

THE STUDENT IMPACT STUDY OF THE ALLIANCE+ PROJECT: THREE CASE STUDIES IN K-12 TECHNOLOGY INTEGRATION

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Alliance 



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Printed in the United States of America.

ISBN 1-931300-29-1

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ABSTRACT

This report presents a general framework for the evaluation of an in-service internet education program for K-12 teachers. Based on the literature of effective integration of technology in the classroom and formative evaluation studies conducted over the past four years, the framework identifies specific criteria for the effective integration of unique and compelling applications of the internet in the classroom. The criteria encompass six distinct categories that define the teaching and learning environment: (1) clearly defined learning objectives; (2) alignment of those objectives with national curriculum standards, state curriculum standards, or both; (3) inquiry-based learning tasks that rely on both group and individual work; (4) appropriate student use of diverse technology tools and resources; (5) appropriate use of assessment to guide and measure student learning; and (6) students' sharing of results with an audience beyond the classroom as a means to connect classroom learning with the local community and larger communities of learners. Three case studies from the Alliance+ project are presented to illustrate an application of the framework. The study should be of interest to policymakers and all those working on diverse approaches to school reform, including student-centered learning, inquiry-based learning, project-based learning, and the effective integration of technology in the classroom.

ACKNOWLEDGMENT

The work reported herein was supported under the Technology Innovation Challenge Grant program as administered by the Office of Learning Technologies, U.S. Department of Education.

FOREWORD

Alliance+, a five-year U.S. Department of Education Technology Innovation Challenge Grant, affected nearly 7,000 K-12 teachers and more than a half million students through a distinctive partnership among community colleges, a major technical university, a college of teacher education, and several other educational organizations dedicated to improved teaching and learning. This collaboration positively affected K-12 schools and resulted in beneficial outcomes for the partner institutions of higher education focused on improving teachers' and students' use of technology in the classroom.

Community colleges engaged in the business of teaching and learning continue to weave a web of delicate balance supporting high-quality teacher professional development and teacher preparation. Through national partnerships and collaborations, community colleges have established proven practice in the art of infusing strategies and methodologies supporting the use of the internet in K-12 classrooms.

Alliance+ exemplifies the important role community colleges play in teacher education and professional development. Nearly 7,000 K-12 classroom teachers have been trained in metropolitan Cleveland (OH), Miami-Dade County (FL), and Phoenix, and throughout Arizona over the past five years in unique and compelling uses of the internet through a curriculum called Savvy Cyber Teacher®, a 30-hour course for K-12 teachers. The course is unique in that technology enhancement is not the primary goal; rather it is used mainly as a means to bring rich curriculum resources to students.

This dynamic curriculum, sporting real-time data projects for students, was developed by the Stevens Institute of Technology's [Center for Improved Engineering and Science Education \(CIESE\)](#). CIESE realized that in the late 1990s, internet and technology practice played a limited role in most K-12 schools. However, they saw a far greater vision for the use of the internet and believed that more compelling applications of this technology could vastly enrich the classroom environment.

Community colleges were chosen by the League for Innovation and CIESE to demonstrate a national model for local partnerships between two-year colleges and neighboring school districts in the area of teacher preparation. Three leading colleges – Maricopa Community Colleges in Arizona, Cuyahoga Community Colleges in Ohio, and Miami-Dade Community Colleges in Florida – were chosen based on an excellent history of K-12 partnerships and an emphasis on quality teacher preparation. The goal of Alliance+ was not only to deliver the 30-hour Savvy Cyber Teacher professional development program for practicing teachers, but also to create an infrastructure of ongoing face-to-face and technology-based support systems that would continue to link K-12 schools with community colleges in the future.

Edward A. Friedman, the Director of CIESE and Alliance+, envisioned the match between community colleges and local school districts, stating that the program builds upon and expands the linkages that already exist and provides additional vehicles for ongoing collaboration to enrich and enhance schools' use and integration of technology.

The project aligns three very different models directed specifically at teacher professional development, yet the far reaching impact on students is undeniable. Approximately half a million students have benefited and participated in real-life applications of unique and compelling projects that can only be accomplished by the internet. Students now have access to the same real-time data and information accessible only to scientists just a few years ago. The data ranges from real-time weather satellite images to data from ships at sea to hourly air quality readings to images from the Hubble Space Telescope. Through many collaborative partnerships, this project has impacted the lives of children and opened the doors to future use of technology in the classroom.

Community colleges continue to evolve with a current emphasis in teacher preparation. The National Association of Community College Teacher Education Programs (NACCTEP), founded by Maricopa Community Colleges, the American Association of Community Colleges, Cerritos Colleges, and the League for Innovation, is an organization that promotes the community college role in the recruitment, preparation, retention, and renewal of diverse PreK-12 teachers. As the community college role in teacher preparation

emerges as a solution to the teacher shortage, many issues surface for consideration. Quality programs must be developed that address the recruitment, preparation, and retention of education candidates. The National Science Foundation's semiannual report, "Investing in Tomorrow's Teachers: The Integral Role of Two-Year Colleges in the Science and Mathematics Preparation of Prospective Teachers" (1998), estimated that 20 percent of today's teachers began their higher education at community colleges, suggesting the vital role these colleges play in preparing the teachers of tomorrow. Boggs and Bragg (1999) report that about 40 percent of teachers completed some – and many completed all – of their science and mathematics coursework at two-year colleges. This aligns with the mission of community colleges as they respond to the need to educate teachers in new and nontraditional ways.

An exciting outgrowth of the Alliance + project is the current development of the Savvy Cyber Professor, a training program for community college math and science faculty. Professor expands the project scope to include community college faculty using the internet as part of their instructional repertoire to enhance instruction and serve as role models for future teachers who experience the power of the internet in a teaching and learning environment.

Alliance+ is a nationally recognized training program, with embedded curriculum materials that have been recognized by the U.S. Department of Education's Eisenhower National Clearinghouse, the American Association for the Advancement of Science, and others, and external evaluation that documents positive impacts on student learning. It will undoubtedly continue to influence the way teachers, students, community college faculty, and teacher preparation programs shape the next generation.

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I. INTRODUCTION

A. Purpose of This Report

This report provides a description of a study conducted in the spring semester of 2002 as part of the evaluation of the Alliance+ project, an internet-in-education professional development program begun in 1998. Prior to this study, the main focus of the research and evaluation component of the Alliance+ project had been the formative evaluation of technology integration in K-12 classrooms. A logic model was used and instruments were developed to assess the extent to which key inputs to the effective integration of technology into teaching and learning were present. These inputs included (a) internet connectivity and access to appropriate technology tools and resources; (b) a set of skills to effectively use technology-based curriculum resources in science, mathematics, and other core subjects; (c) curriculum models to integrate the internet in the classroom; (d) mentoring and support; and (e) structural changes at the school and district level that reflect an understanding of the requirements of the new technology.

The impetus for the present study came with the maturation of the Alliance+ project and with increased pressure from the federal government to demonstrate changes in teaching practices and learning outcomes resulting from technology-based interventions. Although the Alliance+ project was initially conceptualized and approved as primarily a professional development intervention, three and a half years after the project began, it made sense to assess the project's outcomes, specifically in relation to changes in teaching practices and learning outcomes. Thus, the Student Impact Study came into being as a demonstration of what teachers and students can accomplish with appropriate technology resources within a theory-based framework of best practices. The framework is further specified under Section C.

The results of the study should be of interest to teachers, technology specialists, staff developers, administrators, researchers, and all those searching for improved understanding of teaching and learning. The study also offers lessons for policymakers working on diverse approaches to school reform, including student-centered learning, inquiry-based learning, project-based learning, and the effective integration of technology in the classroom.

B. The Alliance+ Project – An Overview

The Alliance+ project is a national training program funded by the U.S. Department of Education, with significant financial contributions from project partners and the participating school systems. The program's goal is to provide hands-on training for K-12 teachers to integrate the internet resources into their classroom curricula and improve science and mathematics education. The project is a joint effort of the Center for Improved Engineering and Science Education (CIESE) at Stevens Institute of Technology in New Jersey; the Polaris Career Center in Ohio; the League for Innovation in the Community College in Arizona; three community colleges (Cuyahoga Community College in Ohio, Miami-Dade College in Florida, and Maricopa Community Colleges in Arizona); other partners; and the participating school systems in Cleveland, Miami, and Phoenix.

The training program is being implemented using a two-tiered model in which community college faculty (Core Team Trainers) train cadres of educators (Mentor Teachers) in the 30-hour graduate-level course. These mentors then train classroom teachers (Mentee Teachers) in their schools and districts. Begun in October 1998, Alliance+ has trained to date nearly 7,000 teachers. To accomplish this purpose, CIESE has developed an extensive training program for educators called the *Savvy Cyber Teacher* that consists of 10 three-hour hands-on workshops. In addition to the training program, a set of support electronic materials, including internet-based classroom projects, has been developed. Friedman (2000) provides a detailed description of the project and the context for the evaluation work reported here.

C. The Student Impact Study (SIS)

Study Criteria

Findings from the formative evaluation of the project over the past four years suggest a progressive integration of technology for teaching and learning purposes (Yepes-Baraya, 1999a-e, 2000a-c)¹. The Student Impact Study (SIS) was designed as a demonstration project, as part of the evaluation of the Alliance+ project to document and assess in some depth how participating teachers integrate technology in the classroom and how the Alliance+ project training activities and curriculum have impacted on the teachers' classroom practices and the educational performance of their students.

Information about the study and its goals was disseminated to prospective participants through the project managers at each site. Teachers were selected on the basis of the connectivity in their schools and access to technology tools, motivation, administrative support, and their likelihood of completing one of the "unique and compelling" applications made available through the Alliance+ program, namely a collaborative project or a project involving the use of real-time databases. Although experience with similar projects was regarded as desirable, not all those who volunteered and were accepted were very experienced. In fact, it is estimated that 59 percent of the participants were experienced, 10 percent were moderately experienced, and 31 percent were inexperienced but willing to experiment. An effort was made to pair the less experienced teachers with those who were more knowledgeable.

Participants were made aware that educational research and the study of best practices in the classroom suggest that the impact of technology on learning is enhanced when **the learning environment meets certain criteria**. Some of these criteria apply to any classroom, whether technology is used or not. Other criteria refer to classroom management and the interaction with and between students. Still other criteria are about the technology tools available, and how students use them. The following are the specific criteria for successful technology integration in a project-based learning environment; these criteria were used for the Student Impact Study:

¹ Extensive documentation about the project and its formative evaluation can be viewed at the project's website: <http://k12science.ati.stevens-tech.edu/papers/>

1. LEARNING OBJECTIVES

- All learning objectives (content- and process-related) are clearly defined and have been successfully communicated to students.
- Objectives are developmentally appropriate.
- The concepts that are part of the learning goals have been identified.

2. STANDARDS

- Objectives are clearly aligned with local, state, or national standards.

3. LEARNING TASKS

- Tasks are appropriate for learning objectives and developmentally appropriate.
- Tasks are engaging.
- Tasks provide opportunity to use one or more technology tools.
- All students, regardless of abilities, are challenged.
- Collaboration, group activities, and student-student interaction are encouraged.
- Students are inspired to do extended learning outside the classroom.
- Teacher is a facilitator of learning.
- Students are involved in making decisions about task selection or task modification.

4. ASSESSMENT

- Assessment criteria are clearly aligned with the learning objectives.
- Assessment criteria are developmentally appropriate.
- Assessment criteria are clearly communicated to and discussed with students; there is evidence of student involvement in establishing the assessment criteria.
- Student products demonstrate understanding of concepts.
- Teachers have carefully documented processes involved.

5. TOOLS AND RESOURCES

- Tools and resources from multiple areas (information, productivity, authoring, networking) are available.
- Tools and resources are developmentally appropriate.
- Students have learned or are learning to effectively use tools and resources.

6. SHARING RESULTS

- Teacher is aware that the nature of the audience for student products affects student effort and the products themselves.
- Audience goes beyond the classroom; there is a real-world connection.
- Students communicate their understanding of concepts to the audience.
- Audience participation provides information that facilitates reflection of the teaching-learning process.

The study criteria were discussed with participants in order to ensure that everyone had a clear understanding of the main tasks involved. Participants were informed that the study team would use the above criteria to **collect evidence** to document and assess each project, and they were encouraged to carefully consider how to **incorporate** these criteria in their implementation plans.

Evidence was collected via **multiple formats**, including surveys, questionnaires, classroom observations, individual and group interviews, and attendance at special presentations scheduled by teachers and their students.

Project and Participant Information

As shown in Tables C1, C2, and C3, a total of 35 teachers (plus 4 computer specialists) in Grades 2 through 11 from Cleveland, Miami, and Phoenix, and about 1,389 students took part in the SIS in the spring 2002 semester. These classes participated in 13 different projects. The time committed to these projects ranged from 4 to 13 weeks. The number of sessions per teacher ranged from 3 to 45, and the duration of each session was 20-300 minutes.

About 50 percent of the participants (18) had had an internet connection in their classroom for three or more years, and 25 percent (nine participants) for two years. Three teachers were on their first year with a connection, and three did not have a classroom connection yet.

Method

Evidence for the study criteria was collected via multiple formats, including the following instruments and methods:

- A project questionnaire
- Teacher pre- and post-surveys
- Student pre- and post-surveys
- Protocols for classroom observations and final presentations
- Focus groups with teachers and students
- Videotapes of the final presentations
- Student products

In addition, the CIESE instructors developed student pre- and post-tests to assess gains in the core content concepts and skills that are part of the unique and compelling projects implemented by the SIS participants and their students.

Table C1. SIS – Projects and Participants

Cleveland (N = 13)

Project	Teacher *	Grade/ Subject	Number Students	Duration (Weeks)	Number Sessions	Time per Session (Minutes)
Wonderful World of Weather	CLE-03	3	24	13	14	45-60
	CLE-07	4	25	5		
	CLE-08	2 Technol.	14	9	45	45
	CLE-15	2	15	9	45	45
Global Sun/Temperature Project	CLE-10	5	25	10	8	45-90
	CLE-14	4	16	7	12	20-30
Musical Plates	CLE-02		6 Science/English	-	3	45
	CLE-05		8 Science	8		
Take a Dip	CLE-06	6-7	10	11		
	CLE-11	5-6	21	8	13	40
Square of Life	CLE-09	2	22	7	10	40-60
	CLE-13	4	21	8	8	40-90
Weather Watchers	CLE-04	2	24	8	8 Labs + Classes	35 (Labs)
Total □	13 + 3	Total □	293			

* These were teachers with their own students. In addition, there were three computer teachers who did not have their own students, but worked collaboratively with five of the teachers listed above.

Table C2. SIS – Projects and Participants**Miami (N = 13)**

Project	Teacher	Grade/ Subject	Number Students	Duration (Weeks)	Number Sessions	Time per Session (Minutes)
Stowaway Adventure	MIA-01	8 Math	27	7	7	90
	MIA-07	7 Math	69	8	8	53
Global Water Sampling Project	MIA-03	10-11 Science	70	5	4	120-240
	MIA-04	9-11 Science	60	7	5	60-300
Human Genetics	MIA-09	7 Science	75	12	11	110
	MIA-12	6 Sci. & Soc. Studies	11	10	6	45-60
Musical Plates	MIA-05	6-8 Science	91	5	Daily	Up to 55
	MIA-11	7 Science	80	12	32	50
Square of Life	MIA-06	7 Science	33	4	10	100
	MIA-10	7 Social Studies	18	7	8	60
Navigational Vectors	MIA-02	8 Technology	200	8	9	50-100
Migration North	MIA-08	6 Social Studies	87	7	6	50
International Boiling Point	MIA-13	6 Science	60	8	4	90-180
Total □	13	Total □	881			

Table C3. SIS – Projects and Participants**Phoenix (N = 9)**

Project	Teacher *	Grade/ Subject	Number Students	Duration (Weeks)	Number Sessions	Time per Session (Minutes)
Square of Life	PHO-01	2	28	?	?	?
	PHO-07	4	24	?	?	?
	PHO-08	2 Technology	12	13	8	60
	PHO-09	5	24	11	10	120
Wonderful World of Weather	PHO-02	4-8	24	8	12	45
	PHO-05	3	13	7	7	45
Stowaway Adventure	PHO-03	6-8 Math. & Tech.	25	4	10	48
Bucket Buddies	PHO-04	3	27	12	15	40
Global Sun/Temperature	PHO-06	6-8 Broadcasting	38	15	30	37-75
Total □	9 + 1	Total □	215			

* These were teachers with their own students. In addition, there was one computer teacher who did not have her own students, but worked collaboratively with one of the teachers listed above.

