AN EVALUTION OF THE REGIONAL ENVIRONMENTAL EDUCATION PROGRAM MIDDLE SCHOOL & HIGH SCHOOL CURRICULUM

A Project of The Schuylkill Center for Environmental Education

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RESEARCH FOR ACTION
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The Regional Environmental Education Program (REEP) is a kindergarten through grade 12 environmental education curriculum written, field-tested and revised by teachers. Administered by The Schuylkill Center for Environmental Education (SCEE), this twelve year initiative has involved more than 3,000 teachers and $1.5 million dollars in an effort to develop a classroom-based, hands-on, sequential curriculum linking environmental issues with their underlying ecological concepts. In addition to awareness experiences and concept-building exercises, each unit contains problem-solving applications and personal student action components.

The seven-unit elementary curriculum (one per grade kindergarten through grade 6) has been formally evaluated, revised, reviewed for technical/pedagogical accuracy and is currently being prepared for national publication.

This summary/report presents the major findings and recommendations from an evaluation study, conducted by Research for Action, of the middle and high school curriculum (eight units, one each for middle school life, earth and physical science courses, plus high school biology, chemistry, environmental science, social studies and physics/technology education courses).

The formal evaluation of the middle and high school curriculum focused on the 1995-1996 school year. 44 teachers from 18 public and non-public schools in Pennsylvania and New Jersey were chosen to provide a diversity of circumstances (rural, urban and suburban schools, with students in both heterogeneous and homogeneous groupings from all levels of the academic scale – educationally challenged to gifted).

Teachers participated in workshops in the summer of 1995 to prepare to teach the curriculum, taught it during the school year, and reconvened in the summer of 1996 to work collaboratively on suggestions for revisions. Like the elementary component, these secondary materials will undergo further revision, editing and critical review prior to publication.

Two broad research questions inform the study:

1. What happens when teachers implement the REEP curriculum in their classrooms? What does the curriculum look like across different classrooms and with different populations? What is the range of students' responses to the curriculum? What do students learn? What is the evidence of student learning?

2. How do teachers evaluate their involvement with REEP? What are teachers' perspectives on the curriculum? Does it do what it sets out to do? How do they assess the summer workshops and other interactions with The Schuylkill Center?

Methodologies included observations at summer workshops, a teacher focus group, classroom observations, teacher and student interviews, surveys and pre/post-testing of curriculum content.

This qualitative and quantitative study found that, across school settings, the REEP curriculum successfully increased students' knowledge about environmental concepts and problems; engaged students through hands-on learning and by connecting science to issues in their everyday lives; and moved many students to assess what values they and society assign to the environment and, in some cases, to change their actions with regard to the environment. The study also brings into sharper focus issues of assessment, pedagogy and professional development as they relate to the revision and future use of the curriculum.

Major findings are identified by Roman numerals with subfindings bulleted. Recommendations (in italics) conclude each section..

I. The REEP curriculum was able to engage students, build students' knowledge, and help students make connections between science and their lives in a wide range of contexts, including in urban and suburban, public and parochial schools and in tracked classes of different levels as well as in heterogeneous groupings. At the same time, issues of economic equity sometimes affected implementation of REEP.

- Across the board, students participating in REEP demonstrated increased knowledge and understanding of the environmental topic they studied.
- Students with a range of pre-existing knowledge about and experience with the environment were engaged by and learned from REEP.
- Testimony of students and teachers indicates that most kids liked REEP, especially hands-on activities, experiments and outside work. Some teachers noted that REEP tended to promote greater involvement and interest among students formerly uninterested in science.
- Students in a range of settings stated that REEP connected better with their lives and concerns than did other science classe.
- Despite REEP's ability to engage and teach students in such varied settings, inequitable resources (e.g. access to laboratory equipment, library resources, fieldtrip sites) across settings sometimes affected teachers' work with REEP, making its use more challenging at poorer, often urban schools.

Recommendations: Provide support for teachers at schools with fewer resources, e.g. by making alternate experiments available or enlisting experienced REEP teachers as resource people. Support teachers facing stumbling blocks to taking students out for fieldwork by finding appropriate sites or addressing the material in other ways.

II. Teachers' beliefs about teaching, their usual approaches to teaching, and their teaching contexts influenced their perspectives on the curriculum, how they taught it and what changes they wanted to make. The data also indicate that teaching REEP shifted some teachers' perspectives on student-centered teaching.

- Teachers' pre-existing styles and beliefs influenced what the curriculum looked like in their classrooms; teachers more familiar with problem-posing and hands-on approaches tended to make the curriculum look more that way than those accustomed to more traditional, teacher-centered teaching.

- How teachers assessed student learning in REEP also was affected by their beliefs, practices and contexts. For example, teachers accustomed to evaluating mainly with tests sometimes had difficulty assessing REEP projects and group work.
- Because of the range of beliefs and practices teachers brought to REEP and their school contexts, they sometimes came down on opposite sides of a variety of REEP pedagogical and curricular issues (e.g. the balance of lecture and experiential learning in the curriculum).
- Though teachers whose philosophy and practices were more consonant with the REEP approach tended to make the curriculum look more student-centered, there is some evidence that involvement in REEP shifted some of the more traditional teachers' beliefs about teaching. Such teachers planned to use approaches like cooperative learning and student discussion more often as a result of REEP.

Recommendations: SCEE can make a choice about whether to focus its work more narrowly on the curriculum or more broadly by also using the curriculum to address larger issues of pedagogy and assessment in environmental education. Such work would involve training and professional development focused on assessment and pedagogy. SCEE could draw on assessments already created by teachers to provide sample quizzes and tests and also to model and explain alternative or holistic assessment.
Although SCEE can not gear one curriculum to all students and contexts, it can make REEP as accessible and useful as possible to teachers working with a wide range of students by providing resources to adapt and supplement the curriculum for higher and lower level learners and by providing more information about approaches like collaborative learning or alternative assessment..

III. Data show that the vast majority of teachers involved in the study plan to use REEP in the future. They differ, however, about whether they will use it as a whole or by inserting discrete REEP sections and activities throughout the year. This range of possibilities raises questions about how the piloting teachers see REEP -- as a curriculum, discrete lessons, or a framework -- and about how it will be used in the future.

Recommendation: SCEE needs to clarify its own priorities with regard to the use of the curriculum, in the light of evidence showing that teachers plan to use it in a range of ways.. SCEE's decisions will shape revising the curriculum, marketing the curriculum, and using it in professional development.

IV. Across different settings, student levels, and REEP units, there was consensus among teachers that REEP facilitated increased knowledge about the environment, increased awareness of the value of the environment and some degree of changed actions among their students. Though SCEE originally conceived of the values and action components as focused on culminating activities at the end of each unit, the data shows that in practice values and action arose in classrooms at many other points of the curriculum as well.

Recommendation: Given some teachers' plans to use pieces of the curriculum, rather than the whole, and the evidence that awareness of and changes in values and actions are not just stimulated by the last lessons of the units, it seems important to integrate values and actions even more thoroughly throughout the curriculum. This might involve highlighting places in earlier lessons where questions of values or possibilities for actions already arise

as well as adding ideas and exercises in earlier lessons.

V. Teachers' most commonly cited goals for their involvement with REEP -- working with a new curriculum and more environmentally informed students -- were also among the most frequent outcomes of the project. REEP was also successful in enabling teachers to become more informed about environmental topics. At the same time, goals with implications for broader change in schools' curricula and commitment to environmental education proved more challenging to achieve.

Recommendation: REEP has the potential to serve as a more effective catalyst toward goals of teacher networking, school change related to environmental education and making science more interdisciplinary, should SCEE decide to adopt these emphases. Developing a teacher network of environmental education teachers would be one way to further these goals.

INTRODUCTION

In 1978 the Pennsylvania Board of Education adopted "Environment" as one of its 12 "Goals of Quality Education" and environmental education was mandated for all students in the Commonwealth. At the same time, though activity packets were available, there was a dearth of environmental education curricula. In response to this situation, The Schuylkill Center for Environmental Education (SCEE) began developing the Regional Environmental Education Program (REEP) in 1983. REEP is a kindergarten through 12th grade environmental education curriculum,[1] written, field-tested and revised by teachers with the oversight of Schuylkill Center staff. During 1992-1994 the elementary curriculum was formally evaluated by teachers and an independent evaluator. It is currently being revised, reviewed by a panel of science experts and prepared for national publication. This report is part of the formal evaluation process for the eight middle and high school curricular units as SCEE moves these towards publication.[2]

All REEP units include what SCEE identifies as "the four components of environmental education -- awareness, ecological understanding, values and personal student action" (SCEE, REEP information sheet). Each of the units is built around one of four ecological concepts -- communities, adaptations, energy, and cycles -- and focussed on a particular environmental problem related to that concept. For example, the high school biology curriculum looks at the concept of adaptation and the problem of endangered species and habitat destruction in wetlands. Each uses a variety of teaching/learning strategies, including lecture, experiential, hands-on, outdoor/field studies, and lab experiments; many activities emphasize small groups and cooperative learning.

The formal evaluation of the middle and high school REEP curriculum focuses on the 1995-1996 school year. Teachers participated in workshops in the summer of 1995 to prepare to teach the curriculum, taught it during the school year, and reconvened in the summer of 1996 to work collaboratively on revising their curriculum. Like the elementary curriculum, these units will be further revised, edited and critically reviewed before publication.

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[1] SCEE describes REEP as a single curriculum with 15 individual units (kindergarten through high school). This report also sometimes refers to a unit as a curriculum as in the high school environmental science curriculum.

[2] The eight units are middle school/junior high school life science, physical science and earth science and high school biology, environmental science, social studies, chemistry, and physics/technology education.

METHODOLOGY

This study examines the 1995-96 piloting of the REEP curriculum by teachers from a range of schools and disciplines. Two broad research questions inform the study:

1) What happens when teachers implement the REEP curriculum in their classrooms? What does the curriculum look like across different classrooms and with different populations? What is the range of students' responses to the curriculum? What do students learn? What is the evidence of student learning?

2) How do teachers evaluate their involvement with REEP? What are teachers' perspectives on the curriculum? Does it do what it sets out to do? How do they assess the summer workshops and other interactions with The Schuylkill Center?

We took a two-tiered approach to collecting data about REEP. Most or all participants were involved in some of the data collection, e.g. teacher surveys, observations and discussions at 1995 and 1996 summer workshops, student pre- and post-tests, teacher and student writing on REEP's value and action components, and analysis of two-thirds of the teacher journals.[3] More intensive data collection took place in nine case study classrooms, including a fall focus group for teachers of those classrooms, observations in those settings, as well as interviews with the teacher and with a group of six to eight students. This fieldwork took place during the time teachers were using the unit. This data collection strategy aimed to provide a deeper and more contextualized understanding of how participants use and respond to the curriculum and how its use is shaped by different settings. Teachers were selected to participate in this phase of the research according to these criteria: to collect data about all 8 REEP units, as well as about the different types of schools (public, parochial), school settings (urban, suburban) and student levels (accelerated, average, lower track, heterogeneous) represented in the study group. Students were chosen for focus group interviews to represent the range of interest in science, achievement levels, gender and race present in the class. (See the appendices for interview and observation guidelines and focus group protocol.)

