

USING SERVICE-LEARNING TO TRAIN FUTURE TEACHERS THROUGH THE TOMORROW'S SCIENTISTS AFTER-SCHOOL PROGRAM

VIRGINIA OBERHOLZER VANDERGON

Department of Biology, 18111 Nordhoff St, California State University, Northridge, CA 91330-8303

virginia.vandergon@csun.edu

MAUREEN SHUBOW RUBIN

Center for Community Service-Learning, 18111 Nordhoff St., California State University, Northridge, CA 91330-8370

maureen.rubin@csun.edu

In the Fall 2001, one section of Introductory Biology (BIOL100) taught by Dr. Vandergon was geared to students in the Integrated Teacher Education Program (ITEP) at California State University, Northridge (CSUN). Using a service-learning model, it included an eight-week after-school science enrichment program for low-income 7th grade students. The CSUN location allowed the *Tomorrow's Scientists* program to take advantage of university laboratories and facilities. ITEP students are on a four year fast-track to obtain both BA degrees in Liberal Studies and California multi-subject teaching credentials. The BIOL100 syllabus was designed in compliance with the California Science Standards. A major goal of this program was to familiarize ITEP students with the California Science Standards by exposing them to concepts and giving them early experience in hands-on science teaching. A second major goal was to excite the ITEP and 7th grade students about science and dispel myths that science is hard or boring. We evaluated the success of this methodology through attitudinal surveys and pre- and post-testing for science knowledge. The ITEP students in this program improved in science content knowledge on average 17% more than students in the normal BIOL100 sections. These students also showed a shift in attitude that showed increased confidence in their knowledge and ability to teach science in a classroom setting. The 7th grade participants showed a 23% increase in science content knowledge in the areas covered in the club activities. Overall, the *Tomorrow's Scientists* after-school program appeared effective for increased science content knowledge and effective pedagogy.

Overview

The Nation's Report Card: Science 2000, a report released by the National Center for Education Statistics (NCES), summarizes the results of a survey conducted by the National Assessment of Educational Progress (NAEP). Among its disturbing findings is data placing the average science test scores for California students among the lowest in the nation [1]. More alarming was the finding that the assessment showed a decline in scores across the United States for 12th graders when compared to scores collected in 1996. For 8th graders across the nation, the scores remained the same compared to 1996, except for California and Maine, where the averages dropped.

Why does California have such low scores in the sciences when it is one of the most productive states in biotechnology and computer science? One reason might be the number of English language learners in California. Although this accounts for some of the low scores, it does not paint the entire picture. The non-Latino white students in California also scored on average lower than other non-Latino white students across the nation. Even the scores of children of college-educated parents were low when compared with similar children in other states. These results may be an indication of the failure of teachers to motivate students and teach science effectively in K-12 classrooms.

There is a positive correlation between teacher preparation and students' scores. The more science content teachers have, the better the scores their students achieved on the science survey [2]. Future teachers are graduating from universities with poor backgrounds in sciences and then are expected to teach science in their classrooms [2]. If this trend is to be reversed, it is apparent that teacher training in science must improve. How are the educators of these future teachers addressing this issue? In California, traditional credentialing programs required five years for completion. There is a tremendous shortage of qualified teachers in California so many districts are hiring teachers on emergency credentials. Given this situation, adding more science courses to teacher credentialing curricula does not seem like a feasible alternative to the current teacher education design. So what might be a better approach?

The root problems of poor teacher preparation in science are varied, but lead us to ask many questions about teacher preparation in science content and pedagogy. Are California universities doing a good job educating the future teachers in science content to provide them with a solid foundation? What should science educators do to improve the quality of science instruction at primary and secondary schools? What can be done to improve the delivery of the content? What can be done to improve the confidence of the future teachers so that they are more likely to include science in their curricula? What type of content is being taught to these future teachers? What resources are available to the future teachers once they are in their own classrooms? Can a change in pedagogy increase content knowledge and confidence? Would service-learning, an innovative pedagogy, make a positive difference in future teachers' confidence, knowledge, and ability to teach science? If a service-learning component were added to a content course what should the module look like? Does a service-learning component open the door to further inquiry so that new teachers can think critically and seek new ideas?

