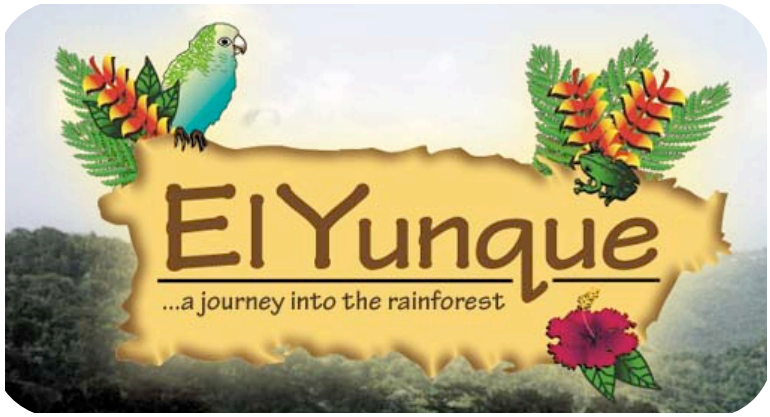

Evaluation of Journey to El Yunque

FINAL REPORT

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Overview of Report

This report describes the design, implementation and outcomes of the NSF-funded Journey to El Yunque curriculum. As formative evaluators, the role of SRI International was to document the development of the curriculum and to collect empirical evidence on the impact of the intervention on student achievement. The evaluation answers four research questions:

(1) How well does the *Journey to El Yunque* curriculum and accompanying assessments align with the National Science Education Standards for content and inquiry?

(2) How do teachers rate the effectiveness of the professional development workshop in teaching them to use the *Journey to El Yunque* curriculum and assessment materials?

(3) How do teachers implement the *Journey to El Yunque* curriculum?

(4) To what extent does the *Journey to El Yunque* curriculum increase students' understanding of ecology and scientific inquiry abilities?

The first research question was addressed with an expert review of the curriculum materials and assessments. Surveys and teacher logs were used to gather information about teacher perceptions of the professional development workshop and of the curriculum materials. Student understanding of content knowledge and science inquiry skills was evaluated using a pretest and a posttest comprised of released state and national test items related to ecology and graph interpretation.

This report begins with a brief overview of the Journey to El Yunque curriculum. The methods and findings related to the alignment study follow. The methods and findings related to research questions 2-4 are discussed within the context of the evaluation research study. The final section of the report contains conclusions and recommendations based on the results of the evaluation.

Description of *Journey to El Yunque* Curriculum and Assessments

Journey to El Yunque was designed as to provide students with a knowledge base of ecology content and incorporates content addressed by the National Science Education Standards, nationally-implemented textbooks, and El Yunque scientists. The curriculum is designed as a replacement unit for approximately two textbook chapters that typically cover ecology content at the middle school

level. *Journey to El Yunque* contains modules on Resource Cycles (water, carbon, nitrogen), Producers (Yagrumo and Tabonuco tree species), and Consumers (snails, mushrooms, walkingsticks, caterpillars, coqui, and anoles), and a food chain activity with caterpillar, anole, Yagrumo and Tabonuco species represented.

Students are taught about dynamic ecological systems in the Journey to El Yunque modules through symbolic simulations developed with *STELLA* modeling software. The simulations are presented to students on the website in Flash. These simulations are used to illustrate how populations of trees, coquí, walking sticks, snails, mushrooms, caterpillars and anoles may be affected by environmental changes due to the hurricane. Students can manipulate features of the environment (e.g., amount of hurricane debris, number of predators) and explore how the populations change. These simulations are key to enabling students to develop inquiry skills. For example, students use a graphing tool to predict how the animal populations will change in the 60 months following a hurricane. This modeling activity also is intended to teach students about the advantages and limitations of using computer simulations to model real ecological phenomena.

Instructional Approach

Journey to El Yunque is designed to promote a cognitive apprenticeship approach to teaching science inquiry about complex ecological relationships. The inquiry process is scaffolded so that students learn how to analyze data in order to draw conclusions about research questions. The apprenticeship processes include modeling, coaching and feedback from the teacher. In addition, scaffolding of inquiry may be provided through written materials provided to students (e.g., tables that help students to organize data).

Summative Student Assessment

The summative student assessment is a test of ecology knowledge, which includes publicly released ecology items from state and national science tests. The 31-item assessment addresses topics taught in the curriculum, such as population dynamics, energy flow, and graph interpretation.