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[3] Forty-four teachers completed the initial workshops; thirty-six are on the final list of participants. Of the eight who dropped out during the year, one left teaching altogether. At least three transferred to different schools and could not teach REEP in their new settings. Four did not remain in communication with SCEE. Thirty teachers submitted pre- and post-tests for their students. Twenty-five teachers gave SCEE their teacher journals; we analyzed selected portions of seventeen journals, distributed across the REEP curriculum. Twenty-eight attended the final series of workshops. Because of somewhat shifting attendance, we collected twenty-five evaluations of the workshops and twenty-four surveys.

The next section of this report describes the methodology and findings of the quantitative portion of the study. The final section sets out the major findings of the study and the related recommendations.

QUANTITATIVE RESULTS

PURPOSE: The purpose of the quantitative analysis was to determine if there was significantly greater gain in knowledge from pretest to posttest of students receiving the REEP curriculum versus control subjects who did not receive the REEP curriculum. Final posttest scores of students exposed to the REEP curriculum were compared with those students in the control group to determine if students in the REEP curriculum performed significantly higher.

SAMPLE: Sample data was collected from 32 teachers (including REEP and volunteer control teachers). A total of 1484 REEP unit tests were received of which 952 were actually used in the final analysis. Subjects were deleted from the final analysis due to incomplete pairs of pre- and posttest unit results, procedural problems in the administration and scoring of the unit tests, or reports by teachers of major variations that occurred in the implementation of the REEP units.

The sample included both students that received the REEP units (n= 756 students) and control students who did not receive the REEP curriculum (n = 196 students). An attempt was made to assure that the control groups were similar to the REEP groups by selecting control classes within the same schools that were similar in general achievement levels to the REEP groups. Percentages of students distributed across the 5 general achievement levels (Accelerated, High, Middle, Low, and Mixed) for both the REEP and the control groups are presented in Table 1 and Figure 1 and 2. The control sample did not include any students classified in the "Accelerated" category; however, it did include a higher percentage (as compared to the REEP sample) of "High" and "Middle" level students and a much lower percentage of "Low" and "Mixed" achievement level students. Descriptive characteristics of the sample are presented in Table 2.

UNIT TESTS: Each of the 8 units utilized a unit evaluation test that assessed student knowledge as it related to the information contained in the units. The tests were designed by teachers/developers of the units. Items retained (both objective and open-ended questions) for the final versions of the tests were based on teachers'/developers' agreement that the items appropriately sampled content knowledge from the REEP units. In addition, a set of standardized scoring procedures were developed for each of the eight unit tests.

The tests were used to generate pretest and posttest data from the student samples and

were scored by REEP teachers. Students were also asked to rank their interest level in science on a scale from 1 to 5 where 1 was "very disinterested" and 5 was "very interested". Table 2 presents how students "Interest Level in Science" was distributed across the 5 categories. A majority of the sample was "Somewhat Disinterested" in science (41.8%) with only 10% of the sample interested in science. Interest may have some impact on attention and motivation to learn; however, no quantitative data was collected on student perceptions of how interesting the REEP materials were to the students.

In addition to the unit test data, information was collected from a teacher questionnaire. The following data was collected: 1) classification by teachers about the general achievement level of the class (Accelerated, High, Middle, Low, and Mixed), 2) grade level, and 3) whether the class was a control class or REEP class (see Table 2 for frequency counts and percentages). In addition, teachers were asked to indicate when they started and completed the REEP unit, if there were any special circumstances that may have affected testing, and if they modified or substantially changed any of the components of the REEP unit. Responses to these questions were used to determine if a class was excluded from the analysis due to problems in implementing the REEP units or in following, appropriately, the testing procedures, i.e., one teacher noted the test was given on the last day of school to seniors which resulted in a less than serious approach to taking the test.

PROCEDURES: Teachers were asked to administer the unit tests prior to and after teaching the REEP units. REEP teachers were asked to score both the REEP and control class tests using the scoring key. Unit test results along with the teacher questionnaire were returned to the program evaluator.

RESULTS:

- **Was there significant gain from pretest to posttest for the REEP and control groups?**

To determine whether there were statistically significant pretest to posttest gains, a paired sample t-tests were performed for both the REEP and control groups. The results indicate that the REEP treatment groups showed statistically significant gain from pretest to posttest on all of the 8 unit tests ($p < .001$), while none of the control groups significantly gained from pretest to posttest ($p > .05$, nonsignificant-ns). Table 3 presents the means, standard deviations and t-test results. Figures 3 to 5 present graphs of pretest and posttest means for those units that had matching control groups. Figures 7 to 10 present graphs of means for units that did not have matching control groups.

- **Did the REEP group perform significantly better than the Control group on the posttest?**

An Analysis of Covariance (ANCOVA) was performed to test whether or not there was a significant posttest difference between the REEP and control groups. The ANCOVA was used to not only assess whether there was a significant difference between the two groups on the posttest, but it also checked to see if inequalities in the initial pretest performance of the groups could have contributed more to the differences than the REEP curriculum. The results of the ANCOVA are presented in Table 4 and Figure 11. These results show that the 4 REEP groups that had matching control groups (Physical Science, Earth Science, Environmental Science and Chemistry) scored significantly higher ($p < .001$) on the posttest than the control groups, even when the posttest means were adjusted to take into account initial differences in pretest performance.

- **Were the changes from pretest to posttest educationally significant?**

Although statistical significance represents a good indicator of what we might expect to occur in the population, it does not always suggest whether the changes were of significant educational importance, i.e., did the students, overall, meet educational standards or criteria for acceptable performance. If we agree that the criterion for acceptable performance on most classroom tests is above 60% of the total test score, then we could use this criterion to decide on whether the gains from pretest to posttest were educationally significant.

Overall averages on the pretests in the REEP groups indicate performance at or below the 60% cutoff criterion of acceptable performance. This suggests that all of the REEP groups started out at below acceptable performance levels. Students in 6 out of the 8 units scored above the 60% criterion on the posttests (range 66% - 80%). The Physics and Biology groups were the only two groups that did not meet acceptable levels of performance on the posttest. In the Physics group, the substandard performance is likely due to three problems: 1) the excessively high standard deviation (SD = 18.10), 2) small sample size (n=19), and 3) a mixed but not balanced achievement level group The Biology sample was made up of primarily low achieving students; therefore resulting in less than acceptable performance (the overall mean on the posttest represented only 29% on the test.). See Table 5 for the percent correct on each of the REEP units on the pretests and posttests.

- **What effect did general achievement levels of the students have on the results?**

Teachers were asked to classify their classes into one of the 5 general achievement levels: 1. Accelerated Level, 2. High Level, 3. Middle Level, 4. Low Level, and 5. Mixed Level.

Tables 6 and 7 provides the overall means (means are computed from data across all units) for both the pretest and posttest scores across the 5 achievement level categories for both the REEP and control samples. Visual inspection of the REEP group means suggests that all achievement level groups gained from pretest to posttest (see Table 6). Overall, the highest percentage gain from pretest to posttest was in the Middle, Low, and Mixed groups (with the exception the REEP biology-low level group and physics-mixed level group), while the Accelerated and High groups had a lower percentage gain. The Control group means, as expected showed little gain from pretest to posttest for each of the 5 achievement level groups (see Table 7)

CONCLUSIONS:

- The REEP sample consistently showed significant gains from pretest to posttest on all the units, while the Control sample consistently showed no significant change from pretest to posttest on all the units. Visual inspection of the data also suggests that even low achieving students benefited significantly from the program.
- The REEP group showed significantly better performance than the control group on unit posttests, with greater variability in performance in the middle, low, and heterogeneously grouped (mixed) students.
- The educational benefits of the REEP units occurred across most of the units with the exception of biology and physics. Most of the groups exceeded acceptable levels of performance on the posttests based on what is considered acceptable classroom test performance.

OVERALL FINDINGS AND RECOMMENDATIONS

Finding 1: The REEP curriculum was able to engage students, build students' knowledge, and help students make connections between science and their lives in a wide range of contexts, including in urban and suburban, public and parochial schools and in tracked classes of different levels as well as in heterogeneous groupings. At the same time, issues of economic equity sometimes affected implementation of REEP, raising particular challenges for teachers at poorer, often urban schools.

Across the board, students participating in REEP demonstrated increased knowledge and understanding of the environmental topic they studied. As discussed above, the quantitative data indicate that the REEP sample (in contrast to the control sample) consistently showed significant gains from pre-test to post-test. The REEP students also performed significantly better than the control group on the post-test. Teacher reports further corroborate this finding. Almost all teachers reported that their students gained information (23 out of 24) and an understanding of the concepts underlying environmental issues (21 of 24) from REEP (July 1996 survey).

Students with a range of pre-existing knowledge about and experience with the environment were engaged by and learned from REEP. Most students indicated that through REEP they had gained a solid understanding of the scientific concepts behind environmental topics. This was true even when students had prior experience with environmental work or study. For example, one environmental science class included the president and vice-president of the school's environmental club. Unlike their fellow students, they had heard of the topic of acid rain, but as one said, "I didn't know it happened all the time or understand about pH" (interview, 10/30/95)" Two members of a ninth grade environmental science class had had exposure to environmental topics in elementary or middle school, one because she was the ecology commissioner of her school and the other because a teacher was a "real environmentalist" (interview, 3/28/96). But they felt that in REEP they had learned new things or understood them better.

Even when the topic was a relatively familiar one like recycling, students still reported liking and learning from the curriculum. Before studying it, many students thought they were already very familiar with recycling. But as one teacher explained in the summer workshop, such students didn't necessarily have a deep understanding of the processes, scientific concepts or vocabulary related to the topic. He cited the example of spi codes and which plastics can be recycled and noted that by the end of the curriculum, most students understood the codes and

concepts (fieldnotes, 7/10/96). A student in another class explained his new knowledge this way: "instead of just separating the stuff -- plastic from glass -- and throwing it on the curb, you understand why you separate it" (interview, 11/7/95).

