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ABSTRACT

The Paired School Science Project (PSSP) conducted between public and parochial schools was evaluated over a period from 1968-71. A pilot program was carried out among fifth and sixth grade students of 30 schools in the 1967-68 school year. During the study period, these classes of the paired schools were bused to the Franklin Institute for integrated physical-biological science instruction one day a week for seven weeks. Students ate lunch together and then left for their respective schools. The program was extended to a whole day experience beginning in 1970, and a workshop for teachers and principals was added during the last school year. Museum resources and examination of urban environmental problems were emphasized. The student interaction category system, cultural awareness questionnaires, achievement tests, semantic differentials, sociometric studies, and interview techniques were used in evaluation. A parent questionnaire was used in the 1970-71 school year. Analyses showed that significant gain differences existed between the PSSP and the control groups. Parent participation was fairly successful. Sensitivity to environmental problems was enhanced, and student interactions occurred mostly between paired schools from similar geographic locations. Six days of social interaction had little effect on student attitude changes. (CC)

AN EVALUATION OF A MUSEUM SCIENCE EDUCATION PROJECT WITH SOCIAL INTEGRATION AND URBAN ENVIRONMENTAL PROBLEMS AS A FOCUS*

BY

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HISTORY OF THE PAIRED SCHOOL SCIENCE PROJECT

The Paired School Science Project (PSSP) was pilot tested during the 1967-1968 school year. It involved the pairing of both public and parochial elementary schools whose fifth- and/or sixth-grade classes were bused to the Franklin Institute for integrated science instruction. This science enrichment program started out as a mini-course in astronomy using the planetarium lessons as a focus and workshops for the development of materials which were taken to the home school. Pupils from the two schools ate lunch together and then left for their respective schools. There were three eight-week cycles involving some 30 schools during the first year. ESEA Title I supported PSSP with an initial grant of $16,000.

During the 1968-1969 school year, the project continued to be funded under ESEA Title I. The curriculum centered on the physical sciences and the hands-on-experiences of teams of pupils from the paired schools was emphasized in a workshop using an inductive science approach (e.g., see Appendix A). Relevant demonstrations using Museum resources were also presented and the paired schools ate lunch together. During the second year of the project, there were three cycles in which each paired school attended the Franklin Institute for lessons one day a week for seven weeks. This organizational structure was kept the same for the 1969-1970 school year. However, the project was restricted to sixth-grade classes.

With the increased emphasis on environmental education, the project director, Samuel Lepow, decided in the summer of 1970 to expand the program to a whole day experience; previously, pupils attended only a half day. The afternoon was to be used to direct pupil attention to urban environmental problems. The major addition to the program consisted of

field trips to examine and understand urban environmental problems.

An outline of the present organizational structure is presented in Figure 1. Some flexibility has been built in so that pupils can visit exhibits in the Museum.