Expert Review of Curriculum and Assessments

To investigate the first research question (*How well does the Journey to El Yunque curriculum and accompanying assessments align with the National Science Education Standards for content and inquiry?*), two science teaching experts and one ecology expert were invited to review the beta test version of the Journey to El Yunque curriculum. They were asked to make judgments about the module activities and assessment items (formative worksheets and summative pre- and post-test items). The review of curriculum materials focused on the Producers and Consumers Modules. The Producers Module contained two activities and the Consumers Module contained four activities for a total of six activities reviewed. The beta test version did not contain the introductory resource cycling activity nor the culminating food chain activity.

The expert panelists were introduced to the six module activities and worksheets, summative assessment items, and rating procedures. Computers were provided to panelists so that they could view a CD-ROM with the *Journey to El Yunque* Web site. In addition, panelists made independent judgments about the module activities and worksheets and the summative assessment items.

For each of the six activities in the beta test curriculum and for each summative assessment item, panelists made judgments about: (1) alignment with the National Science Education middle school life science standards; (2) alignment with important ecological concepts; (3) alignment with the National Science Education inquiry standards; (4) scientific accuracy; (5) required reasoning skills (i.e., recall, analysis, comparison, inference, and evaluation) based on the Quellmalz Framework (Stiggins, 1986) and (6) grade-level appropriateness (i.e., specialized vocabulary, reading load, math skills load, graphics load, and computer manipulation and navigation). Panelists made summary judgments related to the representation of important ecological concepts, the extent to which curriculum materials and assessments prepare students to use science in the world, and developmental appropriateness. Each summary judgment was made twice (once in relation to all of the reviewed curriculum materials and once in relation to all of the summative assessment items). Panelists also made two overall judgments about the formative and summative assessment items: (1) the extent to which formative assessment items are likely to provide useful information to teachers about student

attainment of knowledge and skills; and (2) the extent to which summative assessment items are likely to provide useful information to stakeholders for accountability purposes.

Findings

As shown in Table 1, content related to *Regulation and Behavior* and *Population and Ecosystem* standards was most prevalent in the modules and assessment items. Two activities addressed *Diversity and Adaptations of Organisms* content. The ecological concepts *Requirements for Life*, *Interaction with the Environment*, *Disturbance*, *Population*, *Habitat*, *Limiting Factors*, *Predator-Prey*, and *Population Dynamics* were addressed in most of the activities and in many of the summative assessment items. Eleven items were identified as not representing any Life Science Standard or ecological concept. Eight of these items were graph interpretation items with little, if any science content. As shown in Table 2, most activities and summative items addressed one of three inquiry standards: *Develop Descriptions, Explanations, and Predictions*, *Think Critically and Logically to Make Relationships between Evidence and Explanations*, or *Use Mathematics in All Aspects of Scientific Inquiry*. The other five aspects of scientific inquiry were not widely represented in the activities or items.

Table 1

Number and Percentage of Module Activities and Summative Assessment Items Related to Life Science Standards and Ecological Concepts

NSES Life Science Standard	Ecological Concept	Activities* (n = 6)		Items (n = 33)	
		#	%	#	%
Regulation and Behavior	Requirements for Life	5	83%	10	30%
	Interaction with the Environment	5	83%	13	39%
	Disturbance	6	100%	3	9%
	Adaptation	2	33%	0	0%
	Life History	1	17%	0	0%
Populations and Ecosystems	Population	5	83%	6	18%
	Community	2	33%	3	9%
	Ecosystem	3	50%	14	42%
	Habitat	4	67%	4	12%
	Diversity	0	0%	1	3%
	Producer	2	33%	5	15%
	Decomposer	1	17%	2	6%
	Consumer	1	17%	4	12%
	Niche	2	33%	1	3%
	Herbivore	1	17%	2	6%
	Carnivore	1	17%	2	6%
	Omnivore	0	0%	0	0%
	Food Chain	1	17%	5	15%
	Food Web	0	0%	3	9%
	Trophic Cascade	0	0%	3	9%
	Water Cycle	0	0%	1	3%
	Nitrogen Cycle	1	17%	0	0%
	Carbon Cycle	0	0%	0	0%
	Limiting Factors	6	100%	6	18%
	Predator-Prey	4	67%	5	15%
	Population Dynamics	6	100%	8	24%
	Competition	1	17%	2	6%
	Symbiosis	1	17%	0	0%
	Mutualism	1	17%	0	0%
	Commensalism	1	17%	0	0%
	Parasitism	2	33%	0	0%
Diversity and Adaptation	Extinction	2	33%	0	0%
No Life Science Standard	Pioneer Species	2	33%	0	0%
	Succession	2	33%	0	0%
	Community Maturity	2	33%	0	0%
	Mature Species	2	33%	0	0%
	No Ecological Concept	0	0%	11	33%

**Note*. Activities include: Producers Background Reading, Producers Model Activity, Consumers Background Reading, Consumers Prediction Activity, Consumers Model Activity, and Consumers Model v. Actual Activity. Worksheets that accompany each activity were also included in the review of each activity.

