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ABSTRACT

The purpose of this study was to explore the results of an early field experience in the Secondary Science Teacher Preparation Program at Indiana University, Bloomington, where the field based program was located in classrooms using the ISCS program. Some of the questions explored were: Will early experience change the preservice teacher's commitment to science teaching and his attitude toward the teacher preparation program? Will it change the preservice teacher's view of the role and nature of science? Will it change their view of students or affect the preservice teacher's major concerns about his abilities and needs as a teacher and cause the teachers to express a need for a broader science background? The group used consisted of 31 students (primarily sophomores) who were pre- and posttested with the Nature of Science Scale, the Teaching Profession Questionnaire and the World Association Scale. The results indicated that this early experience did not significantly alter commitments to science teaching, but it did significantly change their attitudes toward their education and science coursework, as well as generate increased concern about junior high students and their reading problems. A significant change occurred in the preservice teacher's view of the nature of science away from the theoretical model and a trend toward the broader selection of background in the science fields was indicated. (Author/BR)

The Evaluation of an Early Experience in Science Teaching

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Recently a number of teacher preparation models have been proposed and implemented which include early and continuous field experiences for preservice teachers in various content areas. The purpose of this paper is to describe the early field experience in the Secondary Science Teacher Preparation Program at Indiana University, Bloomington, and to examine some of the data obtained from the first field trial of the program.

In the spring of 1974 the early field experience was offered for the first time at Indiana University as a portion of F200, the first required course in the Secondary Science Teacher Preparation Program. The thirty-one students who enrolled were primarily sophomores, with a few juniors and seniors.

A major goal of the program was to give the preservice teachers the maximum possible experience in working with students. Another goal was to prepare the preservice teachers to assist the teachers in classroom instruction. In view of the typically busy schedule of the classroom teachers, the latter goal must always be of predominant concern in cooperative school/university programs.

The field based program was located in classrooms using the Intermediate Science Curriculum Study (ISCS) program. Two aspects of the ISCS program make it well suited for use in a field based experience. The individualized nature of the program permits a number of preservice teachers to work with individual or small groups of students in a teaching

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role without disrupting the normal classroom operations. Secondly, the level of sophistication of the ISCS curriculum is readily handled by the college sophomores.

In the fall of 1973, three ISCS teachers were selected as adjunct faculty members of Indiana University to plan and teach the early experience course. It was decided that a preparation component would be a necessary step before the preservice teachers would be able to interact meaningfully with the junior high students as they worked in the ISCS program. The course was divided into two components called ISCS Preparation and ISCS Participation. Both components were taught in the secondary school by the ISCS teachers.

The ISCS Preparation component consisted of eighteen hours of instruction designed to aquaint the preservice teachers with the ISCS science content, familiarize them with the ISCS format, and prepare them to use questioning techniques employed by ISCS teachers. Four ISCS Teacher Training Units were used for the instruction: Rationale for Individualization, Questioning, Model Testing and Modifying, and Energy and Systems.

In the ISCS Participation component, the preservice teachers worked with the junior high students under the supervision of one of the Adjunct Faculty members. Each preservice teacher was scheduled into a particular junior high classroom for twenty hours contact. This allowed the preservice teacher to work with the same group of students over a six week interval. Although in general the preparation component preceded the participation component, there were some planned interfaces. The students observed the ISCS classes early in the preparation component in order to visualize the program in action. During the participation component,

several after-school seminars and rap sessions were held in order to give the preservice teachers opportunities to share experiences and to offer constructive criticism of the course.

In order to obtain as complete a picture of the program as possible, a large variety of evaluation techniques were used. Three pretest-posttest measures were taken to examine the effect of the program on the concerns, perceptions, and teaching goals of the preservice teachers. Audio tapes were made to record a sample of the preservice teachers' interactions with the junior high students. A questionnaire about the preservice teacher's role was given to the junior high students. And, finally, recordings were made of the rap sessions.