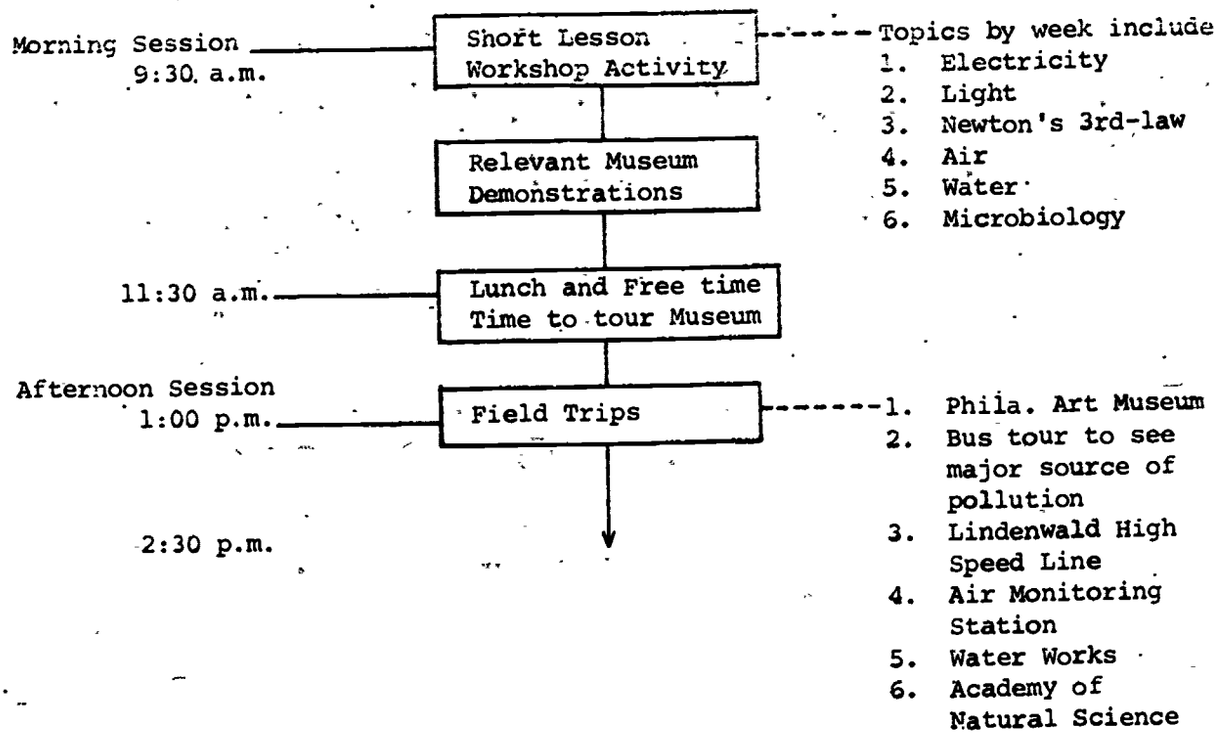

FIGURE I

AN OUTLINE OF THE TYPICAL SCHEDULE FOR ONE DAY IN THE PAIRED SCHOOL SCIENCE PROJECT

In order to facilitate the smooth implementation of each cycle, a workshop followed by a dinner is held for the participating teachers and principals from the paired schools. Teachers and principals are asked to form a circuit using a wire, a battery, and a 1½ volt bulb as part of the workshop. They are also given written materials which summarize the six lessons and a demonstration book to supplement the science instruction at the Franklin Institute back at the home school. This inservice component was added during the current year.

AN EVALUATION MODEL

Before discussing the evaluation of project objectives, a paradigm of the evaluation process (Diamond and Fishman, 1973) will be developed. This model of evaluation can be applied to any stage of the project, including the proposal. This model assumes that the evaluator is an integral component of the project and not an outside agent called in after the fact to make judgments on the achievement of project goals.

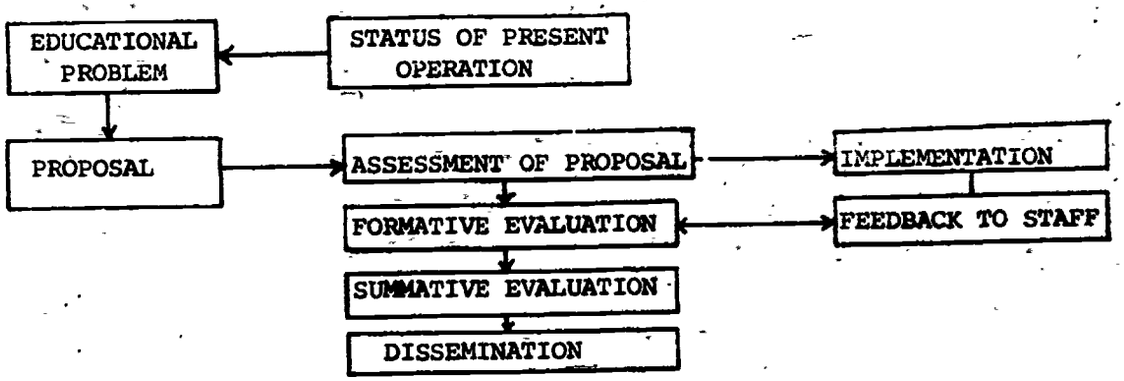

Figure 2

PARADIGM OF THE EVALUATION PROCESS

The evaluator should ideally be involved with the proposal stage of the project. In the proposal, the role of the evaluator can be clearly defined and measurable objectives can be spelled out. If this is not the case, a reassessment of the proposal using monitoring data from feedback loop is necessary to make modifications. Some of the activities which the evaluator should be doing during the formative evaluation include clearer definition of project goals (e.g., behavior objectives), assessment of priorities, progress reports to staff, and proposal revisions.

The formative evaluation may be viewed as a check on the fidelity of the project to its proposal. Discrepancies between the proposal and the project are brought to the attention of the project director.

During the implementation stage, monitoring of the project is conducted to provide a continuous appraisal of progress in meeting objectives and goals, as well as a detailed description of events that impinge upon the project.

In the summative stage, quantifiable measures of the objectives are presented and compared with the baseline data, prior to the implementation of the project. Reports of both the formative and summative evaluations are written up and disseminated.