Many students had little previous experience with or knowledge about environmental issues and most didn't know much about the topic of their curriculum. In fact, only 10% of students in the quantitative sample rated themselves as interested in science generally, with about 60% calling themselves somewhat or very disinterested. Students in one biology class had never heard of wetlands before. One student said, "Everybody's parents say don't run the water, but people don't tell you what would happen if you exterminate wetlands" (interview, 5/14/96). Though told not to waste water, this student had little sense of why this was a problem or how to address it. Despite this lack of prior knowledge about and interest in science and the environment, the majority of students became engaged with and often concerned about the topic of their curriculum. As one student in an earth science class studying solid waste said, "First I thought it would be really stupid. What's the point about trash? But then I sort of got into it a little bit more....we learn stuff that I wouldn't have learned anywhere else" (interview, 11/7/95).

Testimony of students and teachers indicates that most kids liked REEP, especially hands-on activities, experiments and outside work. Some teachers noted that REEP tended to promote greater involvement and interest among students formerly uninterested in science. In focus group interviews with students, they again and again showed the greatest enthusiasm in talking about outside fieldwork and the more dramatic inside experiments and activities. When asked what they would change about the curriculum, a number of students suggested going outside more, even if they had little idea of what they would do once there or how this would connect to the curriculum's topic. Many students found REEP more interesting than other science classes they had had. Several noted that having more activities helped them learn and remember better. In one interview, four students had the following interchange:

Student 1 I like it because I don't just have to take notes, do some work and answer questions that seem kind of easy.
Student 2 Everybody's involved. It's like the whole class is part of it. It's not like you have to sit there and take notes off the board...It's like a whole big group involved.
Student 3 It's more like a chat hour than a lecture.
Student 4 But you still learn.

These students contrast REEP to other classes, concluding that it moves beyond taking notes to more active involvement of more people, not just in activities but also in classroom talk. They compare the classroom talk to chat that involves the whole group (i.e. informal compared to

lectures and involving many students rather than just the teacher) and that is purposeful and connected to learning.

Teacher journals and interviews present a similar picture of student response. In journals, teachers describe especially popular activities, such as town meetings, going outside, constructing dream cars and an extinction game. One teacher described a town meeting where students debated whether an area zoned for agriculture should be changed to commercial zoning:

> Students did get into the debate and took their assigned roles seriously. As the town meeting went on, they really enjoyed it. Some said in their journals it was the best REEP activity. (biology teacher, interview, 5/14/96)

A physical science teacher described an activity to design a "dream car" that was rated according to criteria including government standards. "Kids loved it! They got very involved and verbal with the trade-offs" (journal). She taught English as a Second Language students who in general had a difficult time managing the math and reading level of their curriculum but were able to connect with this and other activities. One teacher called the games "exceptional" and agreed with her colleague that students "really loved them" (interview, life science, 5/30/96). In a year-end survey, when asked to name something that surprised them about student response, the majority who responded cited the high level of student interest in and enthusiasm for the curriculum.

The survey also indicated the curriculum's ability to reach students who are typically disinterested. Five high school teachers indicated that students usually uninterested in science seemed to become interested in REEP. For example, a physical science teacher reported that the curriculum "sparked more interest with students whose interest and achievement in science was usually low." A chemistry teacher reported that "some students who were not interested in chemistry indicated a great deal of interest and enthusiasm about this program." Two teachers noted that even two students who normally were behavior problems were involved and interested. Thus REEP seems to have the potential to engage students who often don't do well in science and/or are generally not interested in the subject.

It's difficult to discern patterns regarding what students disliked about REEP, in part because the majority liked it. Some who disliked it seemed disengaged from school generally. Some criticized particular activities, e.g. because they didn't like collecting data about acid rain[4] at home (environmental science class, interview, 10/30/95) or because small group members didn't

[4] Though the curriculum refers to this overall topic as acid deposition, students and teachers

cooperate (biology class, interview, 5/14/96). A few students had more general critiques, e.g. that the topic of acid rain was too narrow for an entire quarter of work (environmental science, interview, 6/4/96) or that the curriculum sometimes seemed repetitive (environmental science, interview, 10/30/96).

Students in a range of settings stated that REEP connected better with their lives and concerns than did other science classes; sometimes they expressed this in terms of REEP being "easier" than "regular" science. In half of the student group interviews,[5] students talked about how the REEP program seemed more connected to issues and concerns in their lives than did other science classes. In a fifth class, which was environmental science, students said of the class as a whole that they could "relate to it better" than other science classes and made similar comments about their REEP unit. For example, one student said she had learned that acid rain "affects you in so many ways." In a sixth class which studied rain forests, students clearly felt strongly about stopping destruction of rain forests, but did not talk as explicitly about such connections. Making connections may have been more difficult, however, since rain forests are physically removed from their everyday lives.

When students in a physical science class described this greater sense of connection to REEP, some indicated that they found it easier than "regular" science. Some described it as easier because there was less memorization or less math, but also because it seemed more like "common sense" and because the projects make "you understand what you're really doing" (interview, 3/30/96). Students in a chemistry class specifically linked the curriculum's easier nature to the fact that they could relate to it (interview, 4/25/96). The way students measured hard and easy seemed to reflect, in part, the degree of a subject's abstraction from their everyday life; REEP's greater connection sometimes made it seem easier and more accessible.

The following two excerpts from student interviews capture this sense of connection that students expressed. In an earth science class at a suburban school, students had this exchange:

Student 1 It's (REEP) about stuff we care about. We all live on the earth so we all have something in common with this course.

Student 2 We need to know some of it to live.

Student 3 It all fits in somewhere. He (the teacher) tells you when you're going to need this in life. All the other classes you wonder why do I need to know this but he tells you you need to know this because it's our earth. (11/7/95)

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tended to use acid rain.

[5] We were not able to interview students in one classroom so there were eight, rather than nine, student focus group interviews.

Students in a chemistry class at an urban school said:

Student 1 I think it's different. And I think it's more interesting than the rest of the curriculum that has been going on....Because it deals more with problems that we see...pollution and everything.

Student 2 What's going on in the daily world.....

Student 3 It relates to what we see. It's not just like we understand what you're trying to do but we can't relate it to anything. (4/25/96)

These students emphasize that the learning that takes place in REEP is not abstract but related to things they see around them like air pollution or trash. Not only is the material and their learning connected to aspects of daily life, but what they learn seems necessary and vital to the students, almost a matter of life and death -- "we need to know some of it to live."

Despite REEP's ability to engage and teach students in such varied settings, inequitable resources across settings sometimes affected teachers' work with REEP, making its use more challenging at poorer, often urban schools. During the summer workshops, teachers constructed many of the props/materials they needed to teach their units. SCEE also supplied teachers with $100 to purchase supplies for their units. Despite this assistance, garnering needed equipment and supplies as well as sites for field studies sometimes presented problems, especially in urban public schools. Teachers at the three urban public schools involved in the case studies all faced equipment problems. Schools sometimes simply did not have a needed piece of equipment (e.g. a calorimeter for a physics experiment) so teachers had to find alternate experiments. A chemistry teacher needed a Tesla coil but since there was only one available for a main school building and its five annexes in different parts of the city, he'd had to postpone doing the experiment that called for a coil (interview, 4/25/96). A high school physics teacher called the equipment situation at her school "extremely bleak" (interview, 4/23/96). A middle school teacher said that her biggest problem with REEP involved the availability of materials. "I made tools. We have no science supplies here, so when we had to go outside to take the temperatures I had meat thermometers" (interview, 5/30/96).

At two of the schools, limited library resources were also a problem. School libraries didn't have needed resources for student research and teachers either had to go elsewhere for them or make do with what they had. One high school has a library "with no one to run it" so even its scanty offerings were difficult for students to use (interview, 4/25/96). A teacher at a private, Catholic high school in Philadelphia also reported that her school library did not have sufficient library books for her class of 21 to research outdoor air pollutants (journal).

While two of the three suburban schools involved in the case studies had sites for field studies (woods, creek, etc.) within walking distance of the school, this was true for only one of the three urban schools involved and it's proximity to such sites is probably atypical for urban schools. An environmental science teacher at a suburban school noted that she felt "fortunate" to have such a site close by and concluded, "if you didn't have that, I don't know what you could do" (interview, 10/30/96). In her journal, an urban social studies teacher touched on the challenges of doing a land use study near her school:

> We looked at an adjacent vacant lot to see if it met agricultural requirements (community garden). But, it isn't school property and it is fenced in so we couldn't dig up the soil....(What stood out or surprised you about this lesson?) Assumptions about access to appropriate location.

There are certainly exceptions to this pattern of more equipment and more accessible field study sites in non-urban schools. On the whole, however, the general pattern involved urban teachers talking about shortages that made their job more frustrating and teaching the curriculum more difficult while suburban public and parochial teachers rarely mentioned this issue.

Recommendations

- Provide support for teachers at schools with fewer resources. Many REEP participants from urban public schools who had the opportunity to make props and buy equipment with a cash grant still expressed concern about the lack of equipment and supplies. It seems likely that teachers who undertake REEP in the future without this extra help would face similar or greater problems. Support for such teachers to use REEP could take a number of forms. For example, SCEE could make alternatives available for some experiments, particularly those which demand equipment which is more expensive or more likely to be unavailable in poorer schools or districts. Alternatives could involve substituting for particular pieces of equipment or substituting different experiments which teach the same concept but are easier to do. A number of the teachers involved in the study have already made such substitutions and could be approached for ideas or examples. Another approach could be for SCEE to identify teachers willing to be resource people for others struggling with implementing REEP in schools with fewer material resources. Resource people would be teachers experienced in using REEP in such settings. Such teachers might work with fellow teachers in their individual schools or beyond. In the latter case, SCEE could serve as a conduit for linking resource people and those who hope to use REEP.
- Provide resources for teachers/schools without access to appropriate fieldtrip sites or facing

was a new curriculum but also because of the new teaching approaches it demanded. The class we observed seemed to reflect both his comfort with the lecture style and his attempt to use more active learning strategies. The double-period began with lecture about pollutants. Then half the class worked in small groups researching pollutants while the other half met with the teacher to work from a hand-out and balance some equations. After the groups switched tasks, the whole class reconvened. Initially the teacher solicited answers from the students to the questions they were researching about pollutants but then seemed to switch into more of a lecture mode, providing answers to the questions the students had worked on (fieldnotes, 4/25/96)

A teacher of ten years noted that REEP didn't seem that different from what she normally does. She usually has her high school physics students work in groups with a hands-on format. In both the whole group preparation for doing an experiment and during the experiment itself, the teacher frequently responded to questions in a problem-posing way. She encouraged students to look at their question from a different angle or to figure it out for themselves. For example, in describing the experiment, she noted that they would be using styrofoam cups rather than calorimeters. "What may be a problem with this?" she asked, rather than explaining that using cups might entail greater heat loss than a calorimeter would. During the lab itself, a number of the groups had difficulty understanding how they could weigh the water they were using. The teacher again responded in a way that encouraged student inquiry. She tried a variety of approaches to encourage one girl to realize she needed to weigh the empty cup and the cup filled with water and subtract one from the other, rather than simply telling her. She posed the following situation: "You're on the scale. I get on. How do we figure out my weight from the combined weight?" Once the girl and her group solved that, she pushed them to apply it to weighing the water. (fieldnotes, 4/18/96)

The three teachers described here have different teaching styles and different levels of experience. Their teaching differs in a variety of ways, including how comfortable they are with small group work and how much they use it; the balance they seek between lecture and discussion in their rooms; and how inquiry-oriented their teaching strategies usually are. How they used REEP reflected some of these already existing differences.