Some of these questions were addressed as we designed and implemented a special section of Introductory Biology (BIOL100) for future teachers at California State University, Northridge (CSUN).

Biology 100 (Introductory Biology)

The non-majors biology course (BIOL100) at CSUN is designed to teach life science concepts to students so they may have a better understanding of scientific methodology and a greater appreciation for the living world. Liberal studies majors (students who will enter teacher credential programs in K-12 education after earning BA degrees) comprise one of the largest groups of BIOL100 students at CSUN. A majority of these graduates will teach Kindergarten through 6th grade upon graduation from the credential program. To better meet the needs of this large group, a pilot offering of a specialized section of BIOL100 was created for liberal studies students. This section was first offered in Spring 2001 and was open to a special subgroup of liberal studies majors, those enrolled in the Integrated Teacher Education Program (ITEP). ITEP students are identified upon acceptance to the University having met higher GPA and academic criteria. The ITEP program places students on a fast track, allowing graduates to earn both a Bachelors of Arts degree in Liberal Studies and a California State Multi-subject teaching credential in four years, rather than five years normally required.

In the pilot semester, the BIOL100 course included the typical three hours of lecture and three hours of laboratory exercises. The difference between the traditional BIOL100 and this section was the inclusion of content from the life science standards in the California State Public School Standards [3]. Many of the laboratory experiences were also altered to involve activities that the students could use in their classrooms. A major course project was for each student to choose a life science standard, design a lesson plan, and teach part of that lesson to their classmates. Although this course was successful in integrating content standards, it failed to provide any actual practice in teaching content and pedagogy to K-6 grade students. The students were unable to evaluate how their efforts would be received, comprehended, and

absorbed by the real target audience. Therefore, in Fall 2001, a mandatory service-learning component was added to a special ITEP section of BIOL100. Service-learning is defined as:

- a. A way to participate in an organized service activity that meets identified community needs; and
- b. a pedagogy that includes reflection on the service activity in such a way as to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility [4].

Addition of a service-learning component to the BIOL100 course had two main goals, first to increase science content knowledge in students, and to increase classroom competency in science instruction. Synthesizing the service learning definition with our goals, we created an after-school science club for local seventh grade students. Seventh grade students were chosen because many of the ITEP students want to work with K-2 because they do not feel confident handling older students.

Why an after school club?

Community members, parents, and educators often look for ways to keep children occupied with positive and productive after-school activities. One popular option for many schools and communities are after-school clubs. Although many of these programs exist, most are not educationally oriented, and of those that are, very few are science related. Two major obstacles to developing science-related after-school activities are the lack of qualified, knowledgeable staff to supervise, and a lack of equipment such as microscopes and laboratory facilities. The BIOL100 class for ITEP students at CSUN eliminated these obstacles and had the added benefit of providing university-level space, resources, equipment, and facilities such as a botanical garden and a planetarium. The after-school club was named *Tomorrow's Scientists* and was conducted for eight weeks with students from four local Title I [5] middle schools in the Los Angeles Unified School District. Most of the middle school students in the program are from the Northeast San Fernando Valley where 34% percent of youth live below the poverty line, 59% have Limited English Proficiency, and 93.7% are eligible for the Federal Lunch Program [6].