EVALUATION FINDINGS

During the 1967-1968 school year, three objectives for the project were defined (Solomon and Brown, 1969). Instruments were designed to measure whether significant improvement in intercultural awareness (i.e., predisposition of an individual to associate with pupil from other school), science achievement in astronomy and attitudes toward school had occurred during the eight days at the Franklin Institute.

The three instruments consisted of (1) a cultural awareness questionnaire; (2) a forty question multiple choice achievement test and (3) a semantic differential. A control group design was used in which pupils who did not participate in PSSP were compared with pupils from the same school who did on instruments two and three.

The pupils' names from the other school were the responses which the cultural awareness questionnaire was to illicit. However, 99 percent of the respondents' choices were from the respondents' own class. Thus, the objective of cultural awareness, as operationally defined by the instrument, was not measured. The instrument, or PSSP, or a combination of both, could be factors which led to the lack of the desired responses.

Two alternate forms of the cognitive test of astronomy achievement indicated that those who received the PSSP treatment had significantly higher scores than the control group. Using social class in an ANCOVA as another variable which may have effected achievement, no significance was shown. Thus, socioeconomic status of an individual has little or no effect on his achievement in PSSP.

The results on the semantic differential indicate that pupils' opinions toward the Franklin Institute science and astronomy, were not different from those of the control group. This may have occurred as a result of interaction between the experimental and control groups back at the home school, or to lack of sensitivity of the instrument.

During the 1968-1969 school year, the following two objectives were evaluated (Davidoff, 1970):

1. To promote the understanding of basic concepts of physical sciences including the pupils' ability to:

   a. Recall basic factual information dealing with the principles of matter and energy.

   b. Define basic concepts and give examples.

   c. Understand the concept of energy and its conversions.

2. To develop positive working relationships with paired school classmates of different ethnic backgrounds as evidenced by:

a. Cooperative group work.

b. Sharing of equipment and ideas.

c. Consideration of others.

Two null hypotheses were tested using a Student Interaction Category System and a specially prepared science test.

H_{O_1}: Students will spend the major portion of their time in goal directed activities, as measured by the Student Interaction Analysis Scale (Prototype).

H_{O_2}: There are no significant differences ($p<.05$) in science achievement between students who participate in the Paired School Science Project and control groups as measured by a locally produced Science Achievement Test.

Since the Student Interaction Category System (Davidoff, 1969) was a protype instrument, any conclusions drawn from the instrument are tentative. Null hypothesis one was rejected at the .01 level, indicating that there was a significant percentage of goal-oriented behavior as compared with goal-disruptive behavior. The ratio of goal-oriented behaviors to goal-disruptive behaviors was 6.5 to 1.

It appears that PSSP does provide the type of environment suggested by Allport (1954) for reducing prejudice by establishing equal status contacts between pupils of differing ethnic background in the pursuit of common goals in the science lesson.

Null hypothesis two was rejected for both the public and non-public schools at the .01 level, indicating that the PSSP experimental group learned more science than the control group. Using ANOVA with blocking on pretest science scores, the statistics indicated that children

gained, according to their initial knowledge level.

The design evaluating the cognitive objective, H_{O_2}, was kept the same for the 1969-1970 evaluation. A new instrument, Three American Twins on A Bus (Davidoff 1970, and Singer, 1966) was developed to measure objective two. However, due to its experimental nature, no conclusions were made on the obtainment of objective two. This instrument has been revised and will be mentioned in the review of the 1971-1972 findings.

The findings on the cognitive objective replicated the previous two year's results in that H_{O_2} was rejected. In a sense, one would expect children who receive the special Franklin Institute science lessons to have higher scores on the science measure than those who did not. The findings in the third year may be more generalizable in that random selection procedures were used in selecting the schools and classes which attended the Institute. Some confounding of the treatment between the experimental and control high pretest group appears to have occurred because of the significant gains made by the control group. This may have resulted from the sharing of materials and lessons back at the home school.

During the 1970-1971 school year, the research centered on answering two questions.

1. Has PSSP provided the conditions that are considered prerequisite for the attainment of its objectives?

2. Have PSSP pupils demonstrated knowledge and understanding of basic concepts of physical science?

Monitoring data, as presented in Table 1, indicated that question one could be answered in the affirmative. Systematic monitoring indicated consistent results; appropriate materials had been available and used;

instructors had been fulfilling their specified roles appropriately; and pupils had been attentive during the PSSP activities.

INSERT TABLE 1

The test results, using form A of the science test as posttest, indicated that significant gains occurred over the previous two year's nonparticipant comparison group's mean of 13.8.