How teachers assessed student learning in REEP also was affected by their beliefs, practices and contexts. REEP provides some quizzes and tests but also seeks to encourage alternative assessment for measuring student learning. Individual participating teachers and their schools had a range of different assessment requirements and differing degrees of familiarity with

standard versus alternative assessment. Before teaching REEP, most participants (36 of 41) reported that they used quizzes and tests for assessment. The other most common forms of assessment were projects (24), lab reports (16) and homework (9). A handful of teachers used approaches such as journals, student presentations, portfolios, and debates. Thus most teachers used tests but a minority integrated alternative assessment into their practice.

After teaching REEP, about half the group surveyed said that REEP had fewer tests or quizzes than they normally give. On the other hand, several said there was too much testing. Some of the former group were required to give a certain number of tests per marking period and found this harder to do with REEP. Some teachers made up their own tests and some suggested including more assessment instruments in REEP for teachers to use and amend.

Often those teachers who emphasized projects, group work and journals in their evaluations of students, found REEP congruent with their usual assessment practices. Some weighed class participation, discussion or even group interaction as they assessed students during REEP. A few teachers who normally used more traditional assessment instruments found it difficult to assess REEP projects and group work. One case study teacher who expressed such views was also eager to do more alternative assessment, though it was not an emphasis at her school. She hoped to "get the (administration) downstairs used to alternative methods of assessment" (physical science, 3/30/96). Using REEP made her confront her own uncertainty about non-traditional methods but also fit into her larger personal and institutional change agenda.

Because of the range of beliefs and practices teachers brought to REEP and their school contexts, they sometimes came down on opposite sides of a variety of REEP pedagogical and curricular issues. Teachers' different backgrounds with regard to issues of assessment and teaching style clearly affected their recommendations for modifying the curriculum. The diversity of opinions in education generally about the appropriate balance of lecture and experiential learning is reflected in the REEP group. While nine teachers were satisfied with that balance in the curriculum, ten felt there was too much lecture and four (all high school teachers) said there was not enough. This raises questions for SCEE as it revises the curriculum about how to integrate the sometimes contradictory teacher recommendations and to balance them with SCEE's own philosophy.

Teachers also evidenced opposing beliefs about the appropriateness of the curriculum's difficulty level for their students. Four of the nine case study teachers voiced concern that the curriculum was too easy for their students or would be too easy for an accelerated group. A

biology teacher said, "The curriculum seems more geared to lower track kids" and said she would have to enrich it to use with higher level students (interview, 5/14/96). A chemistry teacher at an urban public school said, "In some respects it's too easy for the kids....You've got to keep pushing them (in math). I just didn't think there was enough (challenging math)" (interview, 4/25/96). At the same time, three case study teachers reported that the curriculum level was fine for very heterogeneous classes which included special education and honors students (interviews: 10/30/95, 5/30/96; fieldnotes, 7/15/96). The other two teachers, both from the same urban high school, were concerned that some of their students were struggling with the reading levels or the math in their curriculum (interviews: 4/18/96, 6/6/96). These kinds of differential evaluations of the curriculum were reflected in the larger group of teachers as well.

This data raises a lot of questions including how schools grade and track kids, e.g. what it means to be lower level or accelerated, and what teachers mean when they call a curriculum hard or easy. Perhaps the most important insight from this data is that there were -- and likely will be in the future -- individual students and sometimes groups who found parts of REEP too challenging (e.g. because of lack of background knowledge, reading level of materials, math needed) or too easy (e.g. because they were already familiar with some of the concepts or found parts repetitive or because they were older or higher achievers). The data raises questions about how teachers can adapt REEP in order to meet the needs of their students and so as not to lose students to frustration, on one hand, or boredom, on the other.

Though teachers whose philosophy and practices were more consonant with the REEP approach tended to make the curriculum look more student-centered, there is some evidence that involvement in REEP shifted some of the more traditional teachers' beliefs about teaching. The following excerpts illustrate how using REEP affected some teachers perspectives on teaching:

From a physical science teacher:

> This unit forced me to change from teacher-centered to student-centered learning....I have rarely used (cooperative learning)...before the unit. Now I feel more comfortable with using cooperative learning outside of the unit. (survey)

From a social studies teacher:

> I usually lecture and students take notes. This was more hands-on and asked for more student participation than I usually do. Some activities resulted in student response, discussion and enthusiasm -- this certainly is a plus and I'll work to include this in my daily approach. (survey)

REEP enabled some teachers to try new approaches that these teachers describe as more "student-centered." Like the chemistry teacher described above, REEP helped them take risks

and enter unknown territory. These two teachers deemed these new approaches successful enough to want to try them again.

At the same time, other teachers' experience raises questions about how strategies like collaborative learning or alternative assessment will work for teachers new to them. An earlier example of a beginning teacher putting students in pairs to encourage collaborative learning underlines that simply placing students in small groups doesn't necessarily mean they collaborate or that learning takes place. A teacher who frequently used collaborative learning and group work framed a similar question:

> If I was a teacher who never did that (used small groups) I don't know if this design (REEP) or if the way in which it's presented would have a teacher comfortably moving to that. There's a lot of preparation you really have to do with the class to have them acclimated to working in groups....If I was cold turkey doing that, I think it would be overwhelming. You'd be trying to get them into groups and learning that along with trying to follow the pieces of the curriculum. (interview, 4/23/96)

This teacher expresses concern about whether REEP provides enough scaffolding for teachers unused to non-traditional approaches.

Recommendations

- SCEE can make a choice about whether to focus its work more narrowly on the curriculum or more broadly, i.e. by also using the curriculum to address larger issues of pedagogy and assessment in environmental education. REEP's engagement with alternative assessment and the shape of science pedagogy places it at the forefront of current thinking about the nature of science education and about assessment. SCEE is committed to continuing its work with the curriculum through the process of revision and publication. It could also play a role in the larger educational arena by using the curriculum as a tool to move pedagogy and assessment in environmental education forward. Such work would involve training and professional development focused on assessment and pedagogy.
- SCEE could draw on assessments already created by teachers to provide sample quizzes and tests and also to model and explain alternative or holistic assessment. Many of the teachers appeared unfamiliar with this approach and might welcome opportunities to learn more. Some REEP teachers could serve as resources for this as well as about student-centered pedagogy.
- Although SCEE can not gear one curriculum to all students and contexts, it can make

REEP as accessible and useful as possible to teachers working in a wide range of settings. Doing so would assist teachers unfamiliar with some of the teaching approaches (e.g. collaborative learning) used in REEP. It would also address the needs of teachers who called aspects of it difficult or too easy for their students and of teachers teaching heterogeneous classes. Providing additional information on collaborative learning and small group work could assist teachers in implementing these new approaches. Many teachers requested enrichment and support materials and while literally including such materials for every lesson would be impractical, SCEE might include ideas about how to adapt and supplement the curricula for higher and lower level learners as well as listings of resource materials and of sources of relevant materials.

Finding 3: Data show that the vast majority of teachers involved in the study plan to use REEP in the future. They differ, however, about whether they will use it as a whole or by inserting discrete REEP sections and activities throughout the year. This range of possibilities raises questions about how the piloting teachers see REEP -- as a curriculum, discrete lessons, or a framework -- and about how it will be used in the future.

At the beginning of the pilot, how to use the curricula was an issue because of SCEE's requirement that teachers stick closely to the curricula. Many teachers expressed concern about not being able to modify the curriculum to fit their students and their teaching styles. In interviews and end-of-the-year surveys, teachers continued to refer to feeling restricted or constrained by having to follow the curriculum exactly.[6] They wanted to be able to follow students' spontaneous questions to "springboard into other things" (interview, biology, 5/14/96). As another teacher put it, "I like to go with the flow....if I want to talk about butterflies today and we get into a really good discussion of snakes, we might just stay on snakes all day" (interview, environmental science, 6/4/96). They also wanted to be able to customize REEP for their students by adding material, skipping sections, and providing extra activities for higher and lower level learners. By the end of the pilot, the requirement to stick closely to the curriculum was no longer an issue, since the teachers would be free to make their own choices in the next school year. The way teachers described the choices they would make, however, raised new kinds of questions about the use of the curriculum.

All but one of the teachers surveyed plan to use REEP again. Amidst this very positive

[6] SCEE placed this constraint on teachers in order to control variables during the evaluation study.

response to the curriculum, teachers were also looking forward to making it their own. In a discussion at a July 1996 workshop, most teachers indicated they were committed to figuring out how to utilize REEP with the rest of their curriculums. This was true even for teachers who felt that the REEP material represented a relatively small part of what they had to cover in their class as a whole (e.g. biology). A variety of data sources (fieldnotes, surveys, interviews) indicate that in the future, many teachers plan to use pieces of REEP over the course of a year -- rather than using the whole sequentially. Teachers who plan to use pieces of REEP -- rather than the entire curriculum -- made comments like:

> I will not do the course in a block of time but will try to incorporate it into the existing curricula with emphasis on e.e. (environmental education). [survey, physics teacher]
>
> (I will not use REEP) as a total unit. Since some aspects fit into existing Social Studies curriculum, I'll use them for emphasis. More than anything this made me aware of the importance of including environmental education. [survey, social studies teacher]
>
> I will use it as a supplement throughout the year, incorporating a lesson where it fits into my own curriculum [survey, environmental science teacher]
>
> Acid rain is "too narrow a topic to devote a whole marking period to when you're teaching a year in environmental science." Next year she plans to used it for half a marking period, combining it with the REEP chemistry unit on ozone for the other half of the marking period. [interview, environmental science teacher, 10/30/96]

One teacher seemed to be trying to reconcile two opposing ideas: that she wanted to use REEP piecemeal in the future and that doing so might substantially alter the curriculum impact. She suggested that SCEE should present the curriculum as a framework. "It's idealistic; all curriculums are. It's a great tool but it should be put down in a skeletal way with ideas for modification" (interview, biology, 5/14/96). She planned to use pieces of REEP in the future, taking out the "best" activities and worksheets. She noted that SCEE had done "a lot of work to set it up sequentially; when you have to alter that, it makes a difference in terms of curriculum impact. Yet there has to be some altering to modify for the group you have." In the end of year surveys, two-thirds of teachers (16 out of 24) responded that they could not foresee any changes which would interfere with the integrity of the curriculum. They elaborated with comments such as "the program is strong enough to withstand teacher-initiated changes" or "many of the lessons are self-contained and could be used throughout the year." A smaller group (4 out of 24) indicated their commitment to using the entire unit with comments like: "all lessons should be covered to keep the continuity of the curriculum" or "nothing should be eliminated."