This paper will be limited to a discussion of the portions of the data obtained in the three pretest-posttest instruments. All three instruments, the Nature of Science Scale, the Teaching Profession Questionnaire, and the Word Association Scale, were administered at the start and at the conclusion of the program. These instruments were designed to explore the following questions:

1. Will the early experience change the preservice teacher's commitment to science teaching and his attitude toward the teacher preparation program?

2. Will the early experience change the preservice teacher's view of the role and nature of science?

3. Will the early experience change the preservice teacher's view of students?

4. Will the early experience cause the preservice teacher to express a need for a broader science background?

5. Will the early experience effect the preservice teacher's major concerns about his abilities and needs as a teacher?

The Nature of Science Scale

The Nature of Science Scale (Kimble, 1968)* is designed to determine an individual's concept of science. It is composed of 29 statements about

*Kimball, Merritt E. "Understanding the Nature of Science: A Comparison of Scientists and Science Teachers," Journal of Research in Science Teaching, 5: 110--120 (1967-1968).

scientists and the scientific enterprise. The respondent is asked to indicate whether he agrees, disagrees, or is uncertain about each statement. The theoretical model of the scientific enterprise used in this instrument was developed through extensive study of the literature on the nature and philosophy of science. The respondent's answers for each item are compared with model responses which are based upon the theoretical model.

It was hypothesized that the early experience in an ISCS classroom might effect the preservice teachers' preceptions of the scientific enterprise. Pretest and posttest measurements were taken in order to determine the direction of the change. The model responses for each item and the precentages of the respondents' answers in each category are presented on Table 1. The instrument is presented in Appendix A.

The posttest responses of the preservice teachers differed from the pretest responses on 23 of the items. Of these 19 were in opposition to the model. Thus, it appears that the general effect of the early field experience in the ISCS classroom was to alter the preservice teachers' concept of the nature of science in a direction opposed to that of the theoretical model.

Each of the statements in the scale relates to one of eight assertions about important characteristics of science. Analysis of the items grouped by the assertions they represent shows that an increased percentage of the preservice teachers disagreed with the following assertions:

1. The fundamental driving force in science is curiosity concerning the physical universe. It has no connection with outcomes, applications, or uses aside from the generation of new knowledge.

2. In the search for knowledge, science is process-oriented; it is dynamic, on-going activity rather than a static accumulation of information.

TABLE 1

Nature of Science Scale: Percentages of Agreement, Disagreement, and Unsure Responses in Pretest and Posttest

Item	Model Response	Pre / Post	Percentage of Respondents: Agree	Disagree	Unsure
1.	D	Pre	57.5	35.0	7.5
		Post	64.3	25.0	10.7
2.	A	Pre	27.5	57.5	15.0
		Post	42.9	39.3	17.9
3.	D	Pre	62.5	20.0	17.5
		Post	78.6	7.1	14.3
4.	D	Pre	65.0	25.0	10.0
		Post	75.0	17.9	7.1
5.	D	Pre	32.5	55.0	12.5
		Post	60.7	32.1	7.1
6.	D	Pre	10.0	80.0	10.0
		Post	25.0	57.1	17.9
7.	D	Pre	72.5	25.0	2.5
		Post	64.3	32.1	3.6
8.	D	Pre	52.5	40.0	7.5
		Post	71.4	21.4	7.1
9.	D	Pre	2.5	50.0	47.5
		Post	7.1	39.3	53.6
10.	A	Pre	10.0	82.5	7.5
		Post	3.6	85.7	10.7
11.	D	Pre	32.5	55.0	12.5
		Post	53.6	35.7	10.7
12.	D	Pre	30.0	55.0	12.5
		Post	53.6	42.9	3.6
13.	D	Pre	50.0	35.0	15.0
		Post	53.4	35.7	10.7

Table 1 (cont.)