Table 2

Number and Percentage of Module Activities and Items Related to NSES Inquiry Standards

	Activities* (n = 6)		Items (n = 33)	
	#	%	#	%
Identify Questions That Can Be Answered Through Scientific Investigations				
Clarify and focus questions that guide investigations	0	0%	0	0%
Identify scientific ideas, concepts, and quantitative relationships that guide investigations	0	0%	0	0%
Identify questions and inquiries that are directed toward observations and measure of objects and natural phenomena	1	17%	0	0%
Design and Conduct a Scientific Investigation				
Identify and control appropriate variables in an experiment	0	0%	0	0%
Describe how to collect systematic observation and/or detect inaccuracies	0	0%	0	0%
Describe how to collect accurate measurements and/or detect errors in measurement	0	0%	0	0%
Describe how to interpret/analyze data	0	0%	1	3%
Use Appropriate Tools and Techniques to Gather, Analyze, and Interpret Data				
Describe/use tools and techniques to gather data	2	33%	0	0%
Describe/use tools and techniques to organize data	1	17%	0	0%
Develop Descriptions, Explanations, Predictions, and Models Using Evidence				
Describe observations made during an experiment	1	17%	0	0%
Use evidence, logical argument and subject matter knowledge to explain	4	67%	2	6%
Use evidence, logical argument and subject matter knowledge to predict	2	33%	4	12%
Use evidence, logical argument and subject matter knowledge to create models	1	17%	0	0%
Think Critically and Logically to Make Relationships between Evidence and Explanations				
Decide what evidence to use	3	50%	3	9%
Decide how to account for anomalous data	0	0%	0	0%
Review and summarize data to form a logical argument	4	67%	4	12%
Describe or explain possible relationships between two or more variables	4	67%	4	12%
Recognize and Analyze Alternative Explanations and Predictions				
Identify different ideas	1	17%	0	0%
Consider alternative explanations	0	0%	0	0%
Communicate Scientific Procedures and Explanations				
Describe observations to new audience	0	0%	0	0%
Summarize results to new audience	0	0%	0	0%
Use Mathematics in All Aspects of Scientific Inquiry				
Use math to structure questions and explanations	4	67%	0	0%
Use math to gather, organize, and present data	0	0%	1	3%
Use math to answer questions	4	67%	10	30%
No Inquiry	1	17%	14	42%

**Note*. Activities include: Producers Background Reading, Producers Model Activity, Consumers Background Reading, Consumers Prediction Activity, Consumers Model Activity, and Consumers Model v. Actual Activity. Worksheets that accompany each activity were included in the review of each activity.

Overall, the modules, as represented by the six beta test activities, and assessments were considered to be appropriate for middle school students and aligned with each other. As a replacement unit, the curriculum covered the critical ecology content, as well as additional topics and skills. Most of the inquiry skills are scaffolded, except for skills related to drawing conclusions based on data, which is appropriate for the middle school level.

Evaluation Research Study

Study Design

A small-scale quasi-experiment was conducted to examine the impact of the curriculum on student achievement. Random assignment of teachers to the treatment condition (Journey to El Yunque) or control condition (regular ecology unit) was attempted. Seven pairs of teachers were randomly assigned to one of the two experimental conditions. Teachers were assigned to conditions within school; each treatment teacher had a control teacher at his or her school. However, random assignment of teachers to condition was not able to be maintained due to unforeseen logistical problems, and only data from 4 pairs of teachers is included in the study.[1] Prior to any ecology instruction students were given a 50-minute pretest that assessed their knowledge of ecology concepts. On the day after the last activity in the ecology curricula, teachers administered a 50-minute posttest. The posttest was not the same as the pretest, but it addressed the same content and included items on graph interpretation. Teachers agreed to teach the ecology unit (Journey to El Yunque or regular ecology unit) during the same time period and to administer pretests and posttests on the same days before and after the unit.