One teacher stated, "Don't remove the action plan. It's what makes this program unique." Most teachers, however, did not seem to have strong feelings about keeping the curriculum as a whole intact.

Recommendations

- In light of the findings regarding the range of beliefs about what the curriculum is and how to use it, SCEE needs to clarify its own priorities for the curriculum. SCEE created REEP to meet the need for environmental education curricula, a need that arose in part from the existence of many unconnected activities and lessons and the unavailability of sequential, planned curriculum. SCEE emphasizes that REEP has a "logical flow" (1995, REEP, Energy/Physical Science unit, preface) and that its goal is to provide a "structured, school-based, sequential environmental education curriculum" (SCEE, REEP information sheet, emphasis original). SCEE sees all four components of REEP (awareness, understanding, values and personal action) as necessary; if a teacher omits the values section, for example, then SCEE would say she is not "doing" environmental education. Thus, SCEE's commitment to the curriculum as a whole seems to be in some conflict with the findings on teacher beliefs about and intentions for the curriculum. These findings raise issues about revising the curriculum, marketing the curriculum, and using it in professional development. Depending on its priorities, SCEE could address these concerns in a variety of ways. Possibilities include: SCEE could follow up with the teachers from the pilot group, utilizing one or more research strategies (e.g. surveys, telephone interviews, focus groups, observations). Such investigation would help SCEE to learn more about how teachers use the curriculum. It could help SCEE address concerns through professional development and other future work with the curriculum.

  If SCEE decides that the curriculum could be used as a framework with options, it will need to consider how to support teachers in emphasizing those elements that SCEE considers most essential. If SCEE wants to position REEP as a curriculum to be used whole, how can SCEE structure the curriculum and support teachers so that its use meets SCEE's objectives? Lastly, what role do state requirements (in Pennsylvania and elsewhere) for environmental education play in SCEE's work with the curriculum and in teachers' use of it?

Finding 4: Across different settings, student levels, and REEP units, there was consensus among teachers that REEP facilitated increased knowledge about the environment,

increased awareness of the value of the environment and some degree of changed actions among their students. Though SCEE originally conceived of the values and action components as focused on culminating activities at the end of each unit, the data shows that in practice values and action arose in classrooms at many other points of the curriculum as well.

REEP aims not only to increase students' knowledge of the environment and environmental science but also to involve them in thinking about what value society and they as individuals place on the environment and in moving towards and initiating action they might take as concerned citizens. The preface to the REEP curriculum states that "In order to be environmental education, each unit should also contain awareness and personal action aspects" (1995, REEP, Energy/Physical Science unit, preface). At the summer 1995 workshops introducing REEP to participating teachers, SCEE staff laid out the key parts of REEP: awareness; knowledge/concepts; values; action (fieldnotes). The preface explains the action component of the curriculum as one which provides "opportunities to translate knowledge and values into personal action to improve the environment." Participating teachers seemed to agree with this vision of action as an important part of environmental education; in the summer 1995 survey, three-fourths of the group included an action component in their definition of environmental education.

All of the units are organized so that the final one or two of eight to ten lessons focus on values and personal or corporate actions to address the problem studied. Fieldwork and the teacher journals indicate that a third of the teachers from whom we have year-end data (e.g. journals or surveys) did not get to the final lessons.[7] Yet discussions with teachers at the two summer 1996 workshops as well as teacher journals revealed that issues of values and personal action arose in most classes, whether or not they reached the final lessons. One teacher described the values and action aspect of the curriculum as "built in. It's there throughout and your own feelings come out." Another said, "questions (related to values and choices) keep coming up in chemistry. We talked about it along the way."

Most teachers indicated that REEP affected the attitudes of many of their students and that some made changes in their lives. When teachers solicited information from students about

[7] Some teachers did not complete the final lessons because they found the curriculum took longer than expected and so they dropped some of the later lessons. Many teachers planned to teach the curriculum in the last quarter of the year and were even further delayed in starting by a

their attitudes after REEP, most reported some changes. A biology teacher stated that 20 out of 23 students reported changed attitudes toward wetlands, the subject of their curriculum. A physical science teacher said that 15 out of 25 of his students indicated their attitude toward the earth changed as a result of REEP and listed the following examples: they became more conscious of the products they buy; more willing to recycle and conserve energy; more aware of the types of fossil fuels. The subjects of students' awareness and attitude changes varied depending on the curriculum. For example, chemistry students, who studied ozone, became more aware of the effects of pollutants, of the ozone hole, and of the effects of sun on skin. Students who studied solid waste became more committed to recycling. Students who studied rain forests became more concerned about destruction of this environment and about helping indigenous people, plants and animals survive. In her journal, a social studies teacher described how students' perspectives were broadened in ways that did not show up on tests:

> Though the testing doesn't reflect it, many of these students became more sensitive to land use planning and other environmental concerns. (In a discussion at the semester's end) most felt they had changed to some extent. The inner city students who at first felt industrial and commercial development should have priority over open space and wilderness admitted these land uses also played an important role in maintaining a quality environment.

Though evaluating the action component itself is tricky,[8] the data indicate that some students moved beyond changed attitudes to taking action as a result of the curriculum. In the focus group interviews, generally two to three students in each group of six to eight were articulate about how they had made or intended to make changes. Teachers also documented changes named by students in discussion and writing. These actions included stopping littering; walking instead of driving (being driven) when possible; eating less meat; using rechargeable batteries; conserving electricity and water; increased use of sunscreen, starting compost piles.

In addition to student reports of taking action, some teachers observed changes in students' behavior. One teacher saw students littering less and recycling more in the classroom and other school areas. Another teacher saw a student approach someone who had thrown their trash on the ground. One teacher described her students as "attacking" others in the lunchroom to give them information from their ozone curriculum. Some teachers also learned (through parents' reactions) that students were trying to institute changes at home. For example, one boy wrote,

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winter with many snow days; they never made it to the end of the curriculum.

[8] For example, we cannot judge students' commitment to such changes over time and much of the evidence is based on students' self-reports.

"My dad thinks I am a big pain in the neck and (REEP teacher) is the reason....(his father has) changed his attitude about the environment and is starting to come around to realize how important this class was." Several teachers indicated that parents (somewhat jokingly) gave them a hard time because their kids were pushing them to turn out lights or recycle more. At the same time, some students felt hindered in making the changes they wanted because of parental resistance, e.g. to starting a compost pile or to recycling.

A smaller percentage of the actions initiated or discussed seemed to extend beyond the individual or family level to participating in organizations or seeking to change larger structures. One group of students planned to work with their teacher to start a recycling program at their school. Other teachers reported that some students joined the school environmental club. A chemistry teacher reported that students said "they now felt more of a responsibility to stop or lessen the type of pollutants that harm the earth." It was unclear whether students knew how they might address these larger levels. One teacher reported that his students said they would look at candidates' environmental records when they voted. Several teachers said their students felt strongly that REEP should be taught again; "it is important to them that their generation be told the alarming facts about the amount of trash the U.S. produces."

The degree and kinds of changes in students' values and actions are shaped by where kids start, the school and neighborhood contexts and what the subject of the curriculum is. For example, some students study energy or acid deposition; their ability to commit to an action plan to increase their use of mass transit may be affected by where they live. Some suburban children may not have many mass transit options and, as some urban children indicated interviews, they already rely on mass transit for most of their travels. The junior high school life science curriculum seemed to pose particular challenges for students when they sought to generate action plans. Its focus on rain forests made it harder for kids to identify individual actions they could take. One teacher reported, "kids weren't left with many concrete things in their mind that they could do to help with the rain forest problem....the most common thought (was) to eat rain forest fruits" (teacher documentation of values and action component). She also noted that many said they would recycle, although they had not discussed this in class and paper is not made from rain forest trees; the students seemed to be searching for some way to make a difference. In a focus group from another class studying the rain forest, students imagined changes they would make in their own environment such as planting more trees. More than other groups, they mentioned more systemic changes such as becoming activists to protect forests, stopping people from cutting

down trees through greater penalties, and starting groups to protect the rain forest and to educate others about the problem. It may be that the geographically removed focus of this curriculum pushed the students to think on these levels.

Recommendations

- Given the previous section's discussion of teachers' plans to use pieces of the curriculum, rather than the whole, and the evidence in this section that awareness of and changes in values and actions are not just stimulated by the last lessons of the units, it seems important to integrate values and actions even more thoroughly throughout the curriculum. This might involve highlighting places in earlier lessons where questions of values or possibilities for actions already arise as well as adding ideas and exercises in earlier lessons.
- Consider ways to make this component even stronger. For example could students in the same high school or doing the same curriculum in different high schools exchange ideas and outcomes? Could SCEE publish a newsletter about implementing REEP for participating teachers that could include samples of students' writing or projects? REEP units might also feature consideration of the relationships between values and action (i.e. how values inform and motivate actions), between actions and change (i.e. how actions bring about change) and of different levels of action and change (e.g. individual, school-wide, systemic).

Finding 5: Teachers' most commonly-cited goals for their involvement with REEP -- working with a new curriculum and more environmentally informed students -- were also among the most frequent outcomes of the project. REEP was also successful in enabling teachers to become more informed about environmental topics. At the same time, goals with implications for broader change in schools' curricula and commitment to environmental education proved more challenging to achieve.

By the year's end, almost all the teachers (22 out of 24 surveyed) reported feeling more up-to-date in their own knowledge of the environment and also reported very positively on the interaction with SCEE that facilitated this goal and the teaching of the curriculum. One fairly new teacher reported, "It's been interesting for me to learn about it (solid waste, recycling) too because I didn't know a lot of this stuff" (interview, earth science, 11/7/95). An environmental science teacher called using the curriculum exciting and continued, "I never taught acid rain before....It's nice to have it all spelled out for me" (interview, 10/30/95).

In surveys and interviews, teachers reported widespread satisfaction with the preparation SCEE provided them for teaching REEP. Most did not feel the need for greater support during the school year; they felt they could call with questions, although few did. Most comments indicated teachers' appreciation of the materials they received and the feeling that "it's up to us now" (to go and teach the curriculum)(interview, social studies, 6/6/96). One commented, "they (SCEE) provided help, fun and enthusiasm" (survey). Even one teacher who complained that REEP participants deserved more money for their work was very complimentary about SCEE's role. She called SCEE "wonderful. They really gave us the best possible start. My hats are off the way they (did) this" (interview, biology, 5/14/96).