II. Finding Evidence for the Study Criteria

D. Three Case Studies: The Classroom Context

Although the SIS has generated a fair amount of quantitative information about the participants' practices, experiences, and performances, the SIS is essentially an attempt to better describe and understand the implementation of a technology-rich project at the classroom level. Accordingly, in addition to general descriptive statistics, this report is based on qualitative data and detailed observations from three case studies (from three classrooms, one for each project site) involving three teachers and one computer specialist selected from the 35 teachers and four computer specialists who participated in the study. The selection of the teachers for the three case studies was done in such a way as to have one teacher for each school type (elementary school, middle school, and high school), and projects with a clear focus on science or mathematics. Other than meeting these criteria, the teachers selected were typical SIS participants.

Brief descriptions of the teachers' classrooms, teaching philosophy, skills, and teaching practices regarding technology integration follow. Subsequent sections of the report (sections E-J) describe evidence available to determine the extent to which the study criteria were present in each of the classrooms selected.

Cleveland, Ohio

Ms. Young² is a third-grade teacher who completed her Alliance+ training in the fall of 2000. She teaches in an urban middle-class school in Cleveland, Ohio. Almost all the 24 students in her class are African American. The classroom has six computers, three of which have been connected to the internet for at least three years. In addition, the school has three labs connected, each with 25 computers. Ms. Young feels that the number of computers connected to the internet that she and her students have access to is sufficient for her purposes. She estimates that 25 percent of her students have a home computer connected to the internet. Ms. Young implemented this project in association with Mr. Osorio, an Alliance+ mentor and elementary content and computer specialist for Grades 3 through 6. Mr. Osorio completed his Alliance+ training in the spring of 1999. Ms. Young has an undergraduate degree in business, a graduate degree in reading, and six years of teaching experience.

Ms. Young's responses to Questions 1 and 2 of the **teaching philosophy** section of the teacher pre-survey (Appendix 1) have been combined into a single scale, where 1 = *strongly favors a teacher-centered approach to teaching and learning*, and 6 = *strongly favors a student-centered approach*. Ms. Young's score of 4.35 suggests that she slightly favors a constructivist (student-centered) approach to teaching and learning.

Ms. Young's self-assessment of her **technology skills** prior to her participation in the SIS indicates advanced skills in word processing, web searches, and email; intermediate skills in collaborative and real-time data projects; and no experience with PowerPoint presentations (although Mr. Osorio was knowledgeable). Her students were assessed as beginners or having no experience in these applications.

Again, prior to her participation in the SIS, Ms. Young declared having attained a moderate degree of **technology integration** in her classroom. She reported integrating technology into a lesson in a core subject area at least once a month. She also reported using technology tools at least once a week to review, practice, and reinforce basic skills, and to develop written products. Participation in internet collaborative projects and work with real-time data was done less frequently than once a month.

Miami, Florida

Ms. Castillo is an Alliance+ mentor who completed her Alliance+ training in the fall of 1998. She teaches science to about 110 10th and 11th grade students in a suburban middle-class school in Miami, Florida. The great majority of her students are Hispanic, many of them new arrivals from Central and South America. Very few students are White or African American. The 29 students who participated in this project were part of an honors chemistry class that included both 10th and 11th graders. The classroom has five computers, all of which had

² The teachers' names have been changed to preserve their confidentiality.

been connected to T-1 internet lines for a period of one year prior to the spring of 2002. Students had access to 30 additional computers connected to the internet in the media lab. Ms. Castillo has a home computer connected to the internet, and estimates that 80 percent of her students do, too. Ms. Castillo has an undergraduate degree in nutrition and food science, a graduate degree in science education, and 12 years of teaching experience.

Ms. Castillo's responses to Questions 1 and 2 of the **teaching philosophy** section of the teacher pre-survey (Appendix 1) have been combined into a single scale, where 1 = *strongly favors a teacher-centered approach to teaching and learning*, and 6 = *strongly favors a student-centered approach*. Ms. Castillo's score of 5.05 suggests that she moderately favors a constructivist (student-centered) approach to teaching and learning.

Ms. Castillo's self-assessment of her **technology skills** prior to her participation in the SIS indicates advanced skills in all categories, including collaborative and real-time data projects. Her students were assessed as mostly intermediate or advanced in traditional technology skills, but as beginners in unique and compelling applications.

Prior to her participation in the SIS, Ms. Castillo declared having attained a moderate degree of **technology integration** in her classroom. She reported integrating technology into a lesson in a core subject area, and having her students develop written products and do research on the internet at least once a month. However, she had not involved her students in internet collaborative or real-time data projects.

Phoenix, Arizona

Mr. Herman is an Alliance+ mentor who completed his Alliance+ training in the spring 2001. He teaches mathematics and technology for Grades 6 through 8 in a suburban middle-class school in Phoenix, Arizona. Of the 25 students who participated in the study, 50 percent were Hispanic, 44 percent were White, and the remaining 6 percent were African American, Native American, or Asian American. Mr. Herman's classroom had 20 computers, all of which had been connected to the internet for two years. In addition, the school has two computers per classroom and in the library that are accessible to students. Mr. Herman believes that the number of computers connected to the internet that he and his students have access to is sufficient for his purposes. He estimates that 30 percent of his students have a home computer connected to the internet. Mr. Herman has an undergraduate degree in math education and five years of teaching experience.

Ms. Herman's responses to Questions 1 and 2 of the **teaching philosophy** section of the teacher pre-survey (Appendix 1) have been combined into a single scale, where 1 = *strongly favors a teacher-centered approach to teaching and learning*, and 6 = *strongly favors a student-centered approach*. Mr. Herman's score of 4.00 suggests that he slightly favors a constructivist (student-centered) approach to teaching and learning.

Mr. Herman's self-assessment of his **technology skills** prior to his participation in the SIS indicates a mastery level in all categories, including real-time data and collaborative projects. His students were assessed as beginners in most categories.

Prior to his participation in the SIS, Mr. Herman declared having attained a moderate degree of **technology integration** in his classroom. He reported integrating technology into a lesson in a core subject about 5 to 10 times per month, and having his students develop written products and do research on the internet at least once a month. He also reported having his students participate in internet collaborative or real-time data projects 1 to 4 times per month.

The data summarized in the Table D suggests that Ms. Castillo is the most experienced teacher and perhaps the one with the strongest subject-matter preparation. Along with Mr. Herman, she also appears to have advanced technology integration skills, including skills in unique and compelling applications. However, despite having completed her Alliance+ training three years prior to the study, she had never implemented a collaborative or real-time data project with her students. In this respect, Mr. Herman appears to be the most experienced of the three instructors: He indicated to have implemented unique and compelling applications with his students at least once per month, while Ms. Young reported doing it less frequently than once a month.

Table D. The Classroom Context – Summary

	Ms. Young Cleveland	Ms. Castillo Miami	Mr. Herman Phoenix
Grade	3	10-11	7
Number of students	24	29	25
Ethnic/Racial makeup	African American	Hispanic	Hispanic White
Number of computers with internet connection in the classroom ³	3	5	20
Estimated % of students with internet connection at home	25	80	30
Teaching philosophy self-ratings ⁴	Slightly to Moderately Constructivist 4.35	Moderately Constructivist 5.05	Slightly Constructivist 4.00
Technology skills self-assessment ⁵ Traditional ⁶ Unique and compelling ⁷	Advanced Intermediate	Advanced Advanced	Advanced Advanced
Assessment of students' technology skills Traditional Unique and compelling	No experience/Beginner No experience/Beginner	Intermediate No experience	Beginner Beginner
Technology integration self-assessment in class ⁸ Traditional Unique and compelling	5-10 times/month < Once a month	1-4 times/month Never	5-10 times/month 1-4 times/month
Undergraduate degree Graduate degree Teaching experience	Business Reading 6 years	Nutrition Science Education 12 years	Math Education 5 years
When Alliance+ training was completed	Fall 2000	Fall 1998	Spring 2001

³ Connected computers were also available in other school locations. Teachers indicated that the total number of connected computers in the school was sufficient for their purposes.

⁴ Answers to two questions have been combined into a single scale, where 1 = *strongly favors a teacher-centered approach to teaching and learning*, 2 = *moderately favors a teacher-centered approach*, 3 = *slightly favors a teacher-centered approach*, 4 = *slightly favors a student-centered approach*, 5 = *moderately favors a student-centered approach*, and 6 = *strongly favors a student-centered approach*.

⁵ Scale used: 1= no experience, 2 = beginner, 3 = intermediate, 4 = advanced, 5 = mastery

⁶ Traditional skills include word processing, PowerPoint or other presentation software, web searches, and email.

⁷ Unique and compelling skills include participation in collaborative and real-time data projects.

⁸ Scale used: 1 = never, 2 = less than monthly, 3 = 1-4 times/month, 4 = 5-10 times/month, 5 = over 10 times/month

E. Learning Objectives and Standards: The Projects Teachers and Students Implemented

The teachers included in this report implemented three different projects. For each project, a brief description is provided, followed by a summary of evidence for the student learning objectives and standards for each project. The actual objectives and standards are presented in the lesson summaries provided by the teachers and included in Appendices 2 through 4.

Cleveland, Ohio – Wonderful World of Weather

Ms. Young and Mr. Osorio, from Cleveland, selected the Wonderful World of Weather, a real-time data project designed for use by students in the elementary grades to allow them to investigate weather phenomena both locally as well as in other places around the world. By using hands-on activities and real-time data investigations, the students develop a basic understanding of how weather can be described in measurable quantities, such as temperature, wind, and precipitation. The project's website provides additional information: <http://k12science.org/curriculum/weatherproj/>.

Miami, Florida – The Global Water Sampling Project

Ms. Castillo, from Miami, implemented The Global Water Sampling Project, a collaborative project designed for high school students to compare the water quality of a local river, stream, lake, or pond with other freshwater sources around the world. The focus of the project is twofold: (a) to assess the quality of water based on physical characteristics and chemical substances, and (b) to look for relationships and trends among the data collected by all project participants. The project's website provides additional information: <http://k12science.org/curriculum/waterproj/index.shtml>.

Phoenix, Arizona – The Stowaway Adventure

Mr. Herman, from Phoenix, implemented The Stowaway Adventure, a multidisciplinary internet-based learning experience designed for middle school students to use real-time data from the internet to track a real ship at sea, determine its destination, and predict when it will arrive. In addition, students have the opportunity to monitor the weather conditions at sea and predict when rough weather might impact on the ship's arrival time. The project's website provides additional information: <http://k12science.org/curriculum/shipproj/>.

Table E summarizes the evidence available to determine if the criteria for learning objectives and standards listed below were met:

- All learning objectives (content- and process-related) are clearly defined and have been successfully communicated to students.
- Objectives are developmentally appropriate.
- Objectives are clearly aligned with local, state, or national standards.

Three main sources of information were available: (a) the teachers, who completed several different surveys, (b) evaluation staff, who conducted observations of teachers' classrooms or student presentations or products, and (c) students, who completed a post-survey. By relying on several sources of evidence, the intent is to cross check the validity and reliability of the findings. This approach to research is called triangulation and often results in a truer portrait of the situation being investigated (Wiggins, 1998).

Most of the teacher information is contained in the lesson summaries in Appendices 2 through 4. These summaries include not only the student learning objectives, but other useful information as well. All projects had a multidisciplinary focus. The content objectives in Table E are shown in descending order of importance for each project. For example, Ms. Young's Wonderful World of Weather project was mostly about science, but it also addressed learning objectives in language arts, social studies, and mathematics.

As shown in the appendices, teachers identified the specific objectives, which made it possible to determine the degree of alignment between objectives and standards and whether the objectives were developmentally appropriate or not. Additionally, teachers identified the main process skills addressed in their projects. In all cases, the same skills were checked, namely, language literacy, science literacy, visual literacy, technology literacy, information literacy, inventive thinking, and effective communication. A definition of these skills, also referred to as 21st century skills, and the form used to collect this information are included in Appendix 5.

The evaluation staff used the protocols in Appendix 6 to rate the extent to which objectives were clearly defined and communicated to students, and the extent to which they were aligned with local, state, or national standards. In all cases the evidence was found to be clear or strong.

Student responses to the post-survey in Appendix 7 indicate the percentage of students in each class that agreed with a number of statements regarding their project experience. In the case of Ms. Young's class, all students agreed that they had learned science, mathematics, English, and computers while engaged on the Wonderful World of Weather project, but only three out of four agreed they had learned social studies. In the case of the two other classes, it is clear that the main focus of Ms. Castillo's Global Water Sampling project was science and computers, while in Mr. Herman's Stowaway Adventure project, the emphasis was on mathematics and computers.

Table E. Learning Objectives and Standards – Summary of Evidence

	Ms. Young Cleveland	Ms. Castillo Miami	Mr. Herman Phoenix
Grade	3	10-11	7
Number of students	24	29	25
Project implemented	Wonderful World of Weather	Global Water Sampling	Stowaway Adventure
Source of Evidence □	Teachers' Lesson Summaries		
Content Objectives ⁹	Science Language Arts Social Studies Mathematics	Science Language Arts Mathematics Career Planning	Mathematics Language Arts Science Social Studies
Process Skills	Language Literacy Science Literacy Visual Literacy Technology Literacy Information Literacy Inventive Thinking Effective Communication	Language Literacy Science Literacy Visual Literacy Technology Literacy Information Literacy Inventive Thinking Effective Communication	Language Literacy Science Literacy Visual Literacy Technology Literacy Information Literacy Inventive Thinking Effective Communication
Source of Evidence □	Classroom Observations and Observations of Student Final Presentations/Products ¹⁰		
Objectives were clearly defined and successfully communicated to students.	4	4	4
Objectives were clearly aligned with local, state, or national standards.	4	3	4
Source of Evidence □	Students' Assessment of their Experience (% Students Agreeing)		
I learned science on this project.	100	87	20
I learned math on this project.	100	47	83
I learned English/language arts on this project.	100	40	20
I learned social studies on this project.	77	40	46
I learned a lot about using computers on this project.	100	77	70

⁹ Shown in descending order of importance for each project

¹⁰ Scale used: 1 = no evidence, 2 = some evidence, 3 = clear evidence, 4 = strong evidence

F. Learning Activities: Cognitive Demands and the Social Environment of Learning

Table F summarizes the evidence available to determine if the criteria for learning activities listed below were met:

- Tasks are appropriate for learning objectives and developmentally appropriate.
- Tasks are engaging.
- All students, regardless of abilities, are challenged.
- Collaboration, group activities, and student-student interaction are encouraged.
- Teacher is a facilitator of learning.
- Students are involved in making decisions about task selection or task modification

As with the all the study criteria, three main sources of information were available to determine the extent to which the learning activities criteria were present in each of the classrooms selected: the participating teachers, evaluation staff, and the participating students.

For the most part, correlations between the teachers' self-assessments and the observers' ratings are high, with the majority of the ratings being 3s and 4s (clear evidence or strong evidence). The one criterion for which there was a major discrepancy between the teachers and the observers was the extent to which students were involved in making decisions about task selection and modification. While Ms. Castillo (Miami) and Mr. Herman (Phoenix) felt that student involvement had occurred to a large extent, the observers found little or no evidence. Ms. Young and Mr. Osorio (Cleveland), on the other hand, acknowledge that, indeed, little student input in this respect had occurred in their class.