[1] Random assignment was not maintained because one treatment teacher could not attend the workshop due to illness and her control partner attended instead. In another instance, the control teacher was reassigned to a different grade level. The treatment teacher recruited another control teacher to replace the original control teacher. Data from only four pairs of teachers is included because a teacher from one pair died, the treatment teacher from another pair was reassigned to teach a different subject, and a third pair did not submit any data after implementing the program. The data was lost when the treatment teacher was hospitalized due to complications from her pregnancy.

Professional Development for Treatment Teachers

A 2-day workshop was designed to help treatment teachers with the logistics of implementing the Journey to El Yunque curriculum. The teachers met at a high school computer laboratory in Williamsburg, VA on June 28 and 29, 2005. On Day 1, the teachers reviewed the activities and accompanying formative assessment worksheets for each module. The teachers were divided into teams that focused on different activities within the unit to simulate the jigsaw approach that might be used with their students. Each teacher group summarized what they learned and provided feedback on the activities. After reviewing the activities, teachers worked to prepare to teach the producers activities. On Day 2, 15 students also attended the workshop. Pairs of teachers were assigned to work with groups of 3 to 4 students on the Producers activities. This exercise gave teachers the opportunity to practice implementing the curriculum and get feedback from students about their experience. The teachers conducted a focus group with the students at the end of the activity. The teachers commented at the workshop that they were surprised at how much information the students retained. In the afternoon of Day 2, the teachers reviewed new screen designs for the *Journey to El Yunque* web site and provided input on the revisions of activities.

Teacher Sample

Teachers completed a survey including questions about their teaching background, their perceptions about how prepared they are to teach the content and inquiry skills addressed in the *Journey to El Yunque* curriculum, their proficiency using technology, and the extent to which their existing science curriculum is integrated with technology. Table 3 summarizes the findings from the background survey. Although treatment teachers on average had more teaching experience than comparison teachers, both groups had a similar distribution of responses to questions about feeling prepared to teach ecology content and inquiry, technology proficiency and the extent to which their technology is integrated with their science units.

Table 3

Teacher Background

Condition	Pair ID	Teacher ID	Grade	Teaching Experience (Years)	Prepared to Teach Content	Prepared to Teach Inquiry	Technology Proficiency	Technology Integration with Science
Treatment	A	1	7	24	*Very*	*Very*	*Adequately* to *Very*	*Infrequent*
	B	2	8	40	*Very*	*Very*	*Adequately* to *Very*	*Frequent*
	C	3	7	20	*Somewhat* to *Adequately*	*Somewhat*	*Not at all* to *Somewhat*	*Moderate*
	D	4	6	3	*Somewhat* to *Adequately*	*Somewhat* to *Adequately*	*Somewhat* to *Adequately*	*Infrequent*
Comparison	A	5	7	7	*Somewhat* to *Adequately*	*Adequately* to *Very*	*Somewhat* to *Adequately*	*Frequent*
	B	6	8	3	*Somewhat* to *Adequately*	*Adequately*	*Adequately* to *Very*	*Infrequent*
	C	7	7	3	*Adequately* to *Very*	*Adequately* to *Very*	*Adequately* to *Very*	*Infrequent*
	D	8	6	missing	*Adequately* to *Very*	*Somewhat* to *Adequately*	*Adequately* to *Very*	*Frequent*

Student Sample

441 students were included in this study with 247 in the treatment condition and 194 in the comparison condition. Table 4 shows the student distribution by sex, grade level, ethnicity, and science achievement level (based on teacher ratings). Treatment and comparison groups were relatively comparable in the student distribution by sex and ethnicity. There are more seventh grade students and fewer eighth grade students in the treatment condition in contrast to the comparison condition. Both groups have small percentages of sixth grade students. There is also a slightly greater percentage of students rated as high science achievers and a slightly lower percentage of students rated as low science achievers in the treatment condition, in contrast to the comparison condition.

Table 4

Student Demographics

	All Students		Treatment		Comparison	
	n	%	n	%	n	%
Sex						
Male	217	49.2	126	51.0	91	46.9
Female	216	49.0	119	48.2	97	50.0
Grade						
6	40	9.1	22	8.9	18	9.3
7	262	59.4	170	68.8	92	47.4
8	139	31.5	55	22.3	84	43.3
Ethnicity						
American Indian or Alaskan Native	8	1.8	4	1.6	4	2.1
Asian	14	3.2	11	4.5	3	1.5
African American	12	2.7	4	1.6	8	4.1
Hispanic	92	20.9	39	15.8	53	27.3
Caucasian	240	54.4	149	59.1	94	48.5
Multi-group*	36	8.2	35	14.1	28	14.4
Science Achievement						
Low	129	29.2	54	21.9	75	38.6
Medium	184	41.7	114	46.2	70	36.1
High	121	27.4	75	30.4	46	23.7

Note. Some student demographic data was missing, so total counts may add up to less than 441 (all students), 247 (treatment), 194 (comparison).
*Many students selected multiple groups to specify their ethnicity.