As indicated above, when asked about goals for REEP, teachers generally responded first in terms of student awareness and learning; most of SCEE's efforts in the pilot also focused on preparing teachers to teach the curriculum with the goal of successfully engaging students and increasing their knowledge about the environment. But in the initial surveys, teachers identified additional goals that extended outside the classroom. When specifically asked about these goals in the second survey, two-thirds indicated that REEP had been a catalyst for their school's involvement in environmental education. It is unclear in what ways teachers felt REEP functioned as a catalyst. It could simply refer to the fact that the majority participating had one or two colleagues also teaching REEP; thus schools may have had much more environmental education going on than in the past. It may not mean that the schools have institutionalized environmental education but simply that more individual teachers are including it in their curriculum.

Survey data supports this interpretation that these responses did not indicate significant school-wide change. Nine teachers stated that they received little or no support for teaching REEP from their schools. One replied that support was "minimal as usual" and another noted that the principal did not observe when invited. Eleven teachers responded positively regarding school support. For example, two reported that the administration publicized REEP in a newsletter for parents and others reported that they were allowed to depart from the usual curriculum to teach REEP. Teacher journals also indicated that several principals came to classes to play roles in town meetings or debates.

For the most part, REEP teachers had limited interaction with their colleagues. Such interaction could potentially have taken place within schools, since most schools had more than one REEP participant, or among teachers using the same curriculum across schools. One teacher said, "we can't interact with anybody we're so busy" (biology, interview, 5/14/96). Others

reported that they simply didn't see some of the other REEP teachers because they taught in different programs or different parts of the building (physics, interview, 4/18/96; surveys)[9]. Several reported sharing parts of the curriculum (sometimes activities or experiments) with non-REEP teachers. Eight teachers reported a range of kinds of conversations with other REEP teachers, e.g. "in passing," about logistics, sharing ideas about what worked, and comparing how they were handling REEP. Two worked together on field trips. A few teachers did significant networking with fellow REEP teachers. Two taught another teacher's REEP curriculum in addition to their own, learning from and with their co-worker about that curriculum.

To some degree, the responses in these areas of school commitment to environmental education and teacher collaboration reflect SCEE's level of involvement. Facilitating interchange among REEP participants (by discipline or by school) during the school year was not a focus of the project. SCEE did seek to make some connections at the school level, however. SCEE provided schools with news releases about their teachers' participation in the program and SCEE staff visited principals at each school where teachers were involved with REEP.

Recommendations

- REEP has the potential to serve as a more effective catalyst toward goals of teacher collaboration across disciplines, school change related to environmental education and making science more interdisciplinary, should SCEE decide to adopt these emphases. SCEE describes REEP as a multi-disciplinary curriculum and the presence of teachers from different disciplines using varied REEP units at the same school has the potential to make REEP specifically, and science generally, more interdisciplinary. Teacher networks have proven to be a powerful way to facilitate school change, professional development for teachers and changes in pedagogy and assessment. A teacher network organized around environmental education and developing teacher leadership could also support new teachers' use of REEP. Such networks could also address larger goals of interdisciplinary environmental education and increased school involvement in environmental education.

[9] The rest of the data in this paragraph also comes from surveys and interviews.

APPENDIX A - Tables and Charts

Table 1. Distribution of subjects across the 5 general achievement level categories.

Categories of Achievement Levels	REEP GROUP Percentages	CONTROL GROUP Percentages
Accelerated	11%	0
High	9%	32%
Medium	38%	47%
Low	20%	9%
Mixed	21%	11%

Figure 1. Percentage of students within the 5 general achievement categories for the REEP group

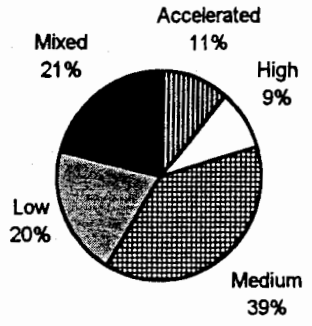


Figure 2. Percentage of students within the 5 general achievement categories for the Control group

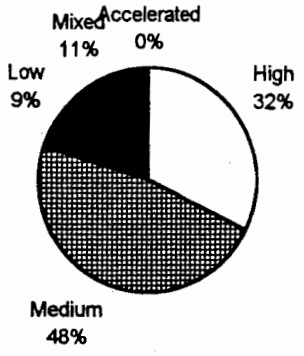


Table 2. Descriptive Characteristics of the Sample (*Sample Size, N = 952)

Characteristics	Count	Percent
Group:		
REEP	756	79
Control	196	21
Achievement Levels		
Accelerated	67	7
High	114	12
Middle	372	39
Mixed	180	19
Low	155	16
Gender:		
Female	558	60
Male	369	40
Interest Level in Science:		
Very Interested	49	5.4
Somewhat Interested	42	4.6
Neutral	259	28.4
Somewhat Disinterested	382	41.8
Very Disinterested	180	19.7
Grade Level:		
Six	131	13.8
Seven	122	12.8
Eight	107	11.2
Nine	82	8.6
Ten	98	10.3
Eleven	288	30.3
Twelve	124	13.0
Unit Tests:		
1. Life Science	162	17
2. Physical Science	230	24.2
3. Earth Science	50	5.3
4. Biology	31	3.3
5. Environmental Science	124	13.0
6. Social Studies	38	4.0
7. Chemistry	298	31.3
8. Physics	19	2.0

*Some counts may not add up to 952 due to missing data

Table 3. Means (and standard deviations) for pretests and posttests and paired t-test results for REEP and Control groups for each unit test.

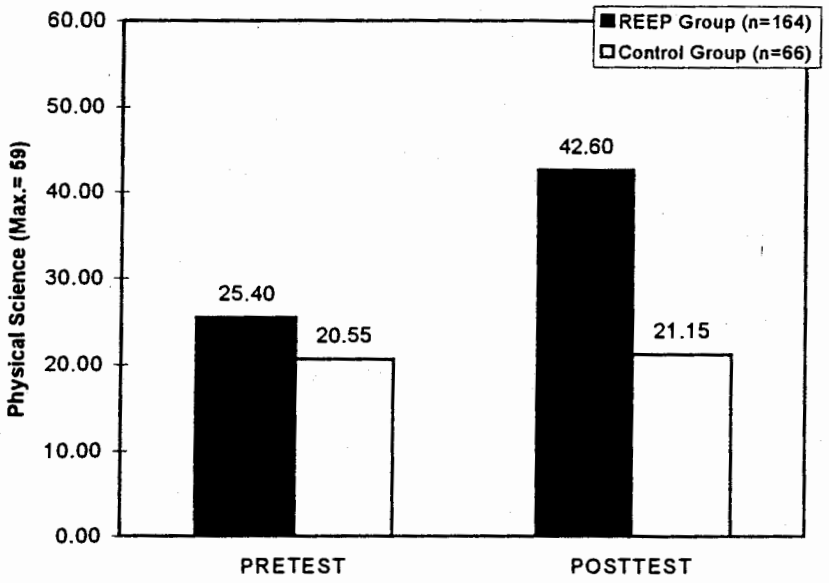
Unit Test	Pre Mean (SD)	Post Mean (SD)	t-value	[c]p-value
1. Life Science ([a]Max. Score = 58)				
REEP Group (n=162)	21.69 (11.70)	38.31 (14.43)	19.48	.001
Control Group ([b]NO CONTROL)				
2. Physical Science (Max. Score = 59)				
REEP Group (n=164)	25.40 (10.22)	42.60 (11.99)	27.47	.001
Control Group (n=66))	20.55 (9.55)	21.15 (9.02)	.94	ns
3. Earth Science (Max. Score = 67)				
REEP Group (n=36)	34.86 (9.11)	53.64 (9.19)	13.16	.001
Control Group (n=14))	33.64 (13.48)	36 (12.35)	1.33	ns
4. Biology (Max. Score = 100)				
REEP Group (n=31)	22.00 (8.65)	29.61 (9.60)	4.96	.001
Control Group (NO CONTROL)				
5. Environmental Science (Max. Score = 45)				
REEP Group (n=77)	22.47 (4.98)	32.07 (4.95)	14.62	.001
Control Group (n=47)	23.96 (4.43)	24.87 (3.96)	1.01	ns
6. Social Studies (Max. Score = 50)				
REEP Group (n=38)	30.21 (5.29)	35.42 (5.83)	4.91	.001
Control Group (NO CONTROL)				
7. Chemistry (Max. Score = 106)				
REEP Group (n=229)	12.49 (6.44)	70.93 (4.84)	40.05	.001
Control Group (n=69)	16.97 (8.43)	16.42 (8.94)	1.10	ns
8. Physics (Max. Score = 72)				
REEP Group (n=19)	23.05 (9.74)	36.74 (18.10)	4.33	.001
Control Group (NO CONTROL)				

[a]Maximum score for unit tests

[b]Unit did not have a control group

[c]p-values = .001 indicate statistically significant gain from pretest to posttest scores. The symbol "ns" indicates no statistically significant grain from pretest to posttest scores.

Figure 3. Pretest and Posttest unit test means for REEP and Control groups for the Physcial Science Unit



Firgure 4. Pretest and Posttest unit test means for REEP and Control groups for the Earth Science Unit

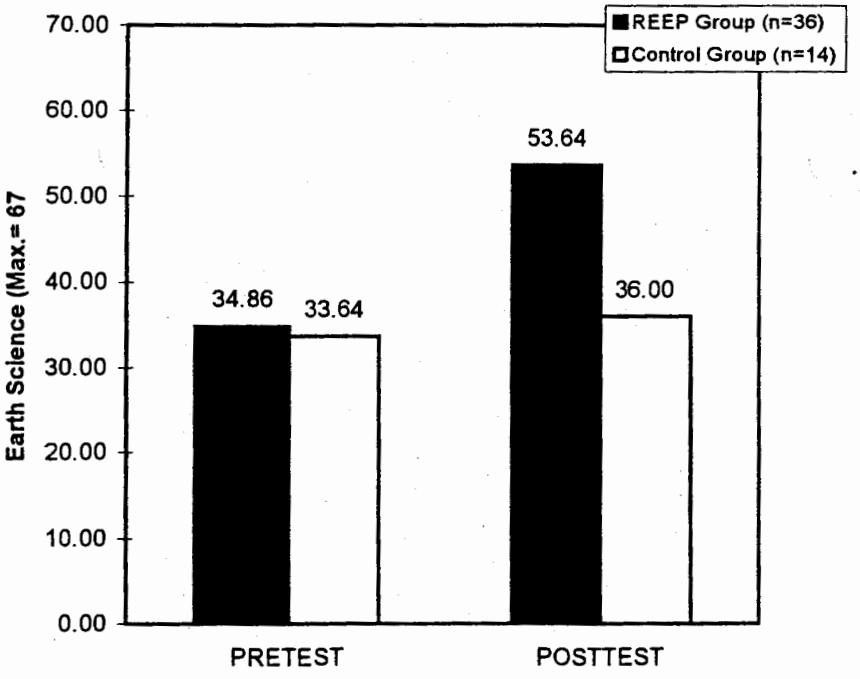


Figure 5. Pretest and Posttest unit test means for REEP and Control groups for the Environmental Science Unit