Student responses evince important differences between the projects. The first difference has to do with teachers asking their students for input prior to the beginning of the project. A slight majority of students in Miami felt that Ms. Castillo had involved them before the project started. Conversely, only a very small minority of the students in Cleveland and Phoenix agreed with this statement. A second difference is the percentage of students who said they liked working on their projects (presumably a correlate of student engagement in learning): The great majority in Cleveland and Miami did like the work, compared with fewer than half of the students in Phoenix. A third difference is about the extent of group work versus individual work in class. In Cleveland, the majority of students identified both individual work and group work. Apparently they worked individually but as a whole class. In Miami, clearly group work was more important than individual work. In Phoenix, slightly more than half of the students indicated working mostly by themselves, and the same proportion indicated working with their classmates.

Table F. Learning Activities – Summary of Evidence

	Ms. Young Cleveland	Ms. Castillo Miami	Mr. Herman Phoenix
Grade	3	10-11	7
Number of students	24	29	25
Project implemented	Wonderful World of Weather	Global Water Sampling	Stowaway Adventure
Source of Evidence □	Teacher Post-Survey ¹¹		
Tasks were appropriate for learning objectives and developmentally appropriate.	3.5 ¹²	4	4
Tasks were engaging.	4	4	4
All students, regardless of abilities, were challenged.	3.5	4	4
Collaboration and group activities took place.	2	4	3
Teacher was a facilitator of learning.	3	4	4
Students were involved in making decisions about task selection and modification.	1.5	4	4
Source of Evidence □	Classroom Observations and Observations of Student Final Presentations/Products ¹³		
Tasks were appropriate for learning objectives and developmentally appropriate.	4	3	4
Tasks were engaging.	4	3	3
All students, regardless of abilities, were challenged.	3	3	3
Collaboration and group activities took place.	2	4	2
Teacher was a facilitator of learning.	4	4	3
Students were involved in making decisions about task selection and modification.	N/A	2	1
Source of Evidence □	Students' Assessment of their Experience (% Students Agreeing)		
Before the project started, the teacher asked the class what we wanted to do.	14	54	3
I liked working on this project.	87	83	46
My classmates enjoyed working on this project.	87	83	20
I worked mostly by myself.	72	20	60
I worked with my classmates.	100	90	57
I worked with my teacher.	91	93	30
I worked with the computer specialist.	100	13	27

¹¹ Scale used: 1 = not at all, 2 = to a slight extent, 3 = to some extent, 4 = to a large extent

¹² Ms. Young's and Mr. Osorio's ratings were averaged.

¹³ Scale used: 1 = no evidence, 2 = some evidence, 3 = clear evidence, 4 = strong evidence

G. Tools and Resources: Learning With and About Technology

Table G summarizes the evidence available to determine if the criteria for tools and resources listed below were met:

- Tools and resources from multiple areas (information, productivity, authoring, networking) are available.
- Students have learned or are learning to effectively use tools and resources.

As shown in the table, a variety of tools and resources were available to the students across sites. In all cases, students were observed actively using technology for different purposes: to collect data, to organize data, and to create presentations or reports of their findings.

As with the criteria in the previous section, student responses show certain similarities, but also some differences between the projects. While it is clear that students across sites used computers and the internet often, a significantly larger percentage of the students in Cleveland and Miami assessed their experience in a positive light than did their counterparts in Phoenix. For example, 100 percent of the students in Ms. Young's class (Cleveland) and 87 percent of the students in Ms. Castillo's class (Miami), but only 53 percent of the students in Mr. Herman's class (Phoenix) agreed with the statement, "Using computers helped me learn better." Similarly, 100 percent of the students in Cleveland and 90 percent of the students in Miami, but only 57 percent of the students in Phoenix agreed with the statement, "I used a computer to learn science or math on this project." The proportion of students agreeing with the last three statements in the table was high across sites and generally indicates a positive attitude toward learning with computers and technology and a place for these tools in their future studies.

Table G. Tools and Resources – Summary of Evidence

	Ms. Young Cleveland	Ms. Castillo Miami	Mr. Herman Phoenix
Grade	3	10-11	7
Number of students	24	29	25
Project implemented	Wonderful World of Weather	Global Water Sampling	Stowaway Adventure
Source of Evidence <input type="checkbox"/>	Teachers' Lesson Summaries		
Technology tools and resources used	Internet Word processing Web cams Thermometer Rain gauge Wind vane	Internet Word processing Spreadsheets PowerPoint Publisher Front Page Lab equipment	Internet Word processing Excel Calculators PowerPoint
Source of Evidence <input type="checkbox"/>	Teacher Post-Survey ¹⁴		
Tools and resources from multiple areas (information, productivity, authoring, networking) were available.	3.5 ¹⁵	4	3
Students are learning to effectively use technology.	3.5	4	4
Source of Evidence <input type="checkbox"/>	Classroom Observations and Observations of Student Final Presentations/Products ¹⁶		
Tools and resources from multiple areas (information, productivity, authoring, networking) were available.	3	4	4
Students are learning to effectively use technology.	4	3	3
Source of Evidence <input type="checkbox"/>	Students' Assessment of their Experience (% Students Agreeing)		
I used a computer a lot during this project.	95	100	97
I wrote a story or a report on the computer.	91	80	47
I used the internet often.	100	96	83
I used a computer to learn science/math on this project.	100	90	57
I can help other students use computers.	95	93	50
Using computers helped me learn better.	100	87	53
Using computers made the project more interesting.	100	87	77
I wish I had more chances to use computers in school.	100	87	74
In college, I want to learn more about computers.	80	89	77

¹⁴ Scale used: 1 = not at all, 2 = to a slight extent, 3 = to some extent, 4 = to a large extent

¹⁵ Ms. Young's and Mr. Osorio's ratings were averaged out.

¹⁶ Scale used: 1 = no evidence, 2 = some evidence, 3 = clear evidence, 4 = strong evidence

H. Assessment: Guiding Students and Documenting Learning

Table H summarizes the evidence available to determine if the criteria for assessment tools and resources listed below were met:

- Assessment criteria are clearly aligned with the learning objectives.
- Assessment criteria are clearly communicated to and discussed with students; there is evidence of student involvement in establishing the assessment criteria.
- Student products demonstrate understanding of concepts.
- Teachers have carefully documented processes involved.

The teachers' lesson summaries described in some detail the varied assessment formats and resources used by teachers to monitor student progress and collect assessment information. In addition to direct observation of student involvement and appropriate completion of worksheets, teachers developed a number of rubrics to involve all students in the assessment of their own work and that of their peers.

As has been the case for most other criteria used in the present study, the teachers' self-assessments were highly correlated with the evaluation's ratings based on classroom observations and observations of the students' final presentations or products. In most cases, ratings of 3 and 4 indicate clear or strong evidence that the expected criteria were met. One criterion that needs further discussion is whether student products demonstrate understanding of the key concepts being learned. For the most part, teachers and observers agreed that this criterion was met; however, post-test results suggest that although progress was made as a result of the intervention, on the average, students across the three sites fell short of mastering the content measured by the post-test. Further discussion of the post-test results is presented in Section J.

Table H. Assessment – Summary of Evidence

	Ms. Young Cleveland	Ms. Castillo Miami	Mr. Herman Phoenix
Grade	3	10-11	7
Number of students	24	29	25
Project implemented	Wonderful World of Weather	Global Water Sampling	Stowaway Adventure
Source of Evidence <input type="checkbox"/>	Teachers' Lesson Summaries		
Assessment tools and resources used	Data collection and reflection sheets Graph completion Class participation Weather logs	Direct observation General rubric Lab report rubric Cooperative work rubric Final product rubric	Accuracy of data collected Direct observation Spreadsheet rubric
Source of Evidence <input type="checkbox"/>	Teacher Post-Survey ¹⁷		
Assessment criteria were clearly aligned with the learning objectives.	3.5 ¹⁸	4	4
Assessment criteria were communicated to and discussed with students.	3.5	4	4
Student products demonstrate understanding of concepts.	3	4	–
Teacher carefully documented assessment processes involved.	3	4	3
Source of Evidence <input type="checkbox"/>	Classroom Observations and Observations of Student Final Presentations/Products ¹⁹		
Assessment criteria were communicated to and discussed with students.	4	3	3
Student products demonstrate understanding of the concepts.	4	3	3
Teachers carefully documented assessment process involved.	3	4	2
Source of Evidence <input type="checkbox"/>	Student Pre-Post Test Comparisons ²⁰ (paired t-tests)		
Mean pre-test score (%) SD)	19.7 (6.4)	10.8 (15.8)	31.2 (27.7)
Mean post-test score (%) (SD)	54.1 (11.1)	44.8 (23.7)	50.4 (16.9)
Gain (% points)	34.4	34.0	19.2
N (valid cases)	20	29	22
Probability	0.0001	0.0001	0.001
Statistical significance	Yes	Yes	Yes

I. Communicating Results: Connecting With the Community and the Real World

Table I summarizes the evidence available to determine if the criteria for communicating results listed below were met:

- Teacher is aware that the nature of the audience for student products affects student effort and the products themselves.
- Audience goes beyond the classroom; there is a real-world connection.
- Students communicate their understanding of concepts to the audience.

Only in the case of Ms. Castillo (Miami) was the evidence consistent that the audience for student products went beyond the classroom. Evaluation staff could ascertain that students in Ms. Castillo's class shared with

¹⁷ Scale used: 1 = not at all, 2 = to a slight extent, 3 = to some extent, 4 = to a large extent

¹⁸ Ms. Young's and Mr. Osorio's ratings were averaged.

¹⁹ Scale used: 1 = no evidence, 2 = some evidence, 3 = clear evidence, 4 = strong evidence

²⁰ See Section J for a description of the tests and a discussion of the results.

local and state legislators the results of their tests and their concerns about the quality of local water. In the other two classrooms the target audience appears to have been students in the same class, other teachers, or school administrators.

With respect to the students clearly communicating their understanding of key concepts, evidence across sites was not as clear as desirable. Although the presentations were technologically well put together, probing students for understanding of key concepts did not always result in students having a firm grasp of the subject matter.

A large majority of students across sites indicated having spent considerable time preparing for their presentation. Similarly, a large majority of the students in Cleveland and Miami reported enjoying working with their classmates on the presentations and sharing their results with others.

Table I. Communicating Results – Summary of Evidence

	Ms. Young Cleveland	Ms. Castillo Miami	Mr. Herman Phoenix
Grade	3	10-11	7
Number of students	24	29	25
Project implemented	Wonderful World of Weather	Global Water Sampling	Stowaway Adventure
Source of Evidence <input type="checkbox"/>	Teacher Post-Survey ²¹		
Audience for student products went beyond the classroom (real-world connection).	2	4	4
Students clearly communicated their understanding of concepts.	2	4	3
Source of Evidence <input type="checkbox"/>	Classroom Observations and Observations of Student Final Presentations/Products ²²		
Audience for student products went beyond the classroom (real-world connection).	N/A	4	2
Students clearly communicated their understanding of concepts.	N/A	2	2
Source of Evidence <input type="checkbox"/>	Students' Assessment of their Experience (% Students Agreeing)		
I created a slide show (PP) with my classmates.	55	90	74
I worked hard to prepare for the final presentation.	100	96	70
My classmates worked hard to prepare for the final presentation.	90	87	63
I liked working with the other students on the final presentation.	96	86	53
I liked sharing the results of this project with other people.	100	83	44

²¹ Scale used: 1 = not at all, 2 = to a slight extent, 3 = to some extent, 4 = to a large extent

²² Scale used: 1 = no evidence, 2 = some evidence, 3 = clear evidence, 4 = strong evidence

J. Other Results

Student Pre- and Post-Test Results

In order to establish a baseline of knowledge and to ascertain progress in the key concepts that are part of the three projects they implemented with their students, participating teachers were asked to administer pre- and post-tests developed by the CIESE instructors. A description of the tests is included in Appendix 8.

As shown in Table J, the pre-test results ranged on the average from 10.8 percent for Ms. Castillo's class to 19.7 percent for Ms. Young's class to 31.2 percent for Mr. Herman's class. These results represent how much the students knew about the content covered in the projects before the projects were implemented.

The post-test results ranged from 44.8 percent for Ms. Castillo's class to 50.4 percent for Mr. Herman's class to 54.1 percent for Ms. Young's class. These results indicate that students across sites made gains in content knowledge as a result of their participation in the projects. In addition, t-tests performed on the three sets of scores show that the pre-post differences are in each case statistically significant.

Despite the gains noted above, the post-test results show that there is ample room for improvement.

Table J.1. Pre- and Post-Test Results

	Ms. Young Cleveland	Ms. Castillo Miami	Mr. Herman Phoenix
Grade	3	10-11	7
Number of students	24	29	25
Project implemented	Wonderful World of Weather	Global Water Sampling	Stowaway Adventure
Source of Evidence <input type="checkbox"/>	Student Pre-Post Test Comparisons (paired t-tests)		
Mean pre-test score (%) (SD)	19.7 (6.4)	10.8 (15.8)	31.2 (27.7)
Mean post-test score (%) (SD)	54.1 (11.1)	44.8 (23.7)	50.4 (16.9)
Gain (% points)	34.4	34.0	19.2
N (valid cases)	20	29	22
Probability	0.0001	0.0001	0.001
Statistical significance	Yes	Yes	Yes

Student Accomplishments (As Reported by Teachers)

Teachers were asked to identify their main student accomplishments as a result of their participation in the CIESE projects. Tables J.2 through 4 show the main student accomplishments for **all the teachers** in the study. Student accomplishments are classified, in general descending order of frequency, into the following five categories: technology skills, general skills, teamwork and group skills, content-specific skills, and attitudes toward learning.

- Teachers identified enhanced *technology skills* as the prime accomplishment of their students. Specific skills mentioned include improved internet search skills, using PowerPoint to develop multimedia student presentations, and creating graphs on Excel.
- Improved *general skills* identified include collecting, recording, and organizing data, improved language skills, presenting results before an audience, and becoming aware of the need for accuracy in measurement.
- Teamwork* and *group skills* refer to students' overcoming conflict and learning to work together. It also involves taking on leadership skills in the classroom, developing an appreciation for working with students in other countries, and being part of a global community of learners.
- Content-specific skills* are those skills related to standards in science, math, social studies, or any other subject that is part of the CIESE collaborative and real-time data projects. Teachers reported, for

example, that students learned how to locate positions on a map using longitude and latitude, and how to make their own weather instruments.

- Teachers also identified improved *attitudes toward learning* as a benefit of student participation in the study. Specifically mentioned were pride, excitement, and motivation in learning, and increased student initiative and the ability to create on their own.

Table J.2. Student Accomplishments as Reported by Teachers**Cleveland (N = 16)**

Student Accomplishments	Number Responding
Technology Skills	27²³
Improved internet search skills	9
Creating a PowerPoint presentation	8
Using computers and technology for learning (besides word processing)	6
Creating and interpreting graphs on Excel	2
Importing pictures into Word	2
General Skills	10
Working with data: collecting, recording, organizing, reaching conclusions	5
Improved language skills	2
Doing a presentation before an audience	1
Improved awareness of need for accuracy in measurement	1
Using higher thinking skills	1
Teamwork and Group Skills	10
Learning to work together – overcoming conflict – teamwork	6
Working with students in other countries – appreciation for global learning	3
Taking on leadership skills	1
Content and Specific Skills	7
Learning how to locate positions on map using longitude and latitude	3
Learning about climate zones	2
Learning about earthquakes and plate tectonics	1
Making their own weather instruments	1
Attitudes Toward Learning	7
Improved attitudes toward learning – pride, excitement, and motivation	4
Increased student initiative and ability to create on their own	3

²³ The total number of responses is greater than the number of teachers because each teacher provided several responses (on average 3.6 responses).