Instrumentation

A measure of students' ecology content knowledge and graph interpretation skills was the primary student outcome measure. Several process measures were used to track factors that could explain the effectiveness or ineffectiveness of the intervention. Table 5 outlines the instruments that were used, when they were administered, and to whom they were administered.

Table 5

Instruments and Administration

Instruments	Administration	Sample
Ecology Achievement Pretest	Day before ecology unit taught	All Students
Ecology Achievement Posttest	Day after ecology unit completed	
Ecology Unit Perceptions	Day after ecology unit completed	
Teacher Workshop Survey	After professional development workshop	All Teachers
Teacher Implementation Survey	End of each week or module	

Ecology Achievement Tests. The Learning Partnership and SRI International developed a strategy to approximate performance on state tests. A test of ecology knowledge was developed using publicly released ecology items from state and national science tests. This strategy ensures that the content covered on the test is consistent with the standards, but provides the flexibility and precision to detect differences that might exist between the *Journey to El Yunque* and control implementations. The items were categorized into the following topics: population dynamics, energy flow definitions, and graph interpretation. Population dynamics questions asked students to speculate how changes to an environment would affect particular species. Energy flow definition questions asked students about the meaning of basic food web terms (e.g., predator, prey, herbivore, consumer, and producer). Graph interpretation items were drawn from math test banks and asked students to interpret graphs across a number of science and nonscience domains. Items were randomly selected from the pool of state test items in each category. After initial piloting, it was determined that the assessment was too easy. Therefore, the easiest items were dropped and more difficult items were added. Overall, the assessment instrument was internally consistent; the Cronbach alpha was .78.

A similar test of ecology was administered as the pretest. It was created using a process similar to the posttest development process. It was based on the items remaining in the same pool of released state and national science test items that were used to create the posttest. The pretest was also internally consistent (Cronbach alpha = .83) and will serve as a covariate for in analyses.

Ecology Unit Perceptions. After completing the posttest, students were asked the following questions about ecology and their ecology unit: *How challenging has your ecology unit been?*; *How successful were you on your ecology unit?*; *How much fun was your ecology unit?*; and *How interested are you in pursuing a job in ecology as a possible future career?* All items were answered on 5-point Likert scales ranging from 1= *Not at all* to 5 = *Very*.

Teacher Workshop Surveys. Teacher workshop surveys were used to document and evaluate the professional development workshop activities. Teachers were asked about the appropriateness

and utility of the content presented and to describe the most and least valuable aspects of the workshop. Teachers were also asked to judge the extent to which they feel prepared to teach Journey to El Yunque.

Teacher Implementation Surveys. Teacher implementation surveys were used to document the implementation of the ecology units. Teachers in the treatment condition were asked to complete a survey for each module after they have completed instruction on the module (typically once a week for 4 weeks). The survey included questions about the number of students who completed the module, the number of class periods needed, the extent to which students were able to work independently, student attention and interest in the module, usefulness of the module for teaching students about ecology, supplemental materials used, instructional approaches used, and time spent on computers. Teachers were also asked to describe any difficulties they had during the module and how they would improve the module.

Teachers in the control condition completed weekly surveys in which they were asked to describe the activities completed by students, the number of students who completed the activities, the number of class periods needed, the extent to which students were able to work independently, student attention and interest in the activities, usefulness of the activities for teaching students about ecology, instructional approaches used, and time spent on computers. To the extent possible, the implementation surveys used in the treatment and control conditions had parallel sets of questions.

Findings

Effectiveness of Professional Development Workshop. For both days of the workshop, a majority of teachers felt that the workshop content level and pacing were appropriate and that the workshop was collaborative and interesting. Most teachers believed that the quality of the curriculum materials was high and unanimously rated the overall quality of the workshop as excellent. Teachers also reported that the workshop was sufficient preparation for teaching *Journey to El Yunque*.

***Journey to El Yunque* Implementation.** Treatment teachers completed surveys to document the implementation of *Journey to El Yunque* or their regular ecology unit. Teachers reported on the

activity structure and instructional approach, provided feedback on technology difficulties and made suggestions for ways to improve the activities.