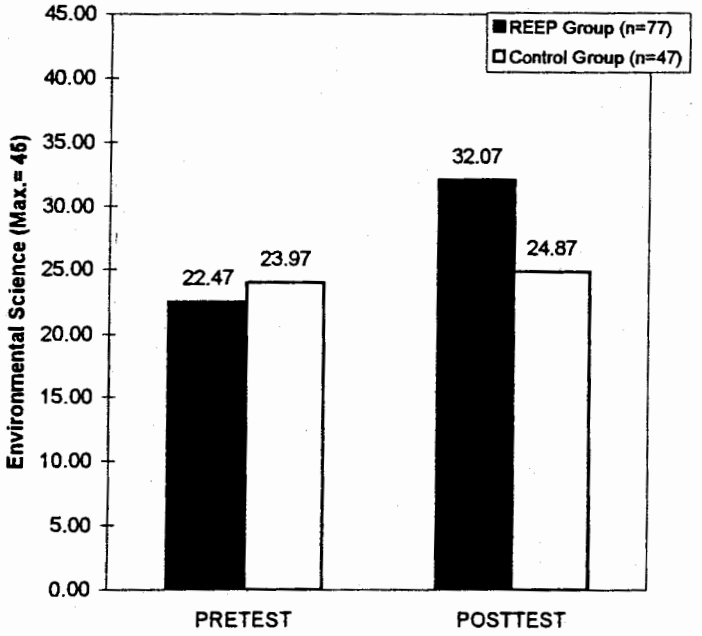


Figure 6. Pretest and Posttest unit test means for REEP and Control groups for the Chemistry Unit

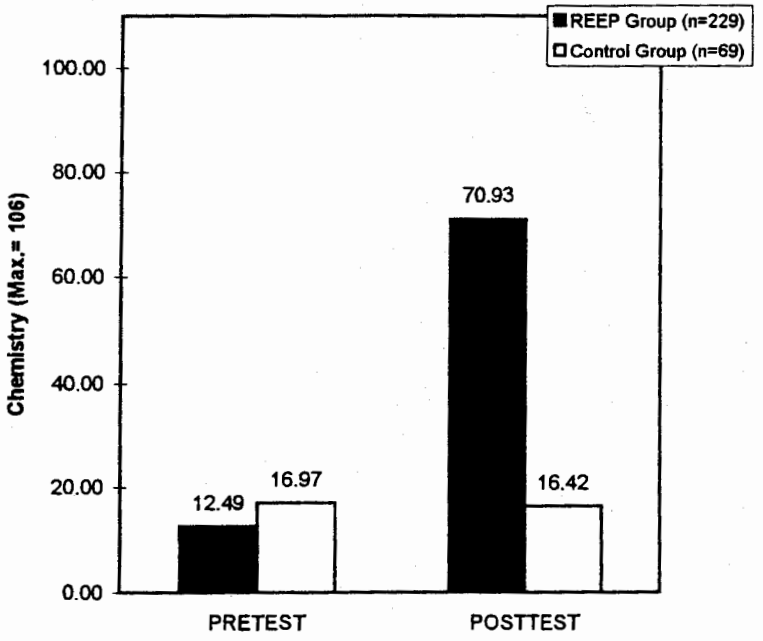


Figure 7. Pretest and Posttest means for the REEP Life Science group (n=162)

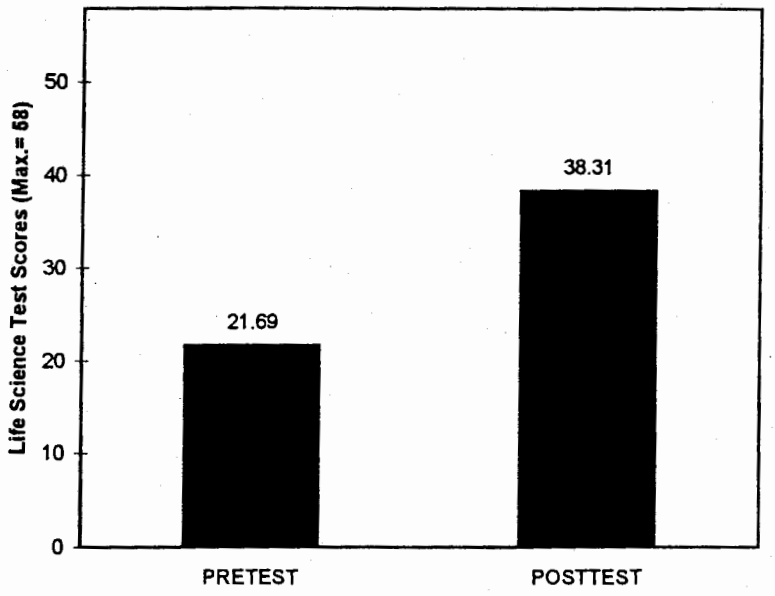


Figure 8. Pretest and Posttest means for the REEP Biology group (n=31)

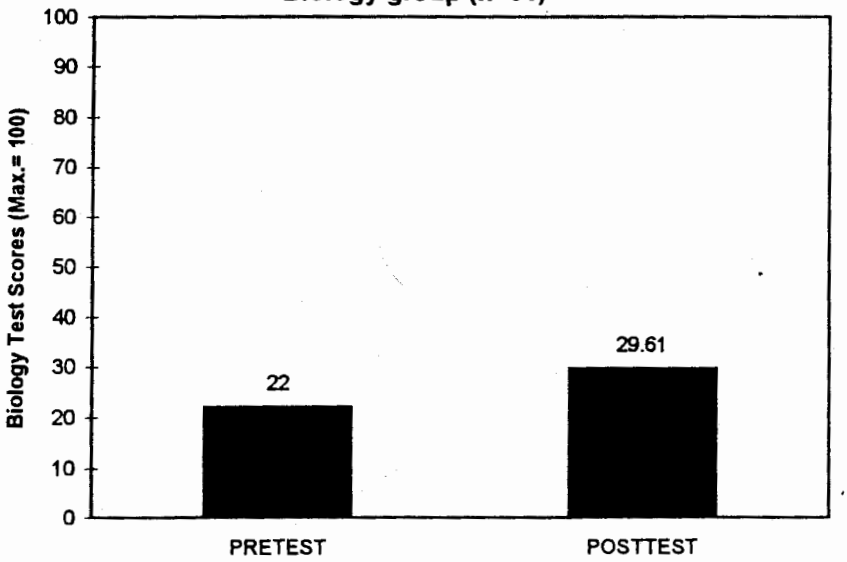


Figure 9. Pretest and Posttest means for the REEP Social Studies group (n=38)

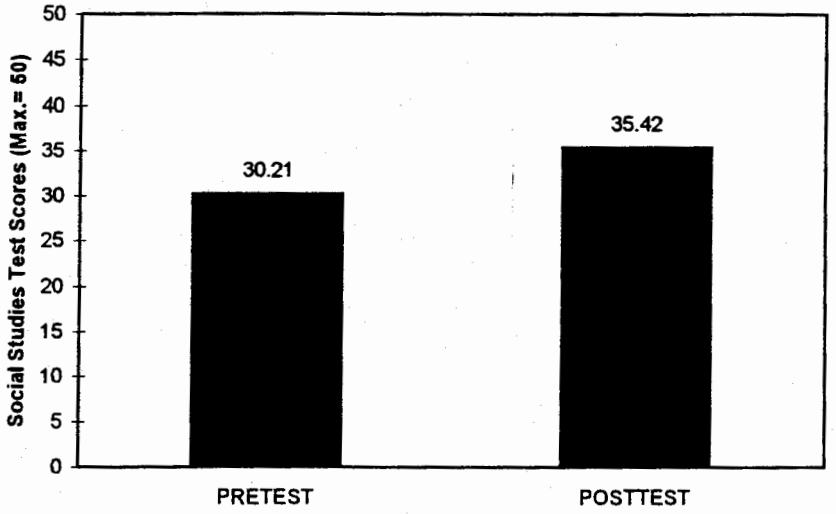


Figure 10. Pretest and Posttest means for the REEP Physics group (n=19)

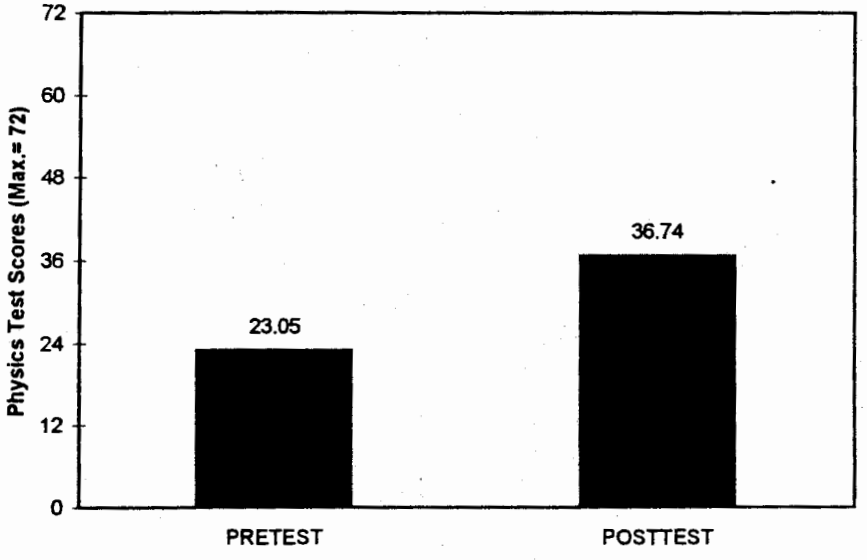


Table 4. Posttest means comparisons of REEP versus Control groups using ANCOVA (*Pretest used as covariate)

	Posttest Means and Standard Deviations			
**REEP Unit	REEP Group	Control Group	f-value	p-value
Physical Science (Max. Score = 59)	42.60 (11.99)	21.15 (9.02)	260.58	.001
Earth Science (Max. Score = 67)	53.64 (9.19)	36.93 (12.35)	41.23	.001
Environmental Science (Max. Score = 45)	32.07 (4.95)	24.87(3.96)	47.69	.001
Chemistry (Max. Score = 106)	70.93 (4.84)	16.42 (8.94)	530.66	.001

* Significant covariate effect was found for all unit tests ($p<.01$).