During the 1970-1971 evaluation of PSSP, a cluster of School community related projects were evaluated, using a parent questionnaire, asking parents to identify projects they knew and/or participated in their child's school. PSSP ranked second (N=1698, 71%) among ten projects for accurate knowledge about the existence of the project in the school. Of the 72 parent responses to: Do you participate in the project, 11% indicated that they had. Bussing and the size of the project appear to be factors which contributed to the high level of accurate knowledge about the existence of the project in their child's school.

The evaluator, during the 1971-1972 school year, asked the same two questions as during the previous year. However, two additional questions were added:

3. Have changes in the PSSP program been implemented?

4. Has a reduction in social isolation occurred as a result of the pairing of schools with pupils from different ethnic backgrounds?

The data collected through systematic monitoring of PSSP indicated that the morning prerequisite activities and conditions were present for achieving objective 1. This data is presented in Table 1.

Due to the addition and dropping of workshop lessons and the field trip program, a revision of the science achievement test was undertaken. After developing an item pool of some 60 items, two tests, similar in context, were designed. To reduce reading dependency, pictures were used when appropriate. Form A and B of the Franklin Institute Science Quiz were administered as alternate forms to be used in a pre-posttest design.

A t test of the difference between the pretest and the posttest scores indicated that a significant gain was made by PSSP pupils. The results of this analysis are presented in Table 2.

INSERT TABLE 2

The next question to be investigated was whether the proposal modification had been implemented. Were the field trips dealing with environmental education implemented? Monitoring data to answer this question are summarized in Table 3. Failure to achieve all the desired conditions indicated some difficulty in modifying PSSP to add an environmental education component. Parent participation in the program was fairly successful and the field trips did occur, as planned. However, the communication of a problem orientation to the field trip was not consistently present and the ecological considerations of the problems of the urban environment were not incorporated into the lessons. Sensitivity to the urban environmental problems may have been the most meaningful outcome of these field trips, as measured by the test and pupil interviews.

INSERT TABLE 3

In answering question four, as to whether a reduction in social isolation had occurred in PSSP, a sociometric study was undertaken using two approaches: (1) direct observation, and (2) a paper and pencil instrument.

The direct observations involved observing whether a pupil talked to a classmate from same school or other. From tallies, a percentage of time talking to members from the other school was calculated. The results are presented in Table 4.

INSERT TABLE 4

Once the strangeness of the new situation wore off, pupils interacted with pupils from either school on an approximately equal basis. However, at the end of the cycle, pupil interaction between schools was reduced to the level found at the beginning of the cycle, except for schools two and three. This pairing of schools (i.e., C and D) which had the best interactions, was a nonpublic with a public school from the same geographic local in the city. A similar observation had been made in the 1967-1968 evaluation. Thus, a higher priority should be given to pairing of schools from similar geographic locations if the integration objective can also be fulfilled.

The paper and pencil instrument was developed from the Three American Twins on a Bus sociometric instrument (Davidoff, 1970) and was entitled Six American Twins on a Bus. Boy and girl twins of the black, Spanish speaking, and white communities are pictured as going on a field

trip on a school bus. Pupils are asked who they would like to do various activities with (association), who they perceived as being well behaved (nonaggressive), and who they perceived as achieving success in school (achievement). Results of the instrument in a pre-to posttest design indicate little change of perceptions on the three scales by the three races (see Table 5).

INSERT TABLE 5

Tentative conclusions suggest that six days of social interaction had little effect on the attitudes and feelings which go into choosing a friend (association), viewing exemplary behavior (nonaggression) and seeing fellow pupils as successful in school (achievement).

In summarizing the findings on the social goals of PSSP, one can say that meaningful interactions between pupils from different ethnic backgrounds are occurring. The equal status contacts between pupils, directed to accomplishing certain goals, (e.g., lighting a light bulb) is a facilitator. However, measurable attitude changes do not appear to be a result of the six days of social interaction.

The cognitive goals of learning more science are being achieved by PSSP. Test results indicate that the concepts of the physical and biological sciences are being communicated.

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TABLE 1

SUMMARY OF OBSERVATIONS MADE DURING 21 VISITS MADE IN 1971 AND 37 VISITS MADE IN 1972 TO PSSP

Desired Condition	Number of Observation Visits					
	Condition Present		Condition Lacking		Condition not Appropriate during Observation	
	1971	1972	1971	1972	1971	1972
1. Scheduled topic was being discussed	20	33	0	0	1	4
2. Science materials were available	20	23	0	0	1	14
3. Pupils were constructing or working with science materials	20	13	0	9	1	15
4. Pupils used materials to solve problems	20	22	0	1	1	14
5. Oral instruction at pupils' level	18	24	0	1	3	12
6. There was a demonstration related to the topic of the day	13	20	2	2	6	15
7. Pupils were attentive to the demonstration	9	16	2	2	10	19