Activity Structure. Teachers varied greatly in how they structured the components of the *Journey to El Yunque* curriculum. Teacher 1 implemented the unit during 9 consecutive school days between January 25 and February 6, 2006. On Days 1 and 2, Teacher 1 taught the Resources and Producers activities. On Day 3, she taught Resources, Producers, and Consumers activities. On Days 4 and 5, she taught Producers and Consumers activities, and on Days 6 through 9 she taught Consumers and Food Chain activities.

Teacher 2 taught the curriculum during 40 days in September, October, and November 2005 and in January 2006. She began with the Resources activities, which were completed over 10 consecutive school days from September 19-30. She taught the Producers activities next. Most of these activities were taught over a period of 9 consecutive school days from October 3-13, and the final Producers activity was completed on October 17. She began the Consumers unit on October 31. Most Consumers activities were completed over a period of 9 consecutive school days from October 31-November 10. The final Consumers activity was completed on November 14. She began the Food Chain activity in January. Again, most of the activities were completed over a period of 9 consecutive school days from January 3-13, with the final activity completed on January 17.

Teacher 3 completed the curriculum during 12 class periods in October 2005. She began with the Producers activities, which were completed on October 5 and 6. On October 18, she began the Consumers activities, and these activities were completed over 5 consecutive school days. The Food Chain activities were introduced to students on October 25 and completed them on October 27. The Resources activities were implemented on October 28 and 31.

Teacher 4 only implemented the Producers, Consumers, and Food Chain activities. These activities were completed in May and June 2006. The Producers activities were taught on 4 consecutive school days starting on May 22. She taught the Consumers activities on June 8 and June 12-15. The Food Chain activities were taught on June 19 and 21.

Table 6 summarizes the number of full or partial class periods that each teacher spent on the *Journey to El Yunque* activities.

Table 6

Number of Class Periods Devoted to Journey to El Yunque Activities by Teacher

	Partial Lessons	Full Lessons	Total Partial and Full Lessons	Total Class Periods
Teacher 1				
Resources	2	1	3	9*
Producers	3	2	5	
Consumers	5	2	7	
Food Chain	2	2	4	
Teacher 2				
Resources	8	2	10	40
Producers	8	2	10	
Consumers	8	2	10	
Food Chain	8	2	10	
Teacher 3				
Resources	2	0	2	12
Producers	0	2	2	
Consumers	5	0	5	
Food Chain	3	0	3	
Teacher 4				
Resources	0	0	0	11
Producers	4	0	4	
Consumers	5	0	5	
Food Chain	2	0	2	

Note. Partial Lesson is defined as less than 50% of a class period devoted to an activity. Full lesson is defined as greater than 50% of a class period devoted to an activity.
*Teacher 1 taught material on multiple activities during single class periods, so the total number of partial and full lessons is greater than the total number of class periods spent on *Journey to El Yunque*.

All teachers implemented the worksheets associated with each activity. All teachers supplemented the Journey to El Yunque materials with some of their own materials. Teacher 1 used drawings from the textbook to help students understand the resource cycles. Teacher 2 provided students with a brief review of basic life science concepts as part of the Producers activity. Teacher 2 also used other materials to review the water cycle, reviewed characteristics of living organisms, provided students with a map of the Caribbean region and Puerto Rico, and asked her students to use

the Web to find El Yunque. Teacher 4 reported that she had to supplement the *Journey to El Yunque* materials "a little," but did not provide details about the resources that she used.

Instructional Approaches. Table 7 shows the range of instructional approaches used by each of the treatment teachers.

Table 7

Instructional Approaches Used by Treatment Teachers

	Teacher 1	**Teacher 2**	**Teacher 3**	**Teacher 4**
Lecture to entire class	X		X	X
Demonstrate exercises at the board			X	X
Use manipulatives or audio-visual material to demonstrate a concept		X		
Use computers to read information	X	X	X	X
Use computers for interactive activities	X	X	X	
Demonstrate an experiment				X
Lead question and answer session		X	X	
Lead whole class discussion		X		
Assign students to work independently	X		X	
Assign students to work in groups			X	
Correct or review homework	X			

Feedback on Curriculum and Technology. Teachers 2, 3, and 4 did not report any difficulties using the technology (e.g., Web access or functionality of simulation-based activities). Teacher 1 reported that only half of her computers could use the flash part of the Food Chain model. In terms of content, Teacher 1 recommended decreasing the Consumer reading segments and simplifying the Resource cycle activity. Similarly, Teacher 2 reported that Resource activity was difficult for her students to understand. Teacher 3 felt that the model vs. actual Consumer activity was confusing for her students and so she made this into a whole-class activity. Teacher 3 also recommended providing answer keys for the worksheets.