**No control groups were available for Life Science, Biology, Social Studies, Physics Units.

Figure 11. Posttest comparisons (means) for REEP and Control groups

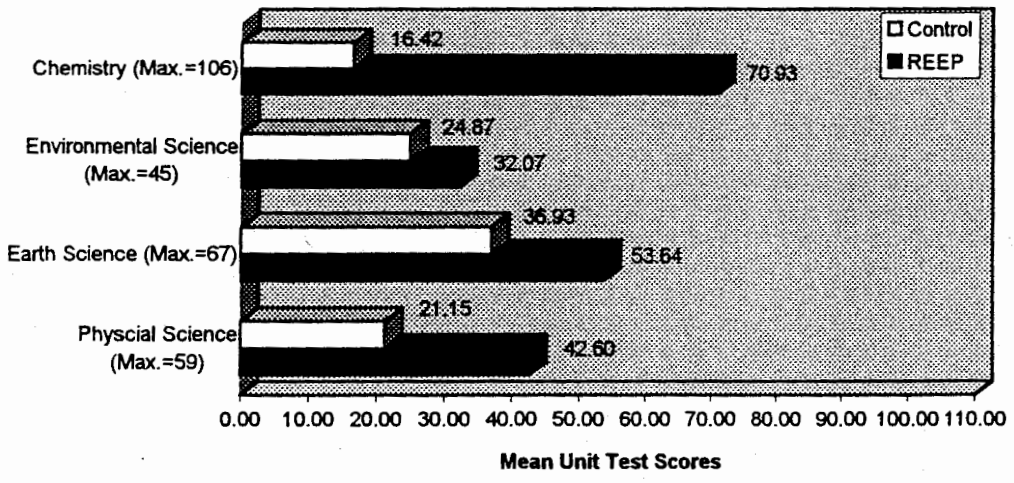


Table 5. Average percent correct from the total test score for each unit for both pretests and posttests.

Unit Test	Average Pretest percent correct	Average Posttest percent correct
1. Life Science ([a]Max. Score = 58)	[a]37%	66%
2. Physical Science (Max. Score = 59)	43%	72%
3. Earth Science (Max. Score = 67)	52%	80%
4. Biology (Max. Score = 100)	22%	30%
5. Environmental Science (Max. Score = 45)	50%	71%
6. Social Studies (Max. Score = 50)	60%	71%
7. Chemistry (Max. Score = 106)	12%	67%
8. Physics (Max. Score = 72)	32%	51%

[a]Average percent is determined by dividing the mean score correct for a particular unit by the maximum score

Table 6 . Means and Standard Deviations for all subjects classified according to general achievement levels, REEP sample

	Pretest		Posttest	
General Achievement Levels	**Means**	**Standard Dev.**	**Means**	**Standard Dev.**
Accelerated	33.29	10.79	50.00	8.75
High	26.99	5.93	56.59	16.11
Middle	22.46	10.77	54.98	26.03
Low	15.70	10.32	43.34	20.18
Mixed	15.48	7.54	39.90	22.34

Table 7. Means and Standard Deviations for all subjects classified according to general achievement levels, Control sample

	Pretest		Posttest	
General Achievement Levels	**Means**	**Standard Dev.**	**Means**	**Standard Dev.**
Accelerated (no data)				
High	25.38	7.80	25.04	5.50
Middle	21.76	10.89	23.91	11.34
Low	6.32	4.00	3.47	2.77
Mixed	26.04	3.80	26.54	4.36

APPENDIX B - Interview and Observation Guides

FOCUS GROUP INTERVIEW GUIDE
OCTOBER 11, 1995

Now that school year has started, you know your classes, what do you think about the REEP curriculum? What's exciting you and what's troubling you?

What are your students like (the ones you will use REEP with)?

We would like the small group of students we'll interview from your class to be representative of the class as a whole and to reflect the range of kids in the class. What might this mean? What categories do we need to think about to get the range and the representativeness?

How might you select the small group?

What do you hope your students will learn?
What would you see as evidence of student learning?
How can we see that?

What would you like to know from your students about the curriculum?

What would you like us to look at that would help you in the classroom?

What would you like to know about what other teachers are doing?

REEP OBSERVATION GUIDE

- In advance, read about day's lesson in curriculum notebooks.

- Write down an overview of the school setting/neighborhood and school building

In the classroom

Room: How is it set up? What's on walls?

Who are the students (e.g. gender, race)?

How are students participating? What are people doing during lectures? What role do different kinds of students play in hands-on activities? In small groups, who gets materials?

Talk: What kinds of questions are there? Who asks them? Answers them? What are the interruption patterns? Do participants refer to earlier activities/learnings in the curriculum or bring in their prior knowledge?

Teacher: affect? physical position and movement? interactions with students?

Select 3 differently positioned students. Every 10 minutes, note what they are doing.

REEP TEACHER INTERVIEW GUIDE

Interview after class.

Discuss the class you have just observed, both giving your feedback/observations and soliciting the teacher's.

Ask about how the teacher picked students for the focus group and for brief characterizations of their range etc.

What's been most exciting for you so far about the curriculum?
What's been most problematic?
Have there been any surprises/things you didn't expect?

How are students responding?
Do you notice any differences among students' responses (e.g. by gender, achievement, race, interest in science)?
How does the level of the curriculum seem for your students?
If teacher is using REEP with multiple classes: How does the response of the group I observed compare with your other classes?

How are you assessing students?

If other REEP teachers are at the school:
Have you interacted at all with any of the other teachers doing REEP? How?

How would you describe the level of support you've received in preparing for and teaching this curriculum?
What other kinds of support would you have liked?

How does the REEP curriculum fit with you usual teaching style?
How does it compare to the content you usually cover? the level of science you usually teach?

How is it working for you to use such a fully developed curriculum that the Schuylkill Center has asked you to stick to closely?

How is this curriculum fitting into the flow of your year? (Is it continuous with what you're already doing? interruptive?) How do the lessons fit into the way class periods are scheduled at your school?

REEP STUDENT INTERVIEW GUIDE

(A group of 6-8, chosen to reflect a range of academic achievement, gender, race, engagement in REEP/science. Can all be chosen by teacher or by combination of blind draw and teacher)

Explain evaluation and that we're trying to find out what students think of the curriculum. Get participant names for during the interview but explain that no names will be used in report. Ask if people are comfortable with tape recording.

What did you think about today's class? (Ask about specifics as appropriate)

How did you get into this class? (did you choose? Is it for certain students? etc.)

How do you like this curriculum? How does this fit with what you have done in this class so far this year? with other science classes you've taken? (Are you doing new kinds of things in class?)

Before you started this curriculum, how much did you know about the environment?

Do as round: What's the main thing you're taking away from this curriculum so far?/What's the main thing that's stuck with you?/What stands out?

Has the curriculum given you new knowledge or ideas?

Have you shared anything you've learned with others?

Were you already involved in anything you'd call environmental? Has this experience made you want to do something connected to the environment?

Do you think anything in this curriculum will make a difference in your life (career choices, eating, daily habits, activism)?

Do you have any recommendations for how this curriculum could be changed and improved?

APPENDIX C - Surveys

Baseline Survey for REEP Participants - Summer 1995
Research for Action

Your name: _____

School: _____Position:_____

Teaching Experience
What grades do you teach? _____

What subjects do you teach? _____

How many years of teaching experience do you have? _____

Is your school (check any which apply):
_____urban? _____suburban? _____rural?

_____a public school? _____ pariochial (church-affiliated)?

_____ private (not church-affiliated)?

Do you teach in any special programs within your school? Please describe.

What kinds of approaches do you use in the classroom?

What kinds of assessment do you use?

How frequently and in what ways do you use resources outside the classroom?

How would you describe your philosophy of teaching? (briefly)

Professional development
What kinds of professional development activities have you participated in?

What have you found especially helpful and why?

Environmental Education and REEP
Have you received a degree in environmental education?
Have you taught environmental education before? In what contexts?

Have you been involved with environmental issues in the past? How?

What do you see as the purpose of environmental education?

What motivated you to become involved with REEP?

What REEP curriculum will you teach?

What do you, your program/school hope to get out of this work with REEP?

What stands out for you from this week's institute?

What questions or concerns do you have about this week's institute, the REEP curriculum and/or implementing REEP at your school?

Survey for REEP Participants - Summer 1996
Research for Action

Your name: _____
School: _____ Position: _____

What grade(s) do you teach? _____
What subject(s) do you teach? _____
Describe the student body of the class(es) to whom you taught the REEP curriculum.

What time of day did your REEP class(es) meet? _____
How many times per week did you teach your REEP unit? _____
What was the total number of hours required to teach your REEP unit? _____
What time of year did you teach the REEP curriculum? _____
Which REEP curriculum did you teach? _____

What stands out for you about working with the REEP curriculum?

A. Structure and Content of REEP curriculum

1. How was the difficulty level of the curriculum for the class/classes to whom you taught REEP?

2. Did the kinds of assessments that you normally use change when you taught the REEP curriculum? In what ways?

3. Did the amount of material covered in a REEP unit allow you to move at a pace you felt comfortable with as a teacher?

Was this a pace your students felt comfortable with?

4. Are there ways in which the REEP curriculum should be modified in the future for different levels? Please explain.

5. Do you plan to use the REEP curriculum in the future?

Are there way(s) in which you plan to modify it? Please explain.

6. Are there changes that you feel would interfere with the integrity of the curriculum? Please explain.

B. Student Response

1. Did you observe any differences among students' responses to the REEP curriculum by gender, race, prior achievement, and/or interest in science?

Please describe your observations.

2. What stands out for you in terms of what your students came away with from the curriculum? Check all that apply and feel free to elaborate.

____ information
____understanding of concepts underlying environmental issues
____ personal habit changes
____ emotional attachment to environmental causes
____ ideas for future change

What were some of these ideas?

3. Were you surprised by any of your students' reactions to the curriculum?

C. Teaching Style

1. How did REEP fit with your usual teaching style?

2. Have there been any changes in your teaching style that you see as resulting from REEP? Please describe.

3. How do you feel about the way the REEP curriculum laid out the balance of
• discussion, lecture, and experiential learning?

•full class and small group work?

D. Environmental Education and REEP

1. What do you see as the purpose of environmental education?

2. Did REEP meet the goals you held for it prior to the start of the program?

If so, which goals were met?

Which, if any, were not?

3. The following are some goals for REEP that teachers expressed in last summer's survey. Check any of these goals that have been met for you.

____ REEP has served as a catalyst for a push forward with school's ivolvement in environmental education

____ Science has become more interdisciplinary at my school as a result of the REEP program.

____ I feel more up to date with environmental issues as a result of the REEP program.

E. Support

1. *If there were other REEP teachers at your school:*

Did you exchange ideas or work with any of the other REEP teachers at your school? Please explain.

2. How do you feel about the level of suport you have received from your school?

3. How do you feel about the level of support you have received from SCEE?

4. Is there anything that you would have liked more help on?

Please feel free to add any other comments/concerns you might have.