 4.34. Individual item responses are shown in Table 7.

Table 7. Student Course Evaluation Data

Item #	Course	Mean Student Response	Item
1	424 401	3.82 4.50	The course outline and instructor presentation adequately explained what was going to happen in the course.
2	424 401	4.02 4.62	Grading procedures were adequately explained and followed.

3	424 401	4.30 3.95	Pretest: Manner of administration
4	424 401	3.80 4.01	Pretest: Feelings about knowing your competencies.
5	424 401	3.60 4.50	Pretest: Feelings about knowing your deficiencies.
6	424 401	4.05 4.50	Component 5.1 Elementary Science Core Overview.
7	424 401	3.98 4.30	Component 5.1 Edith Bowen School Computer Systems.
8	424 401	4.45 4.60	Component 7.1 Project Learning Tree.
9	424 401	4.48 4.75	Overall Course Impression.
10	424 401	3.28 4.25	Testing: Items Covered = Materials Taught.

Qualitative Feedback

Ultimately, the success of the program is measured beyond the methods course. Some indicators of the impact of the program are included in the following interviews:

1. Cooperating Practicum Teachers -

A. There is evidence of excellent preparation in the field of science. They have good content background. I do not feel the need to teach the concepts of science to the students as previously. As an example, when asked to teach a unit on matter, students used to ask questions such as, "What is matter?" "What are principles or properties?" Now, the students can develop the lesson and only need help locating supplies. They also know how to use the equipment for the experiments. "The students try harder to get the concept across to the children now."

B. The questioning strategies of the students are better now under the new program than they were. The ideas are creative, but they do have difficulty locating materials for experiments. They don't realize the time necessary to acquire some supplies and wait until the last minute to get them.

2. Supervisor of Student Teachers -

A. There have been changes between the students taking El Ed 401 and those taking El Ed 424. Those changes are evident in the student teachers and the teaching of science. One of the most evident changes is in the area of lesson planning. The students taking 401 are easily able to do science lesson plans for their teaching.

The lessons the students choose to do are multidisciplinary and don't include the use of the text as the major part of the plan. There have been several students who have chosen to write an entire unit on science when they have a choice of any area of the curriculum. There have been units done on energy, water, solar power, and rocks.

Before the change in the methods course, student teachers rarely chose to teach science. Now the lessons are "more exciting lessons to watch." The student teachers show confidence in the field of science. The cooperating teachers comment on the help they receive in the field of science from the student teachers. The student teachers develop their own equipment and demonstrate many experiments. Their questioning skills have increased, thus allowing student input in the lessons. There is evidence of hypothesis formation, too.

The students seem to be getting methods which are generalizable to all areas of the curriculum. There is a marked difference in their teaching. The students have no fear of science and are generally excited about it.

3. School Administrator -

A. The new teachers seem to have more creative ideas in science than ones who had had the old science methods program. They are not afraid to teach science and have a lot of involvement in it. The children are excited, too, about science and the experiments they do.

Innovative Components

The innovative components are discussed at length in Practice Profile, Part 3 of this report.

DISCUSSION OF RESULTS

The external evaluation by NSTA has confirmed that this project is one of the best elementary science teacher preparation programs in the country. Research literature has played an important role in course development. The entire process from philosophy to objectives to planned learning experiences has fit nicely into the discrepancy evaluation model.

Collaboration has helped give the project breadth and political respectability. People involved have expanded the ownership across campus and into the public schools.

The area that really counts, student performance, has benefited in all dimensions measured. On this basis, the project can be identified as a major success.

IMPLICATION

Both product and process have value for improving teacher education. The model used can be applied broadly to improving methods courses. This will be a primary goal for further funding.

The product, in the form of a science methods course, has already received attention in science education literature. It is expected that the "Users Guide" will be transformed into a methods text.

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