14.	D	12.5	62.5	25.0
		32.1	46.4	21.4
15.	D	30.0	45.0	25.0
		39.3	28.6	32.1
16.	A	47.5	45.0	7.5
		32.1	64.3	3.6
17.	D	32.1	50.0	17.5
		42.9	39.3	17.9
18.	D	7.5	67.5	25.0
		3.6	85.7	10.7
19.	A	65.0	20.0	15.0
		67.9	25.0	7.1
20.	D	55.0	27.5	17.5
		60.7	21.4	17.9
21.	D	95.0	0.0	5.0
		100.0	0.0	0.0
22.	A	35.0	40.0	25.0
		46.4	42.3	10.7
23.	D	25.0	52.5	22.5
		35.7	46.4	17.9
24.	D	77.5	7.5	15.0
		89.3	7.1	3.6
25.	D	7.5	82.5	10.0
		7.1	75.0	17.9
26.	D	20.0	65.0	15.0
		39.3	42.9	17.9
27.	A	5.0	85.0	10.0
		0.0	89.3	10.7
28.	D	25.0	60.0	15.0
		42.9	46.4	10.7
29.	D	42.5	35.0	22.5
		53.6	28.6	17.9

3. In dealing with knowledge as it is developed and manipulated, science aims at ever-increasing comprehensiveness and simplification, emphasizing mathematical language as the most precise and simplest means of stating relationships.

4. There is no one "scientific method" as often described in school science textbooks. Rather, there are as many methods of science as there are practitioners.

5. Science has a unique attribute of openness, both openness of mind, allowing for willingness to change opinion in the face of evidence, and openness of the realm of investigation, unlimited by such factors as religion, politics, or geography.

6. Tentativeness and uncertainty mark all of science. Nothing is ever completely proven in science, and recognition of this fact is a guiding consideration of the discipline.

On the other hand, an increased percentage of the preservice teachers agreed with the following assertions:

1. The methods of science are characterized by a few attributes which are more in the realm of values than techniques. Among these traits of science are dependence upon sense experience, insistence on operational definitions, recognition of the arbitrariness of definitions and schemes of classification or organization and the evaluation of scientific work in terms of reproducibility and of usefulness in furthering scientific inquiry.

2. A basic characteristic of science is a faith in the susceptibility of the physical universe to human ordering and understanding.

In general, the preservice teachers tend to agree less with the theoretical model of the scientific enterprise after completion of the ISCS early experience. One possible cause for this trend might be the concept of science held by the ISCS classroom teachers. At a later date, two of the three teachers were tested with the Nature of Science Scale and were also found to be in great disagreement with the theoretical model. Another possible cause for the trend observed in the data is the nature of the ISCS program and the way that it is being implemented in the classrooms. This possible cause has not yet been investigated.

Word Association Scale

The Word Association Scale consists of a sematic differential composed of twelve evaluative word pairs and three word pairs from other

dimensions which were not analyzed. The respondent was asked to use the word pairs to rate five different concepts. The concepts were: ISCS Teachers, Education Coursework for Science Teachers, Science Coursework for Science Teachers, F200 Core Experience, and Junior High Students. A low mean score indicates a negative attitude, a high mean score indicates a positive attitude. Differences between pretest and posttest concept means were tested using a trials by subjects analysis of variance. There was no significant difference in the pretest and posttest scores for the concept ISCS Teachers. Evidently, the ISCS teachers matched the preservice teachers expectations of classroom teachers. The results of the other four comparisons are shown on Tables II, III, IV, and V.

TABLE II

Analysis of Variance Between Pretest and Posttest of the Word Association Scale for the Concept, Education Coursework for Science Teachers

Source of Variation	Mean Square	df	F-Ratio	P	Pretest Mean Score	Posttest Mean Score
Between Tests	853.2	1	7.2	.01	69.0	61.6
Between Subjects	117.8	30				
Error	118.1	30				