TABLE 2

ANALYSIS OF PUPIL COGNITIVE SCORES ON FORMS A AND B
OF THE FRANKLIN INSTITUTE SCIENCE QUIZ

Testing Period	Pretest	Posttest
N	320	321
Mean	11.88	14.24
S.D.	3.97	4.89
Mean difference	2.36	
t value	6.94	
P	.01	

TABLE 3

SUMMARY OF CHANGES IN PSSP OBSERVED DURING 37 VISITS

Desired Condition	Number of Observation Visits		
	Condition Present	Condition Lacking	Condition not Appropriate during Observation
1. Parents present.	15	20	2
2. Scheduled field trip.	12	0	25
3. Alternate seating on bus.	2	5	30
4. Problem solving orientation to field trip.	4	6	27
5. Pupils attentive during field trip.	9	1	27
6. Pupils thought the field trip was educational.	7	1	29
7. Ecology was one topic mentioned.	11	10	16

TABLE 4

PSSP SOCIOMETRIC INTERACTIONS

School	Percent of Interaction of Pupils from other School (20 Minute Time Intervals)				
	Time 1	Time 2	Time 3	Time 4	Time 5
School A and School B	35%	46%	NOT OBSERVED	NOT OBSERVED	38%
School C and School D	35%	NOT OBSERVED	70%	56%	75%
School E and School F	39%	42%	43%	*	39%

*Too few cases to calculate a meaningful percentage.

TABLE 5

ANALYSIS OF ATTITUDE CHANGE USING THE INSTRUMENT "SIX AMERICAN TWINS ON A BUS" AS A PRETEST AND POSTTEST

Scales		Pretest Mean	Posttest Mean
Achievement	Black	4.45	4.88
	Puerto Rican	6.29	6.17
	White	4.61	5.00
Nonaggression	Black	7.35	7.32
	Puerto Rican	5.59	4.76
	White	5.31	5.72
Achievement	Black	5.50	5.25
	Puerto Rican	6.06	6.82
	White	5.76	5.80
Overall	Black	17.30	17.45
	Puerto Rican	17.94	17.76
	White	15.68	16.52

APPENDIX A

ACTION AND REACTION

A LESSON ON NEWTON'S THIRD LAW

Main Idea	Approach	Behavioral Objective	Ways of finding out if idea has been learned
Action and reaction in a rocket.	Long balloon "rockets" across room on a string.	Students should be able to state where force is applied to the balloon.	Draw diagram of balloon on chalkboard; see if students can draw force arrow in proper location.
Introducing an action and reaction cart.	Instructor shows students an assembled cart. (Made from an 8" length of 2x4 lumber, Tinkertoy wheels and axles, 4 staples to hold the axles in place, 3 nails, 1 rubberband, 1 - 6" piece of string.)		
	Students are asked to make predictions before instructor demonstrates operation of cart. ("Which will go farther, the block or the cart?")	Students should be able to use previous experience to make appropriate predictions.	Tabulate predictions of students.
Constructing an action and reaction cart.	Each student assembles a cart and prepares it for operation.	Students should be able to construct their own cart, using completed cart as a model.	Student's cart should closely resemble model.
Experimenting with an action and reaction cart.	Students set up the cart and block, release the rubber band by burning the string, and measure the distances that the block moved (action) and the cart moved (reaction) from the starting point.	Students should be able to measure accurately and convert measurements to inches.	Instructor observes student making measurements.
	Students repeat the experiment at least twice, again taking measurements.	Students should be able to determine an average from three trials.	Instructor checks on student's computations.

Main Idea	Approach	Behavioral Objective	Ways of finding out if idea has been learned
Newton's Third Law of Motion.	Students' observations are summarized by the instructor. (Idea of experimental error entering into observations is introduced.)	Students should be able to propose various hypotheses as to why there are differences between student results.	"Why didn't the cart and block go the same distances each time?"
	Means are computed on student data.	Students should understand how averaging of data may help to reduce experimental error.	
	Applying Newton's 3rd Law, Action = Reaction or Wt. x Dist. of block = Wt. x Dist. of cart (under ideal conditions)		
	Substitute average weights and distances in the equation and determine how "equal" the results are.	Students should be able to suggest what causes variations from ideal conditions (mostly friction).	Where is the most friction: the flying block or the rolling cart?
Optional Activity Making predictions using Newton's Third Law	Set up two carts so that one cart will provide the action and the other cart the reaction when the rubberband is released. See illustration.	Students should be able to predict that each cart should travel approximately the same distance.	Tabulate predictions of students.