This project thus benefited two critical audiences: the liberal studies majors who could hone their science-teaching skills in the second year of their preparation rather than the fifth year and the local middle schools students who could participate in an after-school science activity that previously did not exist. Overall, we had several goals and learning objectives for this section of BIOL100. These were to:

- Develop a greater awareness and appreciation of the living world;
- Increase the ITEP student's knowledge base and create a resource of notes for teaching life sciences in the K-6 classroom;
- Familiarize ITEP students with the California Science Teaching Standards [3] by exposing them to concepts they need to teach as well as teaching them how to integrate the standards into innovative lesson plans;
- Excite the ITEP and middle school students about science and dispel myths that state science is difficult and boring;
- Address community needs for additional science education and after-school programs;
- Target motivated 7th grade students from low-income neighborhoods;
- Help ITEP students gain experience and confidence in teaching science;
- Assess the value of the program to ITEP students and 7th graders through attitudinal and knowledge-based pre- and post-course tests; and
- Match the middle school students with college-aged mentors/buddies who will encourage college attendance, expose them to a positive experience on a college campus, and help them see that college is a real possibility.

Program description

Participation in the *Tomorrow's Scientists* after-school club was a mandatory component of the BIOL100 section taught to the ITEP students. Seventh graders were recruited into the program by sending flyers in Spanish and English to administrators at four nearby Title I schools with whom the Biology Department (through the California Science Project) and the Center for Community Service-Learning at CSUN had previous partnerships. Acceptance into the program required parental consent and completion of an application packet, and operated on a first-come, first-served basis (Fig. 1). The CSUN Service Learning Center staff wanted to facilitate carpools from participating schools, but parents were not willing or able to provide these rides. Therefore, arrangements were made for the middle school students to be bused onto the University campus by a private van service. Transportation funds from a Learn and Serve America grant were channeled into the *Tomorrow's Scientists* program for this purpose. The vans made four stops each week to pick up the children at their home schools and return them at the end of the day.

For eight weeks, the ITEP students (21 females in this class) planned activities and experiments for the middle schoolers focused on the California life science content standards [3] for 6-8th graders. Both the ITEP students and the middle school students participated for two hours each week in all activities. All ITEP students partnered with the same "buddy" each week, except on the day they presented their lesson. This established some consistency from week to week and helped foster personal mentoring relationships. The ITEP students became role models for their young charges and could also answer their questions about college life and academics, as well as informing them about what it takes to be accepted into college.

In order to incorporate participation in *Tomorrow's Scientists* in the already busy schedule of ITEP students, the club took place during part of the scheduled laboratory time for the BIOL 100 course. The cooperation and support of the Chair of the Department of Biology made this scheduling possible. The curriculum was redesigned as follows:

Weeks 1-4	Lecture and accelerated labs covering basic biology content.
Weeks 5-13	Lecture and <i>Tomorrows Scientists</i> club held during lab times
Weeks 14-16	Lecture and FAST plants experiments [7]

The lecture portion of the course focused on life science themes related to the California State Public School Science Standards for Kindergarten through 6th grade [3]. The course textbook was *Biology, Life on Earth*, by T. Audesirk and G. Audesirk, 5th Ed. [8]. Lectures were designed to both deliver content and demonstrate different teaching methods. One method employed by the instructor (Dr. Vandergon) demonstrated a pedagogy that starts each topic with questions that pre-tests the student's knowledge of a subject, moves to a discussion of their responses, and then begins the lecture. This allows the professor to gain insight into what the students already know and what students think they know. This easily judged misinformed or confusing responses. Another technique was to periodically stop the lecture and ask the ITEP students a multiple-choice question on the topic just covered. The students were all required to answer by holding up an appropriate numbered index card (provided in a packet at the beginning of the semester). This method helped set an appropriate pace for the course because it provided immediate feedback on concept learning. Each topic ended with a follow-up question answered on index cards that were then quickly and easily checked by the instructor. The beginning of the next lecture often began with a repeat of the multiple-choice questions from the previous day as a review. Course grades were based on weekly quizzes, homework, lab assignments, midterms, a final, a science project using FAST plants [7], and their service-learning project. The criteria for the service-learning project as it appeared in the syllabus is shown in Fig. 2.

**Application for *Tomorrow's Scientists*
California State University, Northridge**

Department of Biology

Center for Community Service-Learning

Student name _____ School _____ Grade _____

I, _____ parent or legal guardian of the above-mentioned student hereby give permission for my child to participate in the *Tomorrow's Scientists* program conducted by the Department of Biology and the Center for Community Service-Learning at California State University, Northridge. I understand that the primary objectives of the program are to:

Provide middle school students with a quality after-school science instruction program in Fall 2001.