Analysis of the preservice teachers' attitudes toward their education coursework, shown in Table II, indicates a significant decrease in positive attitude on the posttest. This has serious implications for the program since one of the initial hypotheses was that an early field experience

would cause an increase in positive attitudes. By examining criticisms from the rap sessions held for the preservice teachers the following points have been identified as possible dimensions of the observed change in attitude: there were frequent transportation problems in commuting to the public schools, a number of scheduling problems arose between college classes and the scheduled classroom visits, the total amount of travel time required was viewed as excessive, the ISCS Teacher Training Modules used in the ISCS Preparation component were viewed as inappropriate or too drawn out. Besides the above aspects of the ISCS Preparation and Participation there is one other dimension which probably contributed to the change in attitude. As stated earlier, the ISCS early experience was only a portion of the F200 course. The preservice teachers were also involved in education class experiences on campus. This portion of the course, called F200 core, consisted of more traditional education experiences such as readings, discussions, and microteaching. The preservice teachers were asked to express their attitude toward this one experience in the Word Association Scale, shown in Table III. Their change in attitude on this item is very similar to the changes shown on Table II. Further research needs to be conducted to determine how much of the variance shown in Table II could be attributed to the F200 core experience.

TABLE III

Analysis of Variance Between Pretest and Posttest of the Word Association Scale for the Concept, F200 Core Experience

Source of Variation	Mean Square	df	F-Ratio	P	Pretest Mean Score	Posttest Mean Score
Between Tests	1246.5	1	7.3	.01	69.5	60.5
Between Subjects	152.2	30				
Error	169.7	30				

A change in attitude was also found in the preservice teachers' attitudes toward the required coursework in science, shown in Table IV. It was hypothesized that an opportunity to observe the level of general science concepts mastered by junior high students would cause the preservice teachers to re-evaluate their science preparation. Analysis of this item in the Word Association Scale indicates a decrease in positive attitude on the posttest. However, interpretation of this change of attitude would be difficult with this item alone. Related items are included in the third evaluation instrument, the Teaching Profession Questionnaire. Interpretations of this change of attitude will be discussed in the section of this paper which describes the analysis of those items.

TABLE IV

Analysis of Variance Between Pretest and Posttest of the Word Association Scale for the Concept, Science Coursework for Science Teachers

Source of Variation	Mean Square	df	F-Ratio	P	Pretest Mean Score	Posttest Mean Score
Between Tests	85.9	1	2.7	.10	69.5	67.1
Between Subjects	85.8	30				
Error	31.4	30				

The final concept on the Word Association Scale was Junior High Students. A significant difference was found at the .001 level of confidence as shown in Table V.

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Analysis of Variance Between Pretest and Posttest of the Word Association Scale for the Concept, Junior High Students

Source of Variation	Mean Square	df	F-Ratio	P	Pretest Mean Score	Posttest Mean Score
Between Tests	339.1	1	12.9	.001	57.7	62.4
Between Subjects	166.2	30				
Error	26.2	30				

Teaching Profession Questionnaire

The Teaching Profession Questionnaire is composed of six items related to the individual's teaching goals, professional concerns, and career preparation. The instrument was validated by administering it twice to fifteen science methods students over a two week period. In this section of this paper each of the questionnaire items will be described and the validation and experimental data will be discussed.

Question 1 asked the preservice teacher to rank his intentions to become a science teacher as very strong, moderate, or very weak. No significant differences were found in the pretest and posttest responses although there was a shift from 21 strong commitments on the pretest to 19 strong commitments on the posttest.

Questions 2 and 3 asked the preservice teachers to indicate their major and minor teaching choices in the science fields. The validation group was completely consistant in their responses to these items. The preservice teachers did not change their major teaching choices but seven

of the 31 did indicate a change of interest in their minor teaching area, moving from unsure to senior high general science categories to the junior high ISCS category. This would correlate with the general change in attitude toward junior high students indicated on the Word Association Scale.