Implementation of Comparison Curricula. Teacher 5 taught her ecology for 6 days in the same school and during the same 4 week period as Teacher 1. Although teachers in the same school were supposed to teach ecology during the same time period, Teacher 6 (who was matched with Teacher 2) began teaching ecology on October 13 and taught the ecology activities over 6 non-

consecutive class periods, finishing the unit on November 8. Teacher 7, who was matched with Teacher 3, completed an ecology unit during 19 class periods in the same time frame that Teacher 3 was implementing *Journey to El Yunque*. Teacher 8 began her ecology unit approximately 2 weeks after Teacher 4 began implementing Journey to El Yunque, and finished the unit approximately 2 weeks after Teacher 4. Teacher 4 spent about 19 days on her ecology unit. Table 8 summarizes the total number of days treatment and comparison teacher pairs devoted to teaching ecology.

Table 8

Number of Days Devoted to Ecology for Treatment and Comparison Teachers

Pair ID	Teacher ID	Condition*	Total Number of Days
A	1	T	9
	5	C	6
B	2	T	40
	6	C	6
C	3	T	12
	7	C	19
D	4	T	11
	8	C	19

Note. T= Treatment; C = Comparison

Table 9 summarizes the instructional approaches used by teachers in the comparison group. Only Teacher 8 reported that her students used computers. During the first week, students conducted research and used computers to locate 6 biomes. During the second week, students used computers to research a biome, a specific animal in the biome, and threats to the biome. Teacher 8 also introduced Microsoft PowerPoint to her students as a presentation tool. During the third week, students used computers to present their work to the class.

Table 9

Instructional Approaches Used by Comparison Teachers

	Teacher 5	Teacher 6	Teacher 7	Teacher 8
Lecture to entire class	X	X	X	X
Demonstrate exercises at the board	X		X	X
Use manipulatives or audio-visual material to demonstrate a concept	X	X	X	X
Use computers to read information				X
Use computers for interactive activities		X		X
Use computers (other)		X		X
Demonstrate an experiment		X	X	
Lead question and answer session	X	X	X	X
Lead whole class discussion	X	X	X	X
Assign students to work independently	X	X	X	X
Assign students to work in groups	X	X	X	X
Correct or review homework	X	X		X
Other ("Mapping")	X			

The findings from the implementation surveys helped to document the differences among the treatment and comparison teachers. Teachers in the comparison group were relatively comparable to the teachers in the treatment condition in terms of the methods they used to teach their students, aside from computer use. However, differences in exposure to ecology content were somewhat more uneven within and among teachers in each group. Despite some of these variations in implementation, it still seemed reasonable to examine the impact of the *Journey to El Yunque* curriculum on student performance.

Student Performance. One of the main research questions of the evaluation study was to examine how student performance differs for students in the treatment and comparison conditions. Descriptive statistics are presented first and followed by findings from an analysis of covariance to test differences between groups.

Descriptive Statistics. Pretest and posttest means are presented in Table 10. A t-test demonstrated that pretest means did not differ significantly for treatment and comparison groups [$t(439) = 5.14$, $p = .53$.

Table 10

Pretest and Posttest Means by Condition, Sex, Grade, and Prior Science Achievement

	n	Pretest		Posttest	
		M	***SD***	***M***	***SD***
All Students	441	17.25	5.77	14.09	4.89
Condition					
Treatment	247	17.40	5.49	14.52	4.77
Comparison	194	17.06	6.12	13.55	4.99
Sex*					
Male	217	17.53	5.94	14.40	4.80
Female	216	17.11	5.49	13.84	4.96
Grade					
6	40	14.05	3.63	9.28	3.16
7	262	17.70	5.73	14.05	4.72
8	139	17.33	6.09	15.54	4.73
Science Achievement*					
Low	128	13.61	5.26	11.30	4.53
Medium	183	17.25	4.99	13.87	4.08
High	121	21.14	4.82	17.52	4.39

*Total student count does not add up to 441 because there is missing data for sex and prior science achievement ratings.

Effect of Condition on Student Performance. Table 11 shows findings from an analysis of covariance. Students in the treatment condition scored significantly higher on the posttest than students in the comparison condition [effect size *(d)* = .20].