Have middle school students get excited about science instruction.

Dispel the myths that science is difficult or boring, since research demonstrates that many students lose interest in science at the middle school level.

Expose middle school students to an experience on a college campus and provide them college-aged students who can be their mentors/buddies.

Tomorrow's Scientists will take place from 3:00-5:00 PM. on eight Tuesday afternoons in the Fall 2001 semester, from September 25 to November 13, 2001 in Rooms 1322 of Science A on the California State University, Northridge campus. Laboratory classes featuring instructions and experimentation in biology and life sciences will be supplemented by activities in the CSUN botanical garden and the Bianchi Planetarium. Participating students should wear closed-toe shoes (no sandals) and old clothing due to possible spills.

I hereby authorize *Tomorrow's Scientists* program directors, staff, and assistants to engage in the following:

- To have access to, and to make and receive copies of my child's academic school records through the completion of the 12th grade. I understand that these records will be kept in strict confidence and will be used to: a) monitor my child's academic progress and b) to assess the value of the *Tomorrow's Scientists* program.
- To allow my child to attend classes, perform experiments and participate in on-campus field trips sponsored by and coordinated by the *Tomorrow's Scientists* program. I understand that my child will have adult supervision while on these field trips.
- To use my child's name, photograph, and quotes in *Tomorrow's Scientists* press releases and publications.

I certify that I have read and understand all rules and safety provisions established for this program.

In addition, I agree to assume full responsibility for any risk of injury, death, or property damage arising out of my child's participation in the program and I give permission for my child to receive, if necessary, any emergency medical services by authorized personnel, and that any cost incurred as a result of such medical emergency will be solely my responsibility.

I further release the University from any liability on account of injury to or death of my child arising out of my child's participation in *Tomorrow's Scientists* activities and hold the University harmless for any damage or costs that may be incurred due to the actions of my child during participation in this program.

Fig. 1a. Application form from the *Tomorrow's Scientists* program packet. This form was also made available in Spanish.

Tomorrow's Scientists - Required Signature Page

Department of Biology Center for Community Service-Learning

Student _____ School _____ Grade _____

Parent or Legal Guardian's Signature Date

Parent or Legal Guardian (Please print)

Address City Zip

Home Phone Number Emergency Phone Number

Special Instructions: _____

Note: California State University, Northridge is in the process of arranging free transportation to and from middle schools in the San Fernando Valley. Please fill out the information below if you are able to help with transportation if asked by other parents.

_____ If asked by *Tomorrow's Scientists* participants or their parents, I can provide a ride for _____ students from _____ Middle School to California State University, Northridge on Tuesday afternoons at 2:30 PM from September 25 to November 13, 2001.

_____ If asked by *Tomorrow's Scientists* participants or their parents, I can provide a ride for _____ students from CSUN to _____ Middle School on Tuesday afternoons at 5:00 PM from September 25 to November 13, 2001.

_____ I have a California Driver's License. Number: _____

_____ I have automobile insurance.

Fig. 1b. Required signature release page from the *Tomorrow's Scientists* program packet. This form was also made available in Spanish.

Students were expected to follow the criteria outlined in Fig. 2 when planning their group's *Tomorrow's Scientists* activity. The ITEP students were given at least one in-class hour of preparation each week for lesson planning. In addition, they were expected to spend several hours outside class researching, designing, and preparing the science club activity for which they were responsible. Therefore, each student devoted approximately 28-30 hours to the service-learning component of this four-unit course. The *Tomorrow's Scientists* timeline and organization of activities is presented below.