Question 4 was designed to investigate the concerns that the preservice teachers felt about their readiness to te[illegible] question consists of the following thirteen statements of possible concerns:

A. Earning a good recommendation (from supervisors, principals).
B. Dealing with student reading problems.
C. Planning effective lessons.
D. Handling general classroom obedience problems.
E. Writing lesson objectives that will be relevant to students.
F. Being accepted by the other faculty members.
G. Providing adequate feedback to the students.
H. Determining appropriate evaluation techniqdes.
I. Motivating students to participate more in the learning process.
J. Adjusting to the teacher role.
K. Evaluating pupil progress.
L. Meeting individual student needs.
M. Meeting the demands of the school system.

The respondent was instructed to select from the above list those four items which gave him the greatest concern about his role as a teacher. The respondent was also instructed to make a list of those four items which were of the least concern to him. Each item was validated and scored by comparing the consistancy of the pretest and posttest data for each individual in the group. The validation group responses ranged from 100% consistancy between tests to a consistancy of 12 out of the 15 individuals. The data from the preservice teachers was considered of interest if there was a change of 20% or more of the responses. Only two of those items will be described in this paper.

An interesting shift in concern occurred with Item B: Dealing with student reading problems. It was not placed as a major concern on the

pretest by a single preservice teacher, however, a total of six preservice teachers indicated on their posttests that reading problems were of major concern. This is a predictable change of concern since the preservice teachers had the opportunity to work closely with the junior high students as they read the material in the ISCS program.

The second interesting shift in concern occured with Item E: Writing lesson objectives that will be relevant to students. The changes of scores are presented in Table VI.

TABLE VI

Comparison of Pretest and Posttest Scores for Item E in Question 4 of the Teacher Profession Questionnaire

		Pretest Response: Major Concern	
		YES	NO
Posttest Response: Major Concern	YES	10 (32%)	3 (10%)
	NO	9 (29%)	9 (29%)

The areas on Table VI which show changes in concern are the yes-no or no-yes areas. There were three respondents (or 10% of the total group) who indicated on the pretest that relevant objectives were not a major concern, and then changed their attitude to indicate that this item was a major concern on the posttest. Even a larger group (29%) indicated just the opposite change in major concern. Perhaps this change could be reflecting the fact that the preservice teachers viewed the ISCS program as a completed package which the classroom teacher just implements with-

out being required to formulate objectives. However, more research must be done on this topic before any conclusions could be drawn.

Questions 5 and 6 concern the science preparation of the preservice science teacher. Question 5 lists the four major science fields with a series of topics which are often taught as units within each of the fields. The respondent was asked to check each of those topics which might be essential to his own preparation as a science teacher. The question was scored by comparing pretest and posttest data of the number of topics checked outside the individual's specified teaching field. The researcher hypothesized that the posttest data would show that after the early experience, the preservice teachers would express a need for a broader science background by checking more topics from fields outside their major teaching fields. The validation group was consistant in the two administrations of the instrument. Out of the fifteen students in the validation group, five indicated a total of seven fields which they viewed as non-essential to their preparation.

A difference in pretest and posttest scores was found in the hypothesized direction for the preservice teachers as shown in Table VII. On the pretest six of the respondents indicated a total of ten of the fields which they believed to be non-essential to their preparation. On the posttest four people indicated five non-essential fields.

TABLE VII

Teacher Profession Questionnaire, Question 5:
Science Topics Omitted from List of Essential Studies

Test	Topic	Number of Times Omitted
Pretest	Geology	6
	Biology	1
	Physics	3
Posttest	Geology	4
	Biology	1

The trend shown in Question 5 is also found in the data from Question 6 which asked the respondent to indicate in percentages how much of his preparation time should be spent in the various science fields and in education. The validation group gave consistent responses on the item, showing nine of the respondents indicating a total of 16 non-essential fields in the pretest and 15 non-essential fields in the posttest. The data for the preservice teachers is presented in Table VIII.

TABLE VIII

Number of Topics Omitted Entirely on Question 6 of the Teacher Profession Questionnaire

Major Field	Test	Topic	# of times omitted	Total omitted on test	Total # of people who omitted items
Bio. N=21	Pre-	Phys.	4		
		Geol.	8		
		Astro.	7	19	8
	Post-	Phys.	2		
		Chem.	1		
		Geol.	4		
		Astro.	3	10	4
Phy. Sci. N=10	Pre-	Bio.	3		
		Phys.	1		
		Geol.	1		
		Astro.	3	8	4
	Post-	Bio.	1		
		Phys.	1	2	2

The trends shown in Questions 5 and 6 coupled with the significant change in attitude about the required science coursework from the Word Association Scale suggests that the early ISCS field experience may have

had an effect on the preservice teachers attitude toward obtaining a broader science background before entering the teaching profession.

Summary and Questions

The instruments developed and used in this study have in actuallity allowed for the generation of more hypotheses than they have provided answers. This early experience in ISCS classrooms did not significantly alter the preservice teachers' committments to science teaching, however, it did significantly change their attitudes toward their education and science coursework. Trends toward the selection of a broader background in the science fields were indicated but more research is needed in this area.

The significant change in attitude toward junior high students and the change in concern about reading problems were both predictable. There were other changes in concern, however, which have generated hypotheses for further study such as the lessening of concern for the construction of lesson objectives.

Finally, the significant changes in the preservice teachers' view of the nature of science away from the theoretical model must be pursued by further research.

One aspect of this study which remains to be examined is the question of how much of the changes observed in the preservice teachers can be attributed to a general early experience and how much is solely attributed to the contact with the ISCS program. This is a question which also merits further study.

APPENDIX A

Nature of Science Scale

Read each statement and then enter your response on the answer sheet.
The responses are: A = Agree
B = Disagree
C = Not sure

1. The most important scientific ideas have been the result of a systematic process of logical thought.

2. Classification schemes are imposed upon nature by the scientists: they are not inherent in the materials classified.

3. Thanks to the discovery of the scientific method, new discoveries in science have begun to come faster.

4. The primary objective of the working scientists is to improve human welfare.

5. While a scientific hypothesis may have to be altered on the basis of newly discovered data, a physical law is permanent.

6. The scientific investigation of human behavior is useless because it is subject to unconscious bias of the investigator.

7. Science is constantly working toward more detailed and complex knowledge.

8. A fundamental principle of science is that discoveries and research should have some practical applications.

9. While biologists use the deductive approach to a problem, physicists always work inductively.

10. The ultimate goal of all science is to reduce observations and phenomena to a collection of mathematical relationships.

11. The best definition of science would be "an organized body of knowledge."

12. Science tries mainly to develop new machines and processes for the betterment of mankind.

13. Any scientific research broader than a single specialty can only be carried out through the use of a team of researchers from various relevant fields.

14. Investigation of the possibilities of creating life in the laboratory is an invasion of science into areas where it does not belong.

15. Team research is more productive than individual research.

16. Many scientific models are man-made and do not pretend to represent reality.

17. Scientific investigations follow definite approved procedures.

18. Most scientists are reluctant to share their findings with foreigners, being mindful of the problem of national security.

19. The essential test of a scientific theory is its ability to correctly predict future events.

20. When a large number of observations have shown results consistent with a general rule, this generalization is considered to be a universal law of nature.

21. The scientific method follows the five regular steps of defining the problem, gathering data, forming an hypothesis, testing it, and drawing conclusions from it.

22. One of the distinguishing traits of science is that it recognizes its own limitations.

23. The steam engine was one of the earliest and most important developments of modern science.

24. Scientific research should be given credit for producing such things as modern refrigerators, television, and home air-conditioning.

25. If at some future date it is found that electricity does not consist of electrons, today's practices in designing electrical apparatus will have to be discarded.

26. By application of the scientific method, step by step, man can solve almost any problem or answer almost any question in the realm of nature.

27. Scientific method is a myth which is usually read into the story after it has been completed.

28. Scientific work requires a dedication that excludes many aspects of the lives of people in other fields of work.

29. An important characteristic of the scientific enterprise is its emphasis on the practical.