Table 11

Analysis of Covariance for Student Performance

Source	***df***	***F***	***p***
Pretest (Covariate)	1	353.91***	.00
Condition (Treatment or Comparison)	1	4.97*	.03
S within-group error	438	(13.146)	

Note. Values enclosed in parentheses represent mean square errors. S = subjects. *$p < .05$. ***$p < .001$.

Student Perceptions. Table 12 shows findings from analyses of variance for student perceptions related to (1) level of challenge of their ecology unit, (2) how successful they were on their ecology unit, (3) how fun their ecology unit was, and (4) how interested they are in pursuing a

job in ecology. Students in the treatment group were less likely to perceive their ecology unit as challenging compared to students in the comparison condition on average ($M_T = 2.80$, $M_C = 3.01$) and were less likely to perceive the unit as fun on average ($M_T = 2.91$, $M_C = 3.23$). Students in the treatment group also were more likely to think that they were successful on the ecology unit on average ($M_T = 3.64$, $M_C = 3.47$), although this mean difference is only approaching significance. The mean difference between the two groups in desire to pursue an ecology career was not significant.

Table 12

Analysis of Covariance for Student Perception Outcomes

Source	***df***	***F***	***p***
Level of Challenge			
Condition (Treatment or Comparison)	1	5.66*	.02
S within-group error	406	(.77)	
Perception of Success on Ecology Unit			
Condition	1	3.42~	.07
S within-group error	405	(.87)	
Perception of Ecology Unit as "Fun"			
Condition	1	6.84*	.01
S within-group error	407	(1.57)	
Desire to Pursue Ecology Career			
Condition	1	.60	.43
S within-group error	406	(1.35)	

Note. Values enclosed in parentheses represent mean square errors. S = subjects. ~ $p < .10$. *$p < .05$.

Conclusions

Journey to El Yunque is a well-designed curriculum and assessment replacement unit that addresses important science content and inquiry skills. The curriculum and assessments are aligned to life science content standards and key ecological concepts, and materials cover a broad range of these standards and concepts.

The research study revealed interesting patterns of implementation of the *Journey to El Yunque* curriculum. Teachers varied in the amount of time that they spent on each section of the unit and in when they implemented the Resources activities (either first or last in the sequence of activities). This variation in implementation illustrates the flexibility of the curriculum to meet the needs of different teachers who intend the use the curriculum as a replacement or supplementary unit. However, this amount of variation in implementation raises concerns from an evaluation perspective. The treatment was not consistent for all students in the treatment condition. Students were not exposed to the content for the same duration, and changing the order with which the content is presented could change the nature of the concepts that arise as the materials are introduced. In future evaluation studies in which the goal is to test the efficacy of the curriculum, it will be necessary to provide teachers with more explicit implementation guidelines with respect to pacing of activities and order with which activities must be taught. In addition, in any future evaluations, it will be necessary to ensure that the samples of treatment and control teachers have more equivalent teaching experience.

Given some of these limitations in the evaluation study design, the analyses show that students who participate in the *Journey to El Yunque* curriculum learn more ecology than students in typical ecology classes. Students in *Journey to El Yunque* also seemed to feel more confident about their performance during the curriculum. *Journey to El Yunque* students reported feeling less challenged and more successful, on average, than students in the comparison condition. Given the novelty of this simulation-based curriculum, one might have expected that *Journey to El Yunque* would have also reported that their unit was more fun. However, students in the comparison condition were more likely, on average, to believe that their ecology unit was fun. Perhaps this finding reflects challenges that the *Journey to El Yunque* teachers faced in implementing a new curriculum. Although the *Journey to El Yunque* teachers did not report any significant problems or difficulties with the curriculum, any uncertainty or frustration that they may have experienced in learning how to teach the unit may have been conveyed to students either implicitly or directly.

The Learning Partnership has developed a strong curriculum, and we encourage Dr. Steven McGee and his colleagues to continue to refine the materials, as funding permits. One area that is worthy of further development is teacher materials. Rubrics for activity worksheets and suggestions for how to introduce materials should be provided to teachers. In addition, the Resources activities could be supplemented to assist teachers and students in interpreting the complex models and diagrams. While the student assessments appear to be appropriate measures of ecology content knowledge, it may be interesting to include computer-based items that require students to test hypotheses by manipulating models, as they do in the *Journey to El Yunque* curriculum. These types of items should be particularly sensitive to the instruction provided by the curriculum.

References

Stiggins, R. J., Rubel, E., & Quellmalz, E. S. (1986). *Measuring thinking skills in the classroom*. Washington, DC: NEA Professional Library.