- Week 1 ITEP students were assigned middle school "buddies" and conducted a "get to know you" interview. ITEP student/buddy teams take a science walk through the CSUN botanical garden while performing botanical key activity created by ITEP students.
Middle-school students are pre-tested on knowledge and attitudes in science.
- Weeks 2-7 ITEP students were split into two classrooms, supervised by the instructor, and a graduate student. In the first hour of lab (2 to 3 p.m.), students prepared for day's activity and classmates were briefed on the activity and their responsibilities for the day.
The middle school students arrived at 3 p.m., receive a snack and juice, and convened in labs. The activity was conducted for approximately 90 minutes. The students departed at 5 p.m.
- Week 8 A debriefing session was conducted with the ITEP and middle school students.
Evaluations were filled out by both CSUN and middle schools students.
The middle school students were post-tested on knowledge and attitudes toward science.
A presentation was given in the CSUN planetarium and a farewell party held.

Biology 100 - Service Learning Project:

The service learning component of this class will be an after school science club for local middle schoolers. We will plan and design eight weeks of two-hour activity times with the middle school students. The activities will be based on the California State Science Standards. There will be an emphasis on creation of activities that will interest the middle school students. You will be divided into 6 groups (four students per group) and each group will be responsible for designing the lesson and activities for one club day that focuses on one standard. The first club day will include a pairing up of each of you with one middle school student who will become your activity buddy. You will interview and get to know your assigned buddy during a science walk through the CSUN botanical gardens while performing a botanical key activity. The second through seventh club days will be conducted by the individual student groups who will have a prepared activity that addresses their chosen standard. The eighth week activity will consist of a debriefing session, evaluations by both you and the middle school students, and a farewell get-together. All students will be expected to participate in all club day activities whether they are presenting or not. (see participation requirement below).

Each group activity will be graded in two parts:

The **Lesson plan** will be worth 65 points and will be assessed as follows:

1. The California Science standard that your group chose to address. Demonstrate competence in the standard by writing a short synopsis of the standard and its goals. How will the standard be addressed by your group? (10 pts.; 2pts. for a summary of the standard, 5 pts. for competence, and 3 pts. for how you are addressing the standard.)
2. Prepare a detailed description of everything you will need to implement your activity. This can partially be in the form of a supply list but must include every detail. (10 pts.)
3. Prepare a thorough description of what you plan to do in your activity and estimate the time it will take to do each part. Remember you will be in two rooms so two of you will run the activity in each room. Divide up who is doing what and at what time. This means that you will have to go through it yourselves and practice your activity. (10 pts.)
4. Handouts or other learning aids for the middle school students. These can be outlines, vocabulary words, puzzles, activities that they might do at home to enhance their knowledge of the concepts. (5 pts.)
5. Resources you used to develop your activity. You will need to use outside sources and reference them as indicated on the last page of the syllabus. These sources can include any appropriate resource such as the WEB (provided it is a legitimate site, see me if you have questions), journal articles or books. (5 pts.)
6. Write at least three multiple-choice questions, one of which will be used in designing a pre- and post-test for the middle school students. The questions must be at a seventh grade level and be relevant to the concepts you will be teaching the middle school students. (5 pts.)
7. You will turn in your lesson plan neatly typed and organized with all spelling errors and grammar mistakes corrected. (4 pts.)
8. You will conduct a self-assessment and an individual assessment on the group's participation. (6 pts.)

The **Activity presentation** will be worth 45 points and will be assessed as follows:

1. Presentation must be organized and flow. (7 pts.)
2. Presentation content. Did the students appear to understand the concepts? How did you judge their understanding? (7 pts.)
3. The quality of the presentation. Were the activities fun? Was the activity at the appropriate level for these students? Did you challenge them? Was it too easy or too hard? Did the activity make sense? (7 pts.)
4. Each individual in the group must participate equally. (8 pts.)
5. Did you follow the allotted time schedule? (5 pts.)
6. Self-assessment and an individual assessment on the rest of the group's participation. (6 pts.)
7. Scheduled meetings with instructor. Were you prepared? Did you arrive at the scheduled time? (5 pts.)

Fig. 2. Criteria for the service-learning project component of BIOL100.