Table J.3. Student Accomplishments as Reported by Teachers**Miami (N = 13)**

Student Accomplishments	Number Responding
Technology Skills	18
Creating a PowerPoint presentation and presenting results	9
Using computers for learning (research, online projects, email, chats)	7
Creating spreadsheets	1
Creating Web pages	1
Content and Specific Skills	9
Learning the objectives associated with the projects: Global Water Sampling, Square of Life, Musical Plates, Migration North	6
Applying knowledge and skills in real world situations	3
General Skills	7
Working with data: using information to solve real-world problems	3
Improved language skills – reading, writing, speaking	3
Improved science inquiry skills	1
Teamwork and Group Skills	4
Learning about the importance of collaboration to maximize learning	3
Using rubrics to evaluate peer performance	1
Attitudes Toward Learning	2
Improved attitudes toward learning	2

Table J.4. Student Accomplishments as Reported by Teachers**Phoenix (N = 7)**

Student Accomplishments	Number Responding
General Skills	11
Improved language skills – report writing	5
Improved language skills – presenting before an audience	3
Improved language skills – improving vocabulary	1
Doing creative art	1
Interacting with a weather scientist	1
Technology Skills	9
Using internet to search for information and data	6
Creating PowerPoint presentations	2
Creating Web pages	1
Teamwork and Group Skills	7
Working in groups to accomplish a task	4
Communicating with other students on email	3
Content and Specific Skills	4
Learning about other cultures	1
Learning about the environment	1
Learning about weather and climate	1
How to use hand lenses and microscopes	1
Attitudes Toward Learning	3
Improved confidence and self esteem – enjoying learning	3

Impact of Real-World Data on Science Achievement

Because all projects implemented as part of the SIS involved in some form the manipulation of real-world data (e.g., collection, organizing, transformation, and reasoning with data), teachers were asked to reflect on the impact of real-world data and student achievement. Table J.5 summarizes **all the teachers'** observations:

- About 33 percent of the respondents commented that students learned by *comparing* data they have collected with data collected by students in other classrooms or other schools. Discrepancies pique students' curiosity and give rise to questions.
- About 15 percent observed that students learn that changes in real-time data correspond to changes in some aspect of the *real world*, e.g., atmospheric pressure, temperature, amount of precipitation, or other variables associated with the weather.
- About 15 percent stated that manipulating real-world data makes students aware that *science is a process* that involves asking questions, gathering data, and asking more questions.

Other observations included the following:

- Students learn to make inferences and draw conclusions from data collected.
- Learning from data collection persists longer than learning from a textbook.
- Collecting data keeps students active and more engaged.
- Working with data makes students aware that math and science are intertwined.
- Working with data makes students aware of the importance of accurate measurements.
- Real-world data makes students aware that science is more than experiments in the lab.
- Real-world data makes students aware that science applies to daily lives of many people.

Table J.5. Impact of Real-World Data on Science Achievement
(In the context of a collaborative or real-time data project)

Cleveland, Miami, and Phoenix (N = 38)

Impact	Number Responding
Student Learning	38
Students learn by comparing data they have collected with data from other schools.	13
Students learn that real-time data matches changes in the real world (<i>e.g.</i> , weather).	5
Students learn that science is about asking questions, gathering data, and asking more questions.	3
Students learn to make inferences and draw conclusions from data collected.	3
Learning from data collection persists longer than learning from a textbook.	3
Collecting data keeps students active and more engaged.	2
Working with data makes students aware that math and science are intertwined.	1
Working with data makes students aware of the importance of accurate measurements.	1
Real-world data makes students aware that science is more than experiments in the lab.	1
Real-world data makes students aware that science applies to lives of many people.	

Lessons the Teachers Learned

All participants were also asked to reflect on the main lessons they learned as a result of their participation in the project they selected to implement for the Student Impact Study. They were encouraged to consider all aspects, including what they learned about themselves, their students, teaching and learning, technology, or the subject matter they taught. Three categories of responses were identified: student learning, planning and teaching, and technology.

About 60 percent of all responses involved *student learning*. Many teachers were surprised that children, even young ones, learned to work with computers in a relatively short time. Teachers also learned that students could work well together in a team and learn from one another. A third lesson had to do with student choice and the important difference it makes in student engagement and learning. Also discussed were the lack of experience with graphing assignments on the part of many students, the fact that even technology and hands-on activities will not engage all students, and the tendency for students to plagiarize information off the internet if they are not monitored.

About 35 percent of all responses addressed different aspects of *teaching and planning*. Teachers learned that project-based learning involving technology integration not only requires more classroom time than direct instruction, but also requires more planning and preparation. Some teachers felt, though, that this type of learning is more effective and more rewarding. Teachers also commented on the importance of monitoring and assessing student progress, in particular when cooperative learning is used.

The remaining 5 percent of all responses focused on *technology*, specifically the fact that the internet is a tool that can be used effectively to enhance content learning, and the importance of technology for its own sake.

K. Discussion and Conclusions

In the Alliance+ project, technology integration is intimately related to learning and problem solving in the context of a real-world project. With proper guidance, students are expected not only to develop new content knowledge and skills, but just as importantly new technology skills, leadership and teamwork skills, and increased awareness of the importance of literacy and communication skills as well.

A review of the evidence collected for the three cases featured in this report shows that there is clear or strong evidence for most of the criteria previously identified in Section C. Table K summarizes the evidence collected and described below.

Criteria 1 and 2: Objectives and Standards

All the Alliance+ projects are aligned with national and state standards. However, the projects have been designed to allow teachers flexibility to adapt the projects to their own classrooms and their students' characteristics. A review of the lesson summaries and other documentation provided by Ms. Young, Ms. Castillo, and Mr. Herman demonstrates that the objectives for the projects these teachers implemented were clearly defined and aligned with relevant standards (National Science Education Standards, National Council of Teachers of Mathematics). The learning objectives, however, went beyond learning the subject matter content; they included, in addition, technology use, process skills, and the creation of a final product. It is not clear in all cases how thorough teachers were in prioritizing and communicating these diverse objectives to their students. Judging by the post-test results, it appears that the content-related objectives were not considered as important as they are in a traditional classroom.

Criterion 3: Learning Activities

The Alliance+ projects featured in this report were designed to search for answers to specific questions about the real world or to solve a real-world problem. By emphasizing inquiry and the collection and analysis of data, students are encouraged to stay active and engaged in learning. Student involvement was also to be enhanced by having students make decisions about task selection or modification. The only teacher who clearly gave students a choice about the format for their final products was Ms. Castillo: Students could either create a PowerPoint presentation, design a Web page, or use word processing to produce a brochure.

Criterion 4: Tools and Resources

Technology appears to have been one of the novelty elements for the three classes featured in this report. As shown in the table, the three teachers had attained a fair degree of technology integration with the more traditional uses of technology, but only a modicum with unique and compelling uses of technology. For example, Ms. Castillo had never done a collaborative or real-time data project with her students, and Ms. Young had done it less frequently than once a month. Only Mr. Herman had implemented unique and compelling application with students at least once a month.

Regardless of their prior experience with technology, the teachers in this report took seriously the technology criteria specified in the SIS and made available multiple tools and resources to their students. At every level (elementary school, middle school, and high school) students were observed using or learning to use these tools effectively.

Criterion 5: Assessment

Ms. Young, Ms. Castillo, and Mr. Herman used multiple formats to assess their students' learning. Ms. Castillo, in particular, developed or adapted four different rubrics to communicate her expectations to her students. An advantage of rubrics is that they can be used as an effective communication tool to guide student learning, and to ascertain the extent to which evaluation criteria are understood and shared.

Because of the diversity of learning goals in the study, in addition to improved content knowledge, students made gains in technology skills, literacy skills, group skills, and their own attitude toward learning.

Criterion 6: Sharing Results

Judging by the energy and enthusiasm that accompanied the student presentations, sharing results appears to have been the other novelty element for the three classes featured in this report. Sharing results was included as a criterion for the study because of the well-known positive effect that an audience has on student learning and achievement. In the case of the Student Impact Study, the results presented to an audience involved the use of tools that for most children were new. Thus, students had to consider not only the content involved but also learning new skills and working with their peers to put together their presentation. Given the novelty involved and lack of experience, the presentations lacked polish and sophistication. However, student pride and real accomplishment were evident to the observers.

Table K. Summary of the Evidence Collected

	Ms. Young Cleveland	Ms. Castillo Miami	Mr. Herman Phoenix
Grade	3	10-11	7
Number of students	24	29	25
Project implemented	Wonderful World of Weather	Global Water Sampling	Stowaway Adventure
Number of computers with internet connection in the classroom ²⁴	3	5	20
Teaching philosophy self-ratings ²⁵	Slightly to Moderately Constructivist 4.35	Moderately Constructivist 5.05	Slightly Constructivist 4.00
Technology skills self-assessment ²⁶ Traditional ²⁷ Unique and compelling ²⁸	Advanced Intermediate	Advanced Advanced	Advanced Advanced
Technology integration self-assessment in class ²⁹ Traditional Unique and compelling	5-10 times/month < Once a month	1-4 times/month Never	5-10 times/month 1-4 times/month
Criteria 1 & 2	Objectives and Standards		
Objectives are clearly aligned with local, state, or national standards	4	4	4
Objectives were clearly defined and successfully communicated to students	3	4	3
Criterion 3	Learning Activities		
Tasks were appropriate for learning objectives and developmentally appropriate.	3	4	4
Tasks were engaging.	4	4	3
All students, regardless of abilities, were challenged.	3	4	3
Collaboration & group activities took place.	2	4	3
Teacher was a facilitator of learning.	3	4	3
Students were involved in making decisions about task selection/modification.	1	3	1

²⁴ Connected computers were also available in other school locations. Teachers indicated that the total number of connected computers in the school was sufficient for their purposes.

²⁵ Answers to two questions have been combined into a single scale, where 1 = strongly favors a teacher-centered approach to teaching and learning, 2 = moderately favors a teacher-centered approach, 3 = slightly favors a teacher-centered approach, 4 = slightly favors a student-centered approach, 5 = moderately favors a student-centered approach, and 6 = strongly favors a student-centered approach.

²⁶ Scale used: 1= no experience, 2 = beginner, 3 = intermediate, 4 = advanced, 5 = mastery

²⁷ Traditional skills include: word processing, PowerPoint or other presentation software, web searches, and e-mail.

²⁸ Unique and compelling skills include participation in collaborative and real-time data projects.

²⁹ Scale used: 1 = never, 2 = less than monthly, 3 = 1-4 times/month, 4 = 5-10 times/month, 5 = over 10 times/month

Criterion 4	Technology Tools and Resources		
Tools & resources from multiple areas (information, productivity, authoring, networking) were available.	3	4	3
Students are learning to effectively use technology	3	3	3
Criterion 5	Assessment		
Assessment criteria were clearly aligned with the learning objectives.	3	4	3
Assessment criteria were communicated to and discussed with students.	3	4	3
Student products demonstrate understanding of concepts.	3	3	3
Teacher carefully documented assessment processes involved.	3	4	3
Criterion 6	Sharing Results		
Audience for student products went beyond the classroom (real-world connection).	2	4	3
Students clearly communicated their understanding of concepts.	3	4	3

Conclusions

After three and one-half years of formative evaluation studies on the Alliance+ project, the Student Impact Study was designed to assess the project's outcomes, specifically in relation to changes in teaching practices and learning outcomes. The study was conceived as a demonstration of what teachers and students can accomplish with appropriate technology resources within a theory-based framework of best practices.

By adhering to the study criteria and using their professional judgment, Ms. Young, Ms. Castillo, and Mr. Herman, the three teachers featured in this report, demonstrated to themselves and others how CIESE's web-based curriculum resources and other technology tools can be effectively integrated into teaching to achieve a favorable impact on student learning. Teachers and students' accomplishments were substantial. The thorough documentation required from all participants and data collected throughout the study suggest that in most instances the study criteria were met:

- The learning objectives for the projects these teachers implemented were clearly defined and aligned with relevant national and state standards. Learning objectives went beyond learning the subject matter content; they included, in addition, technology use, process skills, and the creation of a final product.
- The learning activities were designed to search for answers to specific questions about the real world or to solve a real world problem. By emphasizing inquiry and the collection and analysis of data, students were encouraged to stay active and engaged in learning. For example, Ms. Castillo enhanced student involvement by allowing students to make decisions about task selection and/or modification.
- Multiple technology tools and resources were available for student use. At every level (elementary school, middle school, and high school) students were observed using or learning to use these tools and resources effectively.
- Various instruments and formats were used to assess student learning. Ms. Castillo, in particular, developed or adapted four different rubrics to communicate her expectations to her students. Rubrics were used to guide student learning and to ascertain the extent to which evaluation criteria were understood and shared.
- The results presented to an audience involved the use of tools that for most children were new. Students had to consider not only the content involved but also learn new skills and work with their peers to put together their presentation. Given the novelty involved and their inexperience, the presentations lacked polish and sophistication. However, student pride and real accomplishment were evident to the observers. Because of the diversity of learning goals in the study, in addition to improved content knowledge, students made gains in technology skills, literacy skills, group skills, and their own attitude towards learning.

The fact that the pre- and post-test differences were statistically significant but showed more limited student growth than expected can be explained by three main factors: the teachers' varying degrees of experience with technology-rich, project-based learning; the very nature of the study itself; and the testing measures utilized.

When the study was being planned, we thought that it would attract only the most experienced teachers. However, one of the most surprising findings was that not all participants were equally experienced in the use of unique and compelling internet applications with their students prior to their participation in the study. Of the three teachers featured in this report, one had never implemented "unique and compelling" applications in the classroom, one had done it less than once a month, and the third one had done it 1-4 times per month. Apparently, the least experienced participants saw the study as an opportunity to experiment with technology and learn new skills. Many administrators support technology and encourage teachers to use it with their students, but only a few administrators **require** that technology be used frequently, in particular unique and compelling applications of the internet. Those teachers that participated in the study agreed not only to use technology, but also to conduct instruction in a more student-centered fashion than is customary. Once teachers implement collaborative or real-time data with their students, they begin to see the positive effects on their students. In the words of Ms. Young,

I learned that working with small groups and then allowing those students to assist others helps them become more effective learners. Also, giving students responsibilities and encouraging them to follow

through brings better results. I learned I need to communicate more with individual students. I need to plan and implement more project-based units for the students to become more effective learners.

Or, as Ms. Castillo put it,

I plan to use technology as much as possible. I think that it is like any tool in the hands of a “master craftsman (craftswoman).” The correct use of a tool allows for the creation of a masterpiece. In my case, I feel that if I want to be a “master craftsman,” I will need to continue to learn how best to implement technology as one of the tools for learning in my classroom.

The nature of the study itself appears to have shaped teacher expectations as to what was more important and what was less important, and helps to explain the limited results in pre-post content knowledge gains. Although the teachers were well aware of the pre-test and the post-test, there were never any explicit expectations regarding the desirability of test scores increasing. The only requirement explicitly stated and amply discussed was to incorporate the study criteria in their teaching and their students' learning. With technology being a novelty for most students and student presentations looming at the end of the project, two of the teachers admitted to have spent most of their time doing their project's activities and helping students become familiar with the technology tools they needed to create their final presentations. There was not enough time to review the material covered before the post-test was administered.

Last, measuring pre-post gains in content knowledge and skills occurred under less than ideal conditions. The same CIESE instructors who developed the projects implemented by the teachers developed parallel versions of the pre- and post- tests. Although the tests were made available to the teachers prior to the initiation of the projects, due to a tight schedule the tests were not field tested by each participating class. In addition, teachers were free to modify the projects' activities and adapt them to the needs of their students. A review of the teachers' lesson plans indicates that some teachers skipped some activities and other teachers supplemented planned activities with activities of their own. Under ideal conditions, each teacher should have modified the CIESE tests to reflect the activities actually implemented with their students.

Despite the shortcomings identified above, the potential contribution of internet-based unique and compelling applications to effective teaching and learning remains strong. Requiring teachers to integrate collaborative and real-time data projects with their students would appear to be a necessary step to teaching and learning with technology, creating student-centered communities of learners, and improving science and mathematics instruction.

Lessons Learned and Further Research

The Student Impact Study has made it clear that before technology can be effectively integrated in the classroom to enhance student learning, a number of conditions need to be met. Some of these conditions are defined by the six criteria that were part of the study. Other conditions are related to student, teacher, and institutional variables, such as student motivation, adequate teacher preparation in the subject matter being taught, and institutional support for technology integration. Taken together, all of these conditions apply to teaching and learning with or without computers and sophisticated information technology tools. In other words, good teaching is good teaching regardless of the technology used. One of the main advantages provided by technology appears to be related to its potential to enhance student learning by multiplying the interaction of the learner with course materials, other learners, and teachers (Meyer, 2002). This advantage is quite evident in CIESE projects involving real-world problem solving and real-time data. For example, Alliance+ teachers have identified a number of observations regarding how students' manipulation of data can lead to such desirable outcomes as learning to ask questions, formulate hypothesis, make inferences, and draw conclusions. In other words, some of the main cognitive processes associated with critical thinking.

Once connectivity and access to technology are no longer an issue and teachers and students become proficient with Web-based materials and sophisticated technology tools, they should be better able to concentrate on their main goals, namely, teaching and learning. Future studies should attempt to better understand the advantages that Web-based technology provides relative to enhancing teaching and learning. If we are ready to accept that

there are multiple intelligences (Gardner, 1983, 1993) and that learners actively construct their knowledge, then we should try to understand how technology can contribute to developing specific cognitive, affective and psychomotor skills and achieving greater individualization of learning experiences for students with different characteristics.

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ABOUT THE AUTHOR

Mario Yepes-Baraya specializes in science learning, assessment, and evaluation and the professional development of K-12 teachers. Over the past 10 years, first with Educational Testing Service and subsequently with Harcourt Assessment and Stevens Institute of Technology, he has directed research and evaluation studies to assess the impact of education reform and professional development projects on teaching and learning. He earned a B.A. in chemistry, an M.Ed. in science education, and a Ph.D. in educational research and evaluation from SUNY Buffalo.

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M. Appendices

Appendix 1. Teacher Pre-Survey

**Alliance+ Project: Student Impact Study
TEACHER PRE-SURVEY**

January 2002

Dear Participant,

The purpose of this survey is to better understand your teaching philosophy and practices regarding the use of information technology in teaching and learning. The survey is part of the documentation and evaluation of the Student Impact Study that is part of the Alliance+ project. Other activities planned include student surveys, a project questionnaire, classroom observations, and focus groups with teachers and students.

Please read through the instructions below and answer all items to the best of your ability. There are no right or wrong answers. Your best judgment is all we ask for.

Please write your name on this cover sheet in the space provided below. The cover sheet with your name on it will be separated from the rest of the survey when you turn it in to preserve *confidentiality*.

When you have completed the survey, please return it to: _____

If you have any questions about this survey, please call or email me, or contact your local Alliance representatives. Thank you in advance for your assistance in this important endeavor.

Sincerely,

Mario Yepes-Baraya
Director of Alliance+ Research and Evaluation
609-895-1600
m.yepes@att.net

Personal and School Information
(for tracking purposes only)

Name: _____

Phone: _____

E-mail address: _____

School: _____

Address: _____

I. Technology Access for Learners and Teachers

1. How many computers do you have in your *classroom*? _____
2. How many students are participating in the project? _____
3. How many of the computers in your *classroom* are connected to the internet? _____
4. How long have you had an internet connection in your *classroom*?
 - a. I do not have an internet connection in my classroom
 - b. Less than one school year/just starting this school year
 - c. One year
 - d. Two years
 - e. Three or more years
5. What type of internet connection do you have in your *classroom*?
 - a. Modem/standard telephone line connection
 - b. High-speed connection (Circle one: T1, Cable modem, DSL)
 - c. Wireless
 - d. I don't know/not sure
6. Are you able to display a computer screen to the entire class with a projector or large-screen monitor on a TV in your *classroom*?
 - a. Yes (Circle One: Projector, Large Screen Monitor, TV)
 - b. No
7. How many computers connected to the internet in other locations in your school are available to use with your students? _____
8. Where are these computers located? (Circle all that apply.)
 - a. Computer/Media lab
 - b. Library
 - c. Other classrooms
 - d. Other (Please specify): _____
9. Is the number of computers connected to the internet that you and your students have access to in your school sufficient for your purposes? If no, why not?
 - a. Yes
 - b. No
10. Do you have a home computer connected to the internet?
 - a. Yes
 - b. No
11. Estimate the percentage of your students with a home computer connected to the internet: _____

II. Teaching Philosophy

1. Indicate how much you disagree or agree with each of the following statements about teaching and learning.

	Strongly Disagree 1	Moderately Disagree 2	Slightly Disagree 3	Slightly Agree 4	Moderately Agree 5	Strongly Agree
a. Teachers know a lot more than students; they shouldn't let students muddle around when they can just explain the answers directly.						
b. A quiet classroom is generally needed for effective learning.						
c. Students are not ready for meaningful learning until they have acquired basic reading and math skills.						
d. It is better when the teacher – not the students – decides what activities are to be done.						
e. Student projects often result in students learning all sorts of wrong knowledge.						
f. Homework is a good setting for having students answer questions posed in their textbooks.						
g. Students will take more initiative to learn when they feel free to move around the room during class.						
h. Students should help establish criteria on which their work will be assessed.						
i. Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly.						
j. How much students learn depends on how much background knowledge they have – that is why teaching facts is so necessary.						

2. The following pairs of statements describe different teaching philosophies. For each pair of statements, check the box that best shows how closely your own beliefs are to each of the statements in a given pair. The closer your beliefs to a particular statement, the closer the box you check. (Check one box per pair.)

a. I mainly see my role as a facilitator. I try to provide opportunities and resources for my students to discover or construct concepts for themselves.						That's all nice, but students really won't learn the subject unless they go over the material in a structured way. It's my job to explain, to show students how to do the work, and to assign specific practices.
b. The most important part of instruction is the content of the curriculum. That content is the community's judgment about what children need to be able to know and do.						The most important part of instruction is that it encourages sense-making among students. Content is secondary.
c. It is useful for students to become familiar with different ideas and skills even if their understanding, for now, is limited. Later, in college, perhaps, they will learn these things in more detail.						It is better for students to master a few complex ideas and skills well, and to learn what deep understanding is all about, even if the breadth of their knowledge is limited until they are older.
d. It is better when the teacher – not the students – decides what activities are to be done.						While student motivation is certainly useful, it should not drive what students study. It is more important that they learn the history, science, math, and language skills in their textbooks.
e. It is a good idea to have all sorts of activities going on in the classroom. Some students might produce a scene from a play they read. Others might create a miniature version of the set. It's hard to get the logistics right, but the successes are more important than the failures.						It is more practical to give the whole class the same assignment, one that has clear directions, and one that can be done in short intervals that match students' attention spans and the daily class schedule.

III. Technology Skills and Use of Teachers and Learners

1. Use the following scale to describe *your* skills in using the types of applications/software listed in the table below. (Check one box per item.)

Application/software	No experience 1	Beginner 2	Intermed. 3	Advanced 4	Mastery 5
a. Word processing (e.g., Word)					
b. Presentation (e.g., PowerPoint)					
c. Graphics (e.g., Print Shop, Publisher)					
d. Multimedia authoring (e.g., Hyperstudio)					
e. Lesson planning					
f. Software (e.g., Carmen San Diego)					
g. Courseware (e.g., Success Maker)					
h. Web browsers (e.g., Netscape, AOL, MS Explorer)					
i. Email					
j. Collaborative projects					
k. Real-time data bases					

2. Use the following scale to describe the skills of *the students in your class* using the types of applications/software listed in the table below. (Indicate the approximate percent in each box.)

Application/software	No experience 1	Beginner 2	Intermed. 3	Advanced 4	Mastery 5	I don't know 6
a. Word processing (e.g., Word)						
b. Presentation (e.g., PowerPoint)						
c. Graphics (e.g., Print Shop, Publisher)						
d. Multimedia authoring (e.g., Hyperstudio)						
e. Software (e.g., Carmen San Diego)						
f. Courseware (e.g., Success Maker)						
g. Web browsers (e.g., Netscape, AOL, MS Explorer)						
h. Email						
i. Collaborative projects						
j. Real-time data bases						

IV. Professional Development on Appropriate Models of Technology Integration

1. Check the topics that you have received professional development on and rate how useful you found these activities. A five-point scale is provided:

Application/software	Did not attend 1	Not useful 2	Little useful 3	Useful 4	Very useful 5
a. Understanding the difference between technology integration and technology use					
b. Understanding the roles of teachers, students, and technology in collaborative learning					
c. Teaching and learning in a project-based environment					
d. Identifying technology resources for standards-based educational objectives for a given subject					
e. Using instructional design to match educational objectives to technology tools					
f. Developing technology-based lesson plans					
g. Developing performance-based assessments					
h. Working with students to develop scoring rubrics for performance assessments.					

V. School Support and Structural Changes for Technology Integration

1. What types of support and incentives have been provided in your school to assist teachers in using technology to enhance learning? (Circle all that apply.)

- a. Release time for planning
- b. Schedule changes for teachers that allow collaborative planning and learning
- c. Technology resources for classroom and media center
- d. In-service credits
- e. Technology certification
- f. Expectation or requirement that faculty use technology as a learning tool
- g. Acknowledgement and recognition of effective teacher use of technology
- h. Microsystem technician assigned to school
- i. Educational specialists assigned as a school resource
- j. Stipends for attending training classes
- k. Salary incentives for teachers using technology as a learning tool

2. What types of problems or obstacles have teachers encountered that prevent them from integrating technology into the curriculum?

Indicate the extent to which the following are obstacles to integrating technology into your classroom instruction.

Problems or Obstacles	None 1	A Little 2	Somewhat 3	A Lot 4
a. Lack of time to learn about technologically-enhanced instruction				
b. Lack of time to develop technologically-enhanced curriculum				
c. Lack of time in school schedule for projects involving technology				
d. Lack of computers and equipment				
e. Lack of technical support for technology projects				
f. Lack of knowledge about ways to integrate technology to enhance curriculum				
g. Lack of administrative support for integrating technology into the curriculum				

VI. Integrating Technology in the Classroom

1. In what ways, if any, has participating in the Alliance project, including both the new technology in your classroom and participating in professional development activities, changed your instructional practices?

As a result of participating in the project, I

Changes in Instructional Practices	Yes 1	No 2	Not yet, but I will 3	Does not apply 4
a. Spend more time with individual students.				
b. Spend less time lecturing the whole class.				
c. Am more comfortable with small group activities.				
d. More often use cooperative learning techniques.				
e. Am more comfortable with students working independently.				
f. Am better able to provide instruction for students with different abilities/learning styles.				
g. Am better able to teach problem solving and critical thinking.				
h. Am better able to present complex material to my students.				
i. Am more comfortable with classroom management using 1-3 computers				

2. How often do you as a teacher do the following?

As a teacher I do the following:

Classroom Practices	Never 1	Less than monthly 2	1-4 times per month 3	5-10 times per month 4	Over 10 times per month 5
a. Integrate technology into a lesson in a core subject area.					
b. Use computer-based activities, materials, or discussions.					
c. Use TV-computer hookups or other presentation technology for whole-class or group lessons.					
d. Use a computer or other technology to assist a student with a learning problem.					
e. Use a computer or other technology to assist a student with limited English proficiency.					
f. Use a computer or other technology to plan curriculum and lessons.					
g. Exchange ideas about technology and resources with other teachers in the district or in the school.					
h. Use technology to produce communications for parents.					

3. How often do you have your students use technology?

I have my students use technology to

Student Technology Use	Never 1	Less than monthly 2	1-4 times per month 3	5-10 times per month 4	Over 10 times per month 5
a. Review, practice, and reinforce basic skills.					
b. Learn from software that teaches academic content.					
c. Develop written products or graphics and artwork.					
d. Develop multimedia products (slide shows, videos, Hyperstudio stacks)					
e. Analyze or display data (using spreadsheets, graphing software)					
f. g. Do research via CD-ROM.					
g. Do research via the internet					
h. Participate in internet collaborative projects					
i. Work with real-time data on the internet					
j. Contact experts on the internet					

VII. Alliance and Teaching Information

1. Which best describes your current role within Alliance?

- a. Mentor Teacher
- b. Mentee Teacher
- c. Other (Please specify.) _____

2. What is your title? _____

3. What subject(s) do you teach? (Circle all that apply.)

- a. Science
- b. Mathematics
- c. Social Studies
- d. English/Reading/Writing
- e. Elementary (all subjects)
- f. Other (Please specify.) _____

4. What grade level(s) do you teach? (Circle all that apply.)

- K 1 2 3 4 5 6 7 8 9 10
11 12 Other (Please specify.) _____

5. How many classes do you teach? _____

6. How many students do you teach? _____

7. What is the *approximate* percentage of your students by race or ethnic group?

- a. African American _____
 - b. Asian American _____
 - c. Hispanic _____
 - d. Native American _____
 - e. White non-Hispanic _____
 - f. Other (Please specify.) _____
- TOTAL _____ 100% _____

8. When did you complete the *Savvy Cyber Teacher* training course? (Please circle one.)

- a. Prior to summer 1998
- b. Summer 1998
- c. Fall semester 1998
- d. Spring semester 1999
- e. Summer 1999
- f. Fall semester 1999
- g. Fall semester 1999
- h. Spring semester 2000
- i. Summer 2000
- j. Fall semester 2000
- k. Spring semester 2001

9. How would you evaluate your training experience with the *Savvy Cyber Teacher* training course?

- a. Excellent
- b. Good
- c. Fair
- d. Poor

10. How applicable is what you learned in the *Savvy Cyber Teacher* course to the subject you are teaching? (Circle one. If you teach more than one subject, choose the subject the *SCT* is most applicable to and write the name of the course below.)

Subject: _____

- a. Very applicable
- b. Applicable
- c. Somewhat applicable
- d. Not applicable at all

VIII. Background Information

1. Gender

a. Female

b. Male

2. Ethnicity

- a. African American
- b. Asian American
- c. Hispanic
- d. Native American
- e. White non-Hispanic
- f. Other (Please specify.) _____

3. Undergraduate major: _____

4. Graduate major: _____

5. Years of teaching experience: _____ years

6. Years at this school: _____ years

Many thanks for your assistance.

Appendix 2: Lesson Summaries
Cleveland, Ohio – Wonderful World of Weather – Ms. Young and Mr. Osorio

Lesson 1

Title: Relative Weather (February 24)

Student learning objectives

After completing the lesson, students will be able to

- Recognize that short-term weather conditions change daily,
- Understand that weather varies with location, and
- Compare and contrast the weather condition in their location with the weather in other places.

Time dedicated to lesson: 45-minute classroom lesson, four 40-minute computer lab sessions

Lesson Summary

I gave the students an overview of the lesson and handed out slips for them to take home and have a parent help them to find a place where a relative or friend lived at least 200 miles away. We discussed data collection for both Cleveland and the other places. On our first trip to the lab, we looked at a map and located the different cities for which we were going to access data. We practiced going to the Weather Underground and we bookmarked it for future use. We then looked at Weather Underground for Cleveland and explored the different types of weather information available. We tried to record data in our logs, but there wasn't enough time. On several subsequent trips to the lab, we accessed the website, collected and recorded data for the student-selected location as well as Cleveland. They used a teacher-made data collection sheet to access the information we felt we needed.

Technology used

We used the internet for data collection. We used the computer for word processing.

Assessment methods used to measure student learning

We used teacher-made data collection and reflection sheets.

Homework or special assignments for the next lesson(s)

None. Out-of-class work is not customary for this age of student.

Process skills students practiced during this lesson

- Literacy – D1, D2, D3
- Inventive Thinking – T3, T4
- Effective Communication – C1

Students' reaction to this lesson

The students reacted positively to this lesson mainly because of the ownership element to it. They had a specific interest in the partner city for which they were collecting data. This was an important element for the success of this unit. I recently heard a comment from a student about where they might want to move to because its weather was more favorable in the wintertime than Cleveland's. By the end of this lesson, the students enjoyed going to the computer lab, opening the website and getting down to work.

What I learned during this lesson to better help my students to become more effective learners

Since this was a new experience for me, too, I learned that the students need lots of prep time and very clear-cut directions on what they are to do in terms of data collection. They need even more direction in how to write the comparisons between the two cities. This was easy for some students to do, but very difficult for others. Perhaps a more structured template would be advisable for the students who struggle.

Lesson 2 (Osorio)

Title: Looking In on the Weather (April)

Student learning objectives

The students will be able to

- Make weather observations based on sky conditions,
- Understand that weather conditions vary over the day,
- Understand that weather varies with location, and
- Compare and contrast the weather conditions in their location with the weather in other places.

Time dedicated to lesson: Every school day in April – minimum of 20 minutes per session

Lesson Summary

In groups of four, students used weather tools to measure minimum, maximum, and current temperature; precipitation; and sky cover and then recorded this information on a 39" x 31" wall calendar. Students also posted the data on the GLOBE.gov site. When time permitted, this data was reported to the class. Once per week, we compared the school's weather-station data to information given on Weather Underground.com. Both teachers encouraged discussion and helped students express these comparisons in their journal (corresponding teacher worksheet). Students made observations from Leonard's Web Cam site. They also did a fair amount of exploring and sharing in order to choose a special site. The site was bookmarked. During the next lesson, they recorded the weather conditions and made comparisons to Cleveland's weather. This data was added to the weather journal.

Technology used

- Minimum-maximum thermometer
- Rain gauge
- Wind vane
- Internet: Data from Weather Underground.com, weather.com, accuweather.com, and Leonard's Web Cam were accessed and used with increased ease and familiarity.

Assessment methods used to measure student learning

- Participation in class activities
- Completion of study/data sheets for weather journals.
- Completion of graph using class data for the month of April

Homework or special assignments for the next lesson(s)

No homework was specifically given other than to encourage the children to look up at the sky and practice what we were learning about sky conditions and try to predict what kind of weather is coming.

Process skills students practiced during this lesson

- Access information effectively and efficiently, evaluate information critically and competently, and use information accurately and creatively
- Develop their ability to interpret and express ideas using and creating tables and graphs

Students' reaction to this lesson

Our students reacted very positively to this lesson because of the high level of hands-on activities. This was a unique experience for them and compelling because of the opportunity of working with real-time data on the internet, at our school weather station, and using other primary source materials.

What I learned during this lesson to better help my students to become more effective learners

I learned that working with small groups and then allowing those students to assist others helps them become more effective learners. Also, giving students responsibilities and encouraging them to follow through brings better results. I learned that I need to communicate more with individual students. I need to plan and implement more product- and project-based units for the students to become more effective learners.

Lesson 6

Title: Does Summer Always Come in June? (April 19)

Student learning objectives

The students will be able to

- Explain why seasons are reversed in the northern and southern hemispheres and
- Access online data that will demonstrate the season reversal from northern to southern hemisphere

Time dedicated to lesson: One hour in class, four 40-min lessons using Science Court CD, two 40-minute data-collection lab periods.

Lesson Summary

This is an extremely difficult concept for third-graders to understand. We had covered it earlier in the school year, but it still was not clicking with a lot of the students. My partner and I decided to approach it with specific software (Science Court) dedicated to the seasons as well as the lessons in the project. I started by doing Activity Number 1, Why Do We Have Seasons, to refresh the students' memories about the earth traveling around the sun and the tilt of the earth. After explaining our data-collection activity, we proceeded to the lab to begin collecting the data. During the first session we collected data for three locations in the U.S. and three locations in Australia. This was pretty easy for most of the students to do, and I was actually surprised that we got this done in one session. Next, I tried to explain, while the students looked at individual maps, the concept of latitude lines from the equator; but this was very difficult for them to understand, so I ended up picking the partner cities for them to use in the second half of the lesson. We then proceeded to the lab for our second session and again collected the data. This was a little more difficult, because it involved accessing areas outside of the U.S., but once I showed them how to do it, again they collected the data with ease. We then discussed the data and what it meant in the classroom.

Technology used

Internet for data collection

Assessment methods used to measure student learning

We used data-collection sheets as well as a teacher-made worksheet to try to get the students to become comfortable explaining what they found out. While I feel, from talking with the students, that they have a better grasp of why seasons happen, they had a much more difficult time explaining it in writing. Even my best writers had a hard time explaining in words what it was all about.

Homework or special assignments for the next lesson(s)

None

Process skills students practiced during this lesson

- Literacy Skills: D1, D2, D3
- Inventive Thinking Skills: T1, T2, T3, T4
- Effective Communication Skills: C1, C4

Students' reaction to this lesson

This was extremely enjoyable for a couple of reasons. By the time we got to this lesson, the students were totally comfortable with using the Weather Underground for current and historical data. This level of comfort enabled them to complete data collection with a minimum of stress. They felt really proud of the data collection part and some of my weaker students, paired with stronger students, really caught on. They seemed fascinated with the idea that in July, it is winter in another part of the world. They were excited when they answered the question that we posed at the beginning of the lesson: "Does summer always come in June?" Even though some students had difficulty verbalizing why, I think they understand that it doesn't always come in June.

What I learned during this lesson to better help my students to become more effective learners

I need to explain the concept of the first day of summer (June 23) so that they can make the connection that by July 1, the day we collected data for, it is already into summer. This was hard and a little confusing for them, and I didn't realize it would pose a problem. They are still a little confused about tilt, rotation (day and night), and closeness to the sun, but developmentally these are difficult concepts for third graders. I think this lesson made tremendous progress toward understanding seasons.

Lesson 7 (Osorio)

Title: Cloudy Weather

Student learning objectives

The students will be able to

- Identify three basic cloud types,
- Compare clouds they see outside with satellite images, and
- Read a satellite map.

Time dedicated to lesson:

Lesson Summary

Observing and identifying clouds was a small group class begun in March as part of a daily activity outside of our school following GLOBE protocols. After a week of collecting data, another group became the weather team and continued this way until everyone had a turn. We started out observing and estimating cloud cover. Then we identified types of clouds by matching characteristics to pictures on a cloud chart. Students sketched pictures of clouds and also took pictures using digital and 35 mm cameras. In the classroom, students watched the weather cam, looking for changes in the clouds. The teacher asked, "What does this mean?" That led to discussion regarding changing weather. Another day, the students watched the weather cam and periodically (every hour and a half) printed out the picture in order to better compare the changes. These printouts showed clouds moving across the screen. Students were challenged again to make conclusions. Students made posters with word-processed explanations of clouds. In Weather Underground, we used historical conditions to elicit discussion regarding changes and the causes for such changes. Students were challenged to make cause-and-effect statements.

Technology used

Internet: USA Today All About Clouds, cloud cams, and other cloud sites
Students also posted weather data to GLOBE.gov each day.

Assessment methods used to measure student learning

Individual and small group participation in collecting data outdoors
Student's participation in computer lab
Completion of Looking at Clouds worksheet in weather log

Homework or special assignments for the next lesson(s)

No special homework for this lesson, same as Looking in at the Weather lesson.

Process skills students practiced during this lesson

- Browse, search, and navigate on line
- Gain knowledge of science, scientific thinking, mathematics, and the relationship between science, math, and technology
- Improve teaming skills, including students teaching others new skills, assisting others with tasks, and exercising leadership

Students' reaction to this lesson

Students showed much enthusiasm for all of the outdoor activities. They were very willing to share their observations and internet findings.

What I learned during this lesson to better help my students to become more effective learners

I learned that providing hands-on, outdoor activities and the opportunity to share in an informal manner motivated the students to become more effective learners. Exploring within given parameters helped develop self-confidence, and many students began to make connections to previous lessons. I also learned that when students work with partners, they are a bit more relaxed and the task at hand doesn't seem as difficult.

Lesson 4

Title: What Happens at Night? (May 13)

Student learning objectives

The students will be able to

- Explain and demonstrate how the earth's rotation causes day and night;
- Interpret information presented in table form;
- Explain how changing amounts of solar energy during the day and night are the reason for temperature change; and
- Deduce a cause-and-effect relationship from given data.

Time dedicated to lesson: One class period, two 40-minute lab periods

Lesson Summary

Class discussion centered on the fact that the earth's traveling around the sun is the reason for day and night. This was not difficult for the students to understand. We proceeded to the lab and used a teacher-made data-collection sheet to collect data over a 24-hour period for Cleveland, Ohio. The difficulties began because, in order to find the high and low periods for each day, they had to be able to understand military time, and this was difficult for almost everyone. This really impeded the effectiveness of the lesson. It turned a clear-cut data-collection activity into something much harder. We spent two days collecting this data, and some of them still didn't get to finish. We simply ran out of time because it was near the end of the project.

Technology used

Internet for data collection

Assessment methods used to measure student learning

Teacher-made worksheet

Homework or special assignments for the next lesson(s)

None

Process skills students practiced during this lesson

- Literacy Skills: D1, D2, D3
- Inventive Thinking Skills: T1, T2, T3, T4
- Effective Communication Skills: C1, C4

Students' reaction to this lesson

This lesson did not create as much excitement as some of the others. It did have a few difficult aspects to it, and we were at the end of the unit and simply running out of time. I think the students were a little burned out on this unit by that time. They were able to understand the concept, but I am not sure it was because of the data collection or just because it made sense.

What I learned during this lesson to better help my students to become more effective learners

Next time, I would need to find a historical-data website that does not use military time. This concept was just way more than the students could handle at this time. Otherwise, I think it would be a great way to draw conclusions from data because it is so clear-cut as to why the temperature drops at night.

Appendix 3: Lesson Summaries
Miami, Florida – The Global Water Sampling Project – Ms. Castillo

Lesson 1

Title: Introduction to Water Sampling Project

Student learning objectives

The students will be able to

- Understand the purpose of the project,
- Recognize the procedures and parameters for each type of water test,
- Create graphic organizers to display the information that they have researched, and
- Compile information to write their letter of introduction.

Time dedicated to lesson: One two-hour block, two nights (as HW assignment), and 30 minutes in class to edit letter.

Lesson Summary

1. The teacher introduced the Global Water Sampling Project by leading a discussion about chemistry of the environment. The students participated in the dialogue, leading to possible careers in the area of water management.
2. The teacher explained the basic navigation of the website and reviewed the computer safety lab rules with the students. The students logged on successfully and bookmarked the page.
3. Each student decided on the use of a graphic organizer to compile his or her notes. Some students used the Word program to organize the information. They became acquainted with the purpose of the project and the general overview of the tests. Each student noted the basic procedure of each test, the units of measurement used, and the normal and abnormal values for each parameter. They also compiled information about the relationships between water-quality variables and environmental conditions. Students were allowed to discuss their findings among themselves as they proceeded with their research.
4. In the regular seating area, the teacher asked the students to form collaborative groups of four. The students arranged themselves in groups and participated in small group discussions. The teacher walked around taking note of the questions that arose from their first review of the project.
5. The students were assigned a particular section or description of the introductory letter. These included descriptions about our school, their community, the characteristics of their class, the South Florida environment, a general description of the Everglades, and an update of the water restoration project currently taking place in the Everglades. Two groups were selected as editors of the letter.

Technology used

- A computer lab with 30 internet-ready Dell computers was used. The lab is one of two computer labs assigned to the science area. Most of the students had a computer to themselves. Three students decided to double up with a friend.
- Some students obtained information for their letter of introduction from different websites dealing with South Florida and the Everglades.
- The editing of the letter was completed back in the regular classroom on one of four classroom computers.

Assessment methods used to measure student learning

Assessment methods included direct observation and a general rubric to assess the note-taking skills.

Homework or special assignments for the next lesson(s)

Research the assigned section for the letter of introduction.

Process skills students practiced during this lesson

- Literacy – D1, D2, D3
- Inventive Thinking – T1
- Effective Communication – C1, C2, C4

Students' reaction to this lesson

Students were generally pleased to be able to incorporate use of the internet into their learning in chemistry. Many of the students had not heard of several of the water tests that were covered in the project. They were enthusiastic about finding what other groups had done while participating in the project.

What I learned during this lesson to better help my students to become more effective learners

I corroborated that the best way to motivate students to learn is to allow them to explore on their own and formulate questions based on their interests. Many of the students had questions about the coliform bacteria and the possible impact on their drinking water.

Lesson 2

Title: Parts Per Million Lab

Student learning objectives

The students will be able to

- Explain the meaning of concentration and dilution;
- Express concentrations as parts per million and as parts per billion;
- Carry out serial dilutions using food coloring; and,
- After simulating dilute solutions with food coloring, have a clear visual perception of the amount represented by one part per million (1 ppm).

Time dedicated to lesson: One two-hour block

Lesson Summary

1. The teacher initiated the discussion of the chemistry of solutions with examples of known solutions such as coffee, soda, and cleaning agents. A comparison of particulate size was made in order to catalog examples as solutions, colloids, or suspensions. The collected water samples were displayed and used to lead the discussion of the presence of solutes. The students participated in the discussion basing their answers on previous knowledge and experiences.
2. The teacher asked the students to categorize the parts of a solution as solute and solvent. The meaning of concentration and dilution was elicited based on their previous experiences with concentrated cleaning liquids. The students used the commercial food-coloring solution as an example of how concentrations are quantified. The students then calculated the equivalency between percentage, fraction, decimal number, and power of 10 for two examples. The concept of serial dilutions was introduced.
3. To begin the lab, the teacher gave general instructions of where the trays with the materials were located. Students were instructed to work in groups and elaborate a joint report that included the Parts Per Million Powers of 10 Patterns Chart, the purpose, pre-lab questions, data table, and conclusion questions. Students worked in groups to complete the hands-on lab.

Technology used

No technology was used in this lesson.

Assessment methods used to measure student learning

A lab-report rubric was used to measure the understanding of serial dilutions and the mathematical interpretation of these.

Homework or special assignments for the next lesson(s)

Students were asked to find other examples in their homes of solutions involving solids, liquids and gases.

Process skills students practiced during this lesson

- Literacy – D2, D3
- Inventive Thinking – T1
- Effective Communication – C1, C2, C4

Students' reaction to this lesson

Students were amazed at the fact that no food dye was visible after six dilutions. The post-lab discussion led to analysis of certain environmental harmful practices such as discarding oil from cars onto the lawn and the use of pesticides.

What I learned during this lesson to better help my students to become more effective learners

Students need to be offered the opportunity to connect the results of their experiments with real-world applications. Many students acknowledged that their parents had discarded substances that could be harmful, even in very small dilutions, to lawns, in the ocean, or even down the drain in their homes

Lesson 3

Title: Global Water Sampling Project

Student learning objectives

The students will be able to

- Explore the relationship between chemical processes in their environment,
- Conduct qualitative chemical tests to determine water quality, and
- Apply their knowledge of dilutions to classify as normal or abnormal the concentrations of certain substances found in their water samples.

Time dedicated to lesson: One two-hour block

Lesson Summary

1. The teacher initiated the discussion of the purpose of determining water quality. Students participated in the discussion and made inferences about some of the results that they would find. The site from where each water sample was extracted was described in detail, including a showcase of photos. Students located the water collecting sites on a map provided them.
2. The teacher introduced the setup of the Water Monitoring Kits and the rotation schedule. The students gathered in the assigned area for their collaborative lab groups and began completing the tests.
3. Post-lab discussion allowed the students to share their results with the group. The students presented any questions or problems encountered in determining the color and the ranks of their results. The students completed a joint lab report draft using the mean values of the large group discussion. Students were allowed to use the four class computers to access the online site to clarify questions.
4. Part Two. Teacher led discussion about the chemistry of water followed by students accessing the Global Water Sampling site to compare their data with that presented from other schools. Students finalized their conclusions and wrote a final report on the particular water test assigned.

Technology used

Four internet-connected computers were used to facilitate the initial analysis of the data and the correct interpretation of each test. During the second part (data analysis), the students used the computer lab to analyze the values reported by other schools. The students used Microsoft Word and Excel to generate their reports.

Assessment methods used to measure student learning

A lab report and cooperative group rubric was used to assess the students' work in completing their water tests.

Homework or special assignments for the next lesson(s)

Students began formulating ideas for their action plan and decided on the mode of presentation.

Students' reaction to this lesson

Students were impressed that the water was not totally contaminated. Among the values that they did not expect was the pH, which led to a discussion of the buffering properties of the calcium carbonate found in the limestone in Florida. They were also astonished to find the positive tests for coliforms.

Process skills students practiced during this lesson

- Literacy – D1, D2, D3
- Inventive Thinking – T1, T2, T4

What I learned during this lesson to better help my students to become more effective learners

Students will sometimes make incorrect inferences based on scientific reports that apply to specific geographical regions. It is important that they realize that each area has its own inherent problems that respond to a number of variables such as populations, natural resources, and general chemical cycles.

Lesson 4

Title: Our Role as Informed Scientists

Student learning objectives

The students will be able to

- Evaluate the data and compare their results with other schools;
- Use technology to communicate their findings to their community; and,
- Using their scientific knowledge of the problem, determine a viable solution.

Time dedicated to lesson: Three two-hour blocks for the preparation and presentation

Lesson Summary

1. The teacher provided access to computers so that the students can access the data presented by other schools. The students chose at least one school on which to base their comparisons. The students wrote a short analysis of their water site.
2. The teacher asked the students to choose a medium of communication that involves technology. The choices are PowerPoint presentations, a website, or an online published document such as a newsletter or a brochure. The teacher demonstrated examples of these products and reviewed the use of each program: Microsoft PowerPoint and Microsoft Publisher. The students decided which format they would be using and the stakeholder to whom they would address their presentation. Stakeholder options were discussed in class. The class as a group decided on the following individuals and organizations as the most affected or involved in local water-quality issues. The most important stakeholders included people in the tourist industry, such as agents or outfitters; local citizens, such as the Miccosukee Indians; migrant farmers; and local industries, such as agricultural, construction, and quarry. Others to whom they could address their solutions included local or state politicians, environmentalists, and water-plant supervisors.
3. Students presented their project, which analyzes the water situation, addressing the issue to a specific stakeholder.

Technology used

Computers were used in order to develop the presentation products. The software used included the Microsoft Office package including Word, Excel, PowerPoint, and Publisher. Some students chose to create their web page using FrontPage and other alternative web-design software.

Assessment methods used to measure student learning

A rubric to evaluate each of the products (website, PowerPoint presentation, or Publisher document) was implemented. Students were graded on content, message, analysis of the problem, use of graphics, and oral presentation.

Homework or special assignments for the next lesson(s)

The homework assignment consisted of the completion of their project for presentation.

Process skills students practiced during this lesson

- Literacy – D1-D3
- Inventive Thinking – T1-T4

Students' reaction to this lesson

The students were very analytical and critical of their role as scientists. They were empowered by their newly found knowledge and became determined in conveying their message to the stakeholder that they had chosen. They conveyed their interest in learning more about the current changes that are taking place in the Everglades as humans try now to undo the damage that has been done to our local water for generations. It was particularly powerful to the students who have recently arrived from different countries. The fact that they were able to participate in this type of study and develop an action plan was fundamental to their understanding of their new home and surroundings. It is evident that the effect of these lessons will be carried with them and affect the decisions they will make for years to come.

What I learned during this lesson to better help my students to become more effective learners

I am more convinced now than ever of the power of problem-based learning. The opportunities that technology offers in order to compare what is happening to our environment to the water issues faced by other communities is invaluable and can never be found in any textbook. I would like to be able to use these projects more in the future as a springboard to creativity and authentic science.

Appendix 4: Lesson Summaries
Phoenix, Arizona – The Stowaway Adventure – Mr. Allen

Lesson 1

Title: The Stowaway Adventure

Student learning objectives

The students will be able to

- Locate, organize, and interpret written information for a variety of purposes;
- Engage in collaborative decision making; and
- Perform a school or real-world task.

Time dedicated to lesson: 53 minutes

Lesson Summary

1. Students were given a project description sheet one week prior; a parent signature was required.
2. At the beginning of the lesson groups assigned several days earlier, students were given a ship ID code and a variety of maps.
3. Students followed the directions given on Handout Number 2 to locate their ship on a map using real-time images. Students then used a database to locate their ship's previous four positions.

Technology used

iMAC computers were used to access real-time data.

Assessment methods used to measure student learning

Grading accuracy of data collected on Handout Number 2

Process skills the students practiced during this lesson

(D3) Information and visual literacy skills include the ability to decipher, interpret, and express ideas using mages, graphics, icons, charts, graphs, and video.

Students' reaction to this lesson

Students showed enthusiasm for the project when they realized that real-time data was being used.

Lesson 2

Title: The Stowaway Adventure

Student learning objective

The students will be able to

- Understand the world in spatial terms.

Time dedicated to lesson: 53 minutes

Lesson Summary

Maps were made available for students to plot the coordinates determined from Handout Number 2. Students plotted the coordinates, determined a course direction, and predicted a port of call.

Technology used

iMAC computers were used to research information about the port of call.

Assessment methods used to measure student learning objectives

Grading accuracy of data collected on Handout Number 3

Process skills the students practiced during this lesson

Sound reasoning skills: The capacity to think logically in order to find results or draw conclusions.

Students' reaction to this lesson

Some confusion on plotting coordinates, even though a lesson was given a few days prior.

What I learned during this lesson to better help my students to become more effective learners

More time should have been spent practicing how to plot longitude and latitude, along with the conversions of positive and negatives to north, south, east, and west.

Lesson 3

Title: The Stowaway Adventure

Student learning objectives

The student will be able to

- Use concrete and graphic models to derive formulas for finding rates, distance, time, and angle measurements.

Time dedicated to lesson: 53 minutes

Lesson Summary

Students used coordinates and distance calculator provided on the internet to determine the distance the ship had traveled between two points. Time was then calculated between the same two points. Students determined the speed at which the ship was traveling. I then guided groups toward the distance formula if it had not been discovered.

Technology used

iMAC computers were used to access the internet.

Assessment methods used to measure student learning objectives

Grading accuracy of data collected on Handout Number 4

Process skills students practiced during this lesson

Sound reasoning skills enable students to plan, design, execute, and evaluate a solution.

Students' reaction to this lesson

Students were surprised at the speed of the ships.

What I learned during this lesson to better help my students to become more effective learners

An explanation beforehand on how to enter longitude and latitude on the distance calculator would have been beneficial.

Lesson 4

Title: The Stowaway Adventure

Student learning objectives

The students will be able to

- Use concrete and graphic models to derive formulas for finding rates, distance, time, and angle measurement.

Time dedicated to lesson: 53 minutes

Lesson Summary

Students used current coordinates and port of call to enter data into distance calculator, which determines distance left to travel. Students then determined the time remaining to port based on distance and speed. An arrival time was then determined.

Technology used

iMAC computers were used to access the internet. A distance calculator provided by a website was used.

Assessment methods used to measure student learning objectives

Grading accuracy of data collected on Handout Number 5

Homework or special assignments for the next lesson(s)

Students were to prepare a list of possible expenditures to travel back home.

Process skills students practiced during this lesson

Sound reasoning enables students to plan, design, execute, and evaluate a solution.

Students' reaction to this lesson

Students were excited over the progress made over the length of the lessons and were enthusiastic about planning the trip home.

What I learned during this lesson to better help my students to become more effective learners

N/A

Lesson 5

Title: The Stowaway Adventure

Student learning objectives

The students will be able to

- Locate, organize, and interpret written information for a variety of purposes including classroom research;
- Engage in collaborative decision making; and
- Perform a school or real-world task.

Time dedicated to lesson: 53 minutes

Lesson Summary

Students had completed Lessons 2 through 5 of the Stowaway Adventure, and a port-of-call had been determined along with an arrival time. Students began searching the internet to obtain real-time budget data (expense information) for traveling home from the port where they were stranded. I first reviewed the objectives, then let students begin their research. I then facilitated the class in their data collection.

Technology used

iMAC computers with internet access were used to research expenses of port of call.

Assessment methods used to measure student learning objectives:

Observation and summary of data collected

Homework or special assignments for the next lesson(s)

Finish collecting expense data by April 22, 2002, so that class could begin work on the budget spreadsheet.

Process skills students practiced during this lesson

- (D3) Information and visual literacy skills including browsing, searching, and navigating online
- (T2) Creativity and curiosity skills, including curiosity about the world and how it works and a desire to learn
- (T3) Higher-order thinking skills including thinking creatively, making decisions, and real-world problem solving
- (C1) Team skills including the ability to interact smoothly with others and working with others to achieve a goal

Students' reaction to this lesson

Students were cooperative and interested in the differences between the United States and the port of call where they were stranded.

What I learned during this lesson to better help my students to become more effective learners

Students have the ability to search the internet but did not seem interested in comparison shopping. A discussion of careers and salaries may help students realize the importance of saving money on better prices and services.

Lessons 6 and 7

Title: The Stowaway Adventure

Student learning objectives

The students will be able to

- Collect, organize, and display data in a variety of forms, including tables, line and bar graphs, and charts; and
- Determine how different ways of presenting data can lead to different interpretations.

Time dedicated to lesson: 53 minutes

Lesson Summary

Students were to create a spreadsheet, complete with graphs, on expenditures on returning home from the port they arrived at when stowing away. I circulated through the lab, helping students record their data to create a budget.

Technology used

Compaq computers with internet access, Microsoft Office, and Excel to create the budget

Assessment methods used to measure student learning objectives

From a printout of the spreadsheet, the students were assessed on organization of expenses, inclusion of a graph, and conversion rates.

Homework or special assignments specified for the next lesson(s)

Began planning presentation format.

Process skills students practiced during this lesson

(D3) Information and visual literacy skills included accessing information and accurate and creative use of information.

Students used visualization tools to represent data (*e.g.*, graphs).

Students' reaction to this lesson

Students were engrossed and on task.

What I learned during this lesson to better help my students to become more effective learners

Providing a blank spreadsheet for the students would have helped save time. Students spent the first 15 to 20 minutes organizing data and determining column headings and labels.

Lesson 8

Title: The Stowaway Adventure

Student learning objectives

The students will be able to

- Collect, organize, and display data in a variety of forms, including tables, line and bar graphs, and charts; and
- Determine how different ways of presenting data can lead to different interpretations.

Time dedicated to lesson: 53 minutes

Lesson Summary

Students continued to work on their spreadsheets. Spreadsheets should include all expense data on returning home. I visited each group, helping with the spreadsheet and demonstrating the use of formulas and how to create graphs.

Technology used

Compaq computers with internet access, Microsoft Office, and Excel, used to create the budget

Assessment methods used to measure student learning objectives

From a printout of the spreadsheet, students were assessed on organization of expenses, inclusion of a graph, and conversion rates.

Homework or special assignments specified for the next lesson(s)

Began planning final presentation.

Process skills students practiced during this lesson

(D3) Students practiced information and visual literacy skills including accessing information and using it accurately and creatively. They used visualization tools to represent data (*e.g.*, graphs).

Describe your students' reaction to this lesson.

Some students were pleasantly surprised with the tools available on spreadsheets.

What I learned during this lesson to better help my students to become more effective learners

Providing a blank spreadsheet for the students would have helped save time. Students spent the first 15 to 20 minutes organizing data and determining column headings and labels.

Appendix 5: Process Skills Protocol

21st Century Skills Checklist¹

Instructions: Use this checklist in conjunction with the Lesson Summary Sheet. For each lesson summary, identify the 21st century skills that students will be developing or using by checking the appropriate boxes below.

Digital Age Literacy Skills

Name:

Lesson #:

District/school:

(D1) Basic Literacy Skills include	(D2) Scientific Literacy Skills include
<p>Language proficiency (reading, writing, listening, and speaking) using conventional and technology-based media;</p> <p>Ability to read and understand complex documents that include images and information in an expanding array of technologies; and</p> <p>Ability to decipher meaning and express ideas through a range of media.</p>	<p>Knowledge of science, scientific thinking, mathematics, and the relationships between science, mathematics, and technology; and</p> <p>Skills that emphasize scientific inquiry, scientific process, problem-based learning, and the integration of science and mathematics.</p>
(D3) Information and Visual Literacy Skills include	(D4) Cultural and Global Awareness Literacy Skills include
<p>The ability to decipher, interpret, and express ideas using images, graphics, icons, charts, graphs, and video;</p> <p>The ability to access information efficiently and effectively, evaluate it critically and competently, and use it accurately and creatively;</p> <p>Browsing, searching, and navigating online;</p> <p>Critical analysis of documents to determine credibility, purpose, bias, accuracy, and quality; and</p> <p>Use of visualization tools to represent data.</p>	<p>A recognition and appreciation of the diversity of peoples and cultures;</p> <p>The understanding and recognition of the interrelationships among nation-states, multinational corporations, and peoples across the globe; and</p> <p>Both formal and informal dialogues that serve as a bridge to openness and appreciation of diversity and other cultures.</p>

¹ Source: Lemke, C. (2000). *enGauge: 21st Century Skills*. Retrieved January 9, 2002 from <http://www.ncrel.org/engauge/skills/skills.htm>
 Alliance+ Student Impact Study
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Inventive Thinking Skills

Name:

Lesson #:

District/school:

<p>(T1) Skills to Manage Complexity include</p> <p>Taking into account contingencies, anticipating changes, and understanding interdependencies within systems;</p> <p>Resource management (time, space, materials);</p> <p>Looking for, understanding, and monitoring cause and effect; and</p> <p>Examining advantages and disadvantages to determine the most appropriate solution.</p>	<p>(T2) Creativity and Curiosity Skills include</p> <p>Using the imagination to develop new and original things;</p> <p>Developing the self-confidence and motivation to engage independently in learning, exploring, and creatively thinking;</p> <p>Curiosity about the world and how it works and a desire to learn continually;</p> <p>Taking risks, experiencing successes and failures, and then monitoring and adjusting accordingly; and</p> <p>A willingness to think deeply about a subject or problem and share that thinking with others to hear their perspectives, listen to their critiques, and then build on those experiences.</p>
<p>(T3) Higher-Order Thinking Skills include</p> <p>The process of creative problem solving that leads to sound, informed, thoughtful opinions, judgments, and conclusions;</p> <p>Thinking creatively, making decisions, real-world problem solving, seeing things in the mind's eye, knowing how to learn, and reasoning; and</p> <p>Expecting the unexpected.</p>	<p>(T4) Sound Reasoning Skills include</p> <p>The capacity to think logically in order to find results or draw conclusions;</p> <p>The ability to plan, design, execute, and evaluate a solution; and</p> <p>The ability to find, sort through, and evaluate information; check sources; maintain balance; cull extraneous materials; validate information sources; and resolve conflicting accounts of situations.</p>

Effective Communication Skills

Name:

Lesson #:

District/school:

<p>(C1) Teaming Skills include</p> <p>The ability to interact smoothly with others and to work together with one or more people to achieve a goal; and</p> <p>Teaching others new skills, assisting others with tasks, exercising leadership, negotiating and working with diverse groups of people.</p>	<p>(C2) Collaboration and Interpersonal Skills include</p> <p>Devising strategies to divide a task among group members into pieces based on the strengths of the individuals, yet ensure that each has a clear sense of the entire project; and</p> <p>Acknowledging that information technology can play a key role in the ease with which individuals and groups collaborate.</p>
<p>(C3) Personal and Social Responsibility Skills include</p> <p>Individual accountability for ethical, legal actions related to personal actions;</p> <p>Concerns about privacy, intellectual property, ownership, security, inferences about personal characteristics;</p> <p>Ethics and values associated with the application of science and technology in society (<i>e.g.</i>, pollution); and</p> <p>Understanding how citizens impact on their social, personal, professional, and civic lives and the lives of others.</p>	<p>(C4) Interactive Communication Skills include</p> <p>Ability to convey, exchange, transmit, access, and understand information;</p> <p>Use of asynchronous and synchronous communication such as email interactions, email lists, group interactions in virtual learning spaces, chat rooms, interactive videoconferencing; and</p> <p>Knowledge of etiquette often peculiar to particular technology environment and communication tools.</p>

Appendix 6. Classroom Observation/Final Presentations Protocol
Alliance+ Project - Student Impact Study

Scoring Scale for Observation/Presentation

NA - not applicable	1 = no evidence (not at all)	2 = some evidence (somewhat)	3 = clear evidence (to a large extent)	4 = strong evidence (at a very significant level)
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Learning Objectives	NOTES	Assessment	NOTES
Learning objectives were clearly defined and successfully communicated to students. 1 2 3 4		The assessment criteria were clearly communicated to and discussed with the students. 1 2 3 4	
The learning objectives were developmentally appropriate. 1 2 3 4		Students were involved in establishing the assessment criteria. 1 2 3 4	
The learning objectives are clearly aligned with local, state, or national standards. 1 2 3 4		Student products or work demonstrate an understanding of the concepts. 1 2 3 4	
Learning Tasks	NOTES	Teachers have carefully documented the assessment process involved. 1 2 3 4	
Tasks were designed to meet learning objectives. 1 2 3 4		Technology Tools	NOTES
Tasks engaged students. 1 2 3 4		Students had access to a range of technology tools ² . 1 2 3 4	
Tasks provided opportunities to use one or more technology tools. 1 2 3 4		The students had the necessary skills to effectively use the tools. 1 2 3 4	
Students were challenged by the tasks. 1 2 3 4		The technology tools were developmentally appropriate. 1 2 3 4	
Tasks promoted collaboration, group activities, or student-to-student interactions. 1 2 3 4		"Unique and compelling" internet applications were being used to develop problem solving and critical thinking skills. 1 2 3 4	
Teacher played the role of a facilitator of learning. 1 2 3 4		"Unique and compelling" internet applications were being used to develop 21 st century skills ³ . 1 2 3 4	
Students were involved in making decisions about task selection or modification. 1 2 3 4		"Unique and compelling" internet applications were having a positive impact on the learning process. 1 2 3 4	

² Technology Tools include *information technologies* (web sites, CD-ROMs, etc.), *productivity tools* (spreadsheets, word processors, etc.), *authoring tools* (web page editing software, PowerPoint, etc.) and *networking/communication tools* (e-mail, discussion areas, etc.).

³ See 21st Century Skill Checklist for a description of these skill sets.

³ Use the 21st Century Skill checklist to check off the skills you saw being developed as a result of using technology.

Scoring Scale for Observation Checklist

NA - not applicable	1 = no evidence (not at all)	2 = some evidence (somewhat)	3 = clear evidence (to a large extent)	4 = strong evidence (at a very significant level)
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Sharing Results	NOTES		Sharing Results (tools)	NOTES
Teacher planned for sharing of results from the beginning of the project. 1 2 3 4			Students used a range of technology tools to prepare for and create their presentations. 1 2 3 4	
The audience included people from the school or district. 1 2 3 4			Presentations showed that students had the necessary skills to effectively use the technology tools. 1 2 3 4	
The audience included people from outside the school (e.g., scientists, community leaders). 1 2 3 4			Presentations showed that students had been engaged in "unique and compelling" internet applications as part of their project. 1 2 3 4	
Students were able to effectively communicate their understanding of the concepts to the audience. 1 2 3 4			Overall Assessment	NOTES
The presentations demonstrated that the students were engaged during the implementation of the project. 1 2 3 4			Student products or work demonstrate an understanding of the concepts. 1 2 3 4	
Presentations showed that students were inspired to extend their learning beyond the classroom. 1 2 3 4			Student products or work demonstrate skill with technology tools ("non-compelling"). 1 2 3 4	
Presentations and final products met goals set by state and national standards. 1 2 3 4			Student products or work demonstrate skill with technology tools ("unique and compelling"). 1 2 3 4	
Presentations demonstrated students had engaged in collaboration and group activities as part of the project. 1 2 3 4			Students exhibited a high degree of enthusiasm and pride in their work. 1 2 3 4	
Student presentation and final products met goals set by state and national standards. 1 2 3 4			The teacher exhibited a high degree of enthusiasm and pride in the students' work 1 2 3 4	
Members of the audience participated during the final presentation. 1 2 3 4			The audience exhibited a high degree of enthusiasm and appreciation for the teacher's and the students' work. 1 2 3 4	

Instructions: Directly following the classroom observation or presentation, you should answer these questions in as much detail as possible. If necessary, ask the teacher, the students, or the audience. Either type your responses below each question or write them out on a separate sheet of paper. Confidential information can be communicated separately.

Observation and Presentations

What technology was being used? How?

How frequently were the students using technology?

Was the technology integrated into the learning activities or an add-on (*e.g.*, students get to use computer games when they complete their work)?

Did the technology tools support the core learning objectives? How?

How important was the use of technology in obtaining the learning objectives?

Were students using technology to communicate with other communities?

Were "unique and compelling" internet applications being used to develop problem-solving and critical-thinking skills? If so, how?

Were "unique and compelling" internet applications being used to develop 21st century skills? Explain⁴.

Did "unique and compelling" internet applications have a positive impact on the learning process? Explain.

What was the technology proficiency level of the teacher for each tool? For the students?

Did students help each other if technical problems developed?

Did the teacher respond to any technical problems effectively?

Was multidisciplinary learning taking place in the classroom? If so, describe the different skills that were being developed and how these were integrated.

Were cooperative learning or other forms of group work taking place? If so, were group roles assigned? Describe the roles. Were the computers or other technology used in a group setting?

Were the learning activities student centered or teacher centered (*e.g.*, lecture)? What role did the technology play in creating either of these two learning environments?

Where the students engaged? Motivated to learn? Why or why not? What role did technology play?

Were student products being generated through the use and influence of technology? (Note: Products may include stories, published books, artwork, graphics, graphs, charts, video, research reports.)

What student products are being generated? How?

Describe the most impressive use of technology that you witnessed (focus on "unique and compelling" internet-applications if possible).

What was the teacher's impression of the Savvy Cyber Teacher[®] course and how it has impacted on students?

Presentations

Describe the audience for the presentations. Who was present from the school district? Who was present from the community?

Did the teacher properly introduce the presentations and the presenters? Explain if the teacher provided enough contextual information or not.

Describe in detail what the student final products were and provide a few specific examples from individual students.

As part of the project that the students worked on, did they engage in the analysis of real-world data (either real-time data or data from collaborative projects)? If so, describe in general how the students presented this analysis and the impact it appeared to have on their understanding of the concepts.

What technology tools (see definition on first page) were used in the presentations?

Were the students able to demonstrate a high level of understanding of the concepts being presented? Did students meet the learning objectives for the project?

Please describe two or three specific examples of concepts that students presented and why you felt that they demonstrated a high degree of understanding of the subject matter being covered.

During the project implementation, was the internet used to develop problem-solving and critical-thinking skills? If so, how?

Based on the presentation, what 21st century skills did the students develop as a result of participating in the project (use the 21st Century Skill checklist to check off the skills you saw being developed as a result of using technology)?

Did the students engage in multidisciplinary learning as part of the project? If so, describe the different subjects that were being covered and how these were integrated.

Based on the presentations, were the students engaged? Motivated to learn? Provide some examples from the presentations in your response.

Was the teacher enthusiastic about the students' work? How was that enthusiasm communicated?

Describe the audience's response to the presentations? Provide examples of questions or comments.

Describe the most impressive presentation you witnessed, and explain why you thought it was so impressive.

What was the teacher's impression of the Savvy Cyber Teacher[®] course and how it has impacted on students?

Additional notes:

**Appendix 7: Student Post-Survey Responses:
Ms. Young (Cleveland), Ms. Castillo (Miami), Mr. Herman (Phoenix)
Student Technology Survey (Post)**

Percentage of Students Answering YES to Each Question

	Ms. Young Cleveland, Ohio Wonderful World of Weather Project	Ms. Castillo Miami, Florida Global Water Sampling Project	Mr. Herman Phoenix, Arizona Stowaway Adventure Project⁵
Grade(s)	3	9-11	8
Number of students	22	30	30
1. Before the project started, the teacher asked the class what we wanted to do on the project.	14	54	3
2. I liked working on this project.	87	83	46
3. My classmates enjoyed working on this project.	87	83	20
4. I learned science on this project.	100	87	20
5. I learned math on this project.	100	47	83
6. I learned English.	100	40	20
7. I learned social studies.	77	40	46
8. I worked harder on this project than on my regular classes.	77	64	24
9. My classmates worked harder on this project than on regular classes.	58	64	27
10. I worked mostly by myself.	72	37	60

⁵ Mr. Herman offered an explanation for the percentage of students in his class agreeing with certain statements on the survey being noticeably lower than the percentages in the other two classes. According to Mr. Herman, about two-thirds of the students were at-risk students who enjoyed the project, but did not have an appropriate mathematics background and found the project work challenging. The remaining one-third were gifted students who most likely did not find the work challenging enough.

Percentage of Students Answering YES to Each Question

2	Ms. Young Cleveland, Ohio Wonderful World of Weather Project	Ms. Castillo Miami, Florida Global Water Sampling Project	Mr. Herman Phoenix, Arizona Stowaway Adventure Project
Grade(s)	3	9-11	8
Number of students	22	30	30
11. I worked with my classmates.	100	90	57
12. I worked with my teacher.	91	70	30
13. I worked with the computer specialist.	100	23	27
14. Our class worked with a scientist.	27	16	13
15. I worked a lot at home on this project.	10	87	6
16. Our teacher told us how much we were learning.	68	67	13
17. During the project, I spoke with my classmates about how much we were learning.	82	56	6
18. I used a computer a lot during this project.	95	100	97
19. I wrote a story or a report on the computer.	91	80	47
20. I drew pictures on the computer.	91	43	30
21. I created a slide show with my classmates.	55	90	74
22. I used the internet often.	100	96	83

Percentage of Students Answering YES to Each Question

	Ms. Young Cleveland, Ohio Wonderful World of Weather Project	Ms. Castillo Miami, Florida Global Water Sampling Project	Mr. Herman Phoenix, Arizona Stowaway Adventure Project
3			
Grade(s)	3	9-11	8
Number of students	22	30	30
23. I used a computer to learn science on this project.	100	90	17
24. I used a computer to learn math on this project.	100	43	57
25. I used a computer to learn English on this project.	91	33	20
26. I used a computer to learn social studies on this project.	80	33	47
27. I learned a lot about using computers on this project.	100	77	70
28. I worked hard to prepare for the final presentation.	100	96	70
29. My classmates worked hard to prepare for the final presentation.	90	87	63
30. I liked working with the other students on the final presentation.	96	86	53
31. I can help other students use computers.	95	93	50
32. I liked sharing the results of this project with other people.	100	83	44
33. Using computers helped me learn better.	100	87	53

Percentage of Students Answering YES to Each Question

4	Ms. Young Cleveland, Ohio Wonderful World of Weather Project	Ms. Castillo Miami, Florida Global Water Sampling Project	Mr. Herman Phoenix, Arizona Stowaway Adventure Project
Grade(s)	3	9-11	8
Number of students	22	30	30
34. Using computers made the project more interesting.	100	87	77
35. I wish I had more chances to use computers in school.	100	87	74
36. When I go to college I want to learn more about computers.	91	89	77
	Percentage of Students Rating their Own Skills Intermediate or Advanced		
1. Word processing	87	90	70
2. Creating a slide show	5	86	57
3. Email	9	93	54
4. Internet use	91	97	77
5. Online collaborative projects	19	53	34
6. Real-time data projects	64	44	17
7. Contacting experts	0	30	13
8. Creating web pages	9	27	20

Appendix 8: Pre-Tests and Post-Tests Used for the Three Projects in this Report

Wonderful World of Weather

This test contains seven fill-in-the blank questions and three constructed-response questions for a total of 17 points.

Test Objectives

Students will

- Read and interpret a weather report and a climate report,
- Explain the difference between climate and weather,
- Explain why seasons are reversed in the northern and southern hemispheres, and
- Give examples of tools that weather forecasters use to predict weather.

National Science Education Standards

Standard A

As a result of their activities, all students should develop understanding about scientific inquiry.

Standard D

As a result of their activities, all students should develop an understanding that

- Clouds, formed by the condensation of water vapor, affect weather and climate;
- Global patterns of atmospheric movement influence local weather; and
- Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

As a result of their activities, all students should develop an understanding of Earth in the solar system.

NCTM Curriculum Standards

Standard 11: Statistics and Probability

Students will be able to

- Systematically collect, organize, and describe data; and
- Construct, read, and interpret tables, charts, and graphs.

Standard 13: Measurement

Students will be able to

- Extend their understanding of the process of measurement;
- Estimate, make, and use measurements to describe and compare phenomena;
- Select appropriate units and tools to measure to the degree of accuracy required in a particular situation; and
- Understand the structure and use of systems of measurement.

The Global Water Sampling Project

This test consists of five constructed-response questions for a total of 15 points.

Test Objectives

Students will

- Demonstrate an understanding of the pH scale;
- Demonstrate an understanding of the direct relationship between water temperature and dissolved oxygen;
- Explain why water monitoring should be conducted on a regular basis to reveal changes that may occur over time;
- Explain the relationship between levels of turbidity and dissolved oxygen; and
- Explain how nitrate-nitrogen readings can be used as an indicator of water quality.

National Science Education Standards

Standard A

As a result of the activities

- All students should develop an understanding about scientific inquiry.

Standard C

As a result of the activities

- All students should develop an understanding of population and ecosystems;
- All students should develop an understanding of diversity and adaptations of organisms; and
- All students should develop an understanding of change, constancy, and measurement.

NCTM Curriculum Standards

Standard 10: Statistics

- Students will systematically collect, organize, and describe data; construct, read, and interpret tables, charts, and graphs; and make inferences and convincing arguments that are based on data analysis.
- Students will make and use estimates of measurement and use measurements in problem and everyday situations.

Standard 11: Statistics and Probability

- Students will interpret displays of data.
- Students will formulate and solve problems that involve collecting and analyzing data

The Stowaway Adventure

This test consists of nine fill-in-the blank questions and one constructed-response question for a total of 13 points.

Test Objectives

Students will be able to

- Plot a ship's coordinates on a map,
- Use coordinates to determine the direction in which a ship is traveling,
- Calculate the speed of the ship based on the distance it traveled and the time that it took to travel that distance, and
- Calculate the time it will take a ship to reach port based on distance and speed.

National Science Education Standards

Standard A

As a result of the activities

- All students should identify questions that can be answered through scientific investigations;
- All students should be able to design and conduct a scientific investigation;
- All students should use appropriate tools to gather, analyze, and interpret data; and
- All students should develop descriptions, explanations, predictions, and models using evidence.

Standard B

As a result of the activities all students will develop an understanding that the motion of an object can be described by its position, direction of motion, and speed.

Standard D

As a result of the activities all students will develop an understanding that

- Clouds, formed by the condensation of water vapor, affect weather and climate;
- Global patterns of atmospheric movement influence local weather; and
- Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

NCTM Curriculum Standards

Standard 1: Mathematics as Problem Solving

- Students will use problem-solving approaches to investigate and understand mathematical content; formulate problems from situations within and outside mathematics; develop and apply a variety of strategies to solve problems, with emphasis on multistep and nonroutine problems; verify and interpret results with respect to the original problem situation; generalize solutions and strategies to new problem situations; and acquire confidence in using mathematics meaningfully.

Standard 9: Algebra

- Students will understand the concepts of variable, expression, and equation and apply algebraic methods to solve a variety of real-world and mathematical problems.

Standard 12: Geometry

- Students will develop an appreciation of geometry as a means of describing the physical world, and be able to represent and solve problems using geometric models.



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