Topics for The *Tomorrow's Scientists* Fall 2001

As described above, each group chose a life science topic based on the California Standards for grade 6-8 [3]. Brief descriptions of topics and ITEP designed activities follow:

TOPIC 1: GENETICS: INHERITED VS. ACQUIRED TRAITS

Where Did You Get Those Big Brown Eyes?

The ITEP presenters began their presentation with a game that was designed to get the middle-schoolers thinking about their own genetic traits and how these traits make them unique. The middle schoolers made virtual crosses using computer software. In another activity the students compared their fingerprints taken with washable inkpads. The objective was to identify the uniqueness of each individual fingerprint.

TOPIC 2: ENDANGERED SPECIES AND THE FOOD WEB

Where Have All the Species Gone?

Students received a brief introduction to a food web and then went outside to play a game of tag. Both the ITEP and middle-school students participated as members of a food web. The game of tag was played twice, once with no interference and once with "herbicide" treatment. Later the students discussed the activity and the effect endangered species have on food webs.

TOPIC 3: DIGESTION

You Are What You Eat!

On this day, the ITEP students gave the middle schoolers a comprehensive tour of the digestive system illustrated by several exciting experiments and activities. For example, the 7th graders tested how saliva works by using a starch amylase test and determined the pH balance of a variety of products to learn about the pH properties of the human stomach.

TOPIC 4: CELLS

The Building Blocks of Nature

The ITEP leaders used colorful overheads and handouts to ask questions and fill in gaps in the middle schoolers' knowledge of cell structures. The ITEP students helped their middle-school buddies build candy models of a plant and an animal cell. A discussion followed about the differences between plants and animals and how cell types cause those distinctions.

TOPIC 5: DNA

Your Permanent Identity Card

The *Tomorrow's Scientists* exploration of DNA began with a lesson about how DNA functions and a description of the components of DNA. The ITEP students helped their buddies isolate DNA from onion cells. While the experiment was incubating, the groups made candy models of DNA.

TOPIC 6: EVOLUTION AND NATURAL SELECTION

Is It Really Survival of the Fittest?

The ITEP leaders started this day with a questions that assessed their students' previous knowledge. This was followed by a virtual simulation that demonstrated the affects of selection and variation on populations. The group then played a game involving the selection of colored dots from a variety of flowered cloth backgrounds to demonstrate adaptive survival.

Assessment

Many forms of assessment were performed to monitor changes in science attitudes, service-learning attitudes, and to monitor gain in science content. The ITEP students also performed a weekly reflection exercise where they responded in writing to thought provoking questions. A sample of the reflection questions and examples of responses are shown in Fig. 3.

Reflection #1- Following First Week

When the middle schoolers were coming on the first day I was _____.
Fill in the blank above and reflect on how you felt or what you thought about before the middle school students arrived and how you felt or what you thought about after they left. (Write at least a few sentences on each.) Did your feelings or thoughts change from before to after? Why or why not?

Before they came, I felt nervous and excited.

I was unsure how to react once the children arrived.

I was excited because I can't wait to become a teacher.

I was worried that I wouldn't be able to answer their questions.

*I was a bit worried that they would have the attitude of "having to be here"
and not at home hanging with their friends.*

It turned out great at the end.

I began to look forward to the weeks to come.

I realized how fun they were, and how easy it was to talk to them.

I noticed that the students enjoyed the lesson.

After they left I was relieved that they had a good time and were looking forward to coming back.

Reflection #6-Following Week Six, DNA Activity

Reflect on how you think the middle schoolers liked or did not like the DNA activities/experiments. What would you have added to the activities? Did you like doing the activities with the students? How did you feel about actually isolating DNA? Were you able to help the students? Do you think they understood what they were doing? What did you learn in working with the students? (Reflect on any of these questions that apply to you.)

*I thought that the DNA activities were fun and interactive, especially since the content of
that lesson was a little complicated for 7th graders.*

I think they were surprised that they had actually isolated DNA from the onion.

*I don't think the kids understood why the DNA separated, but I think they understood that DNA
was tangible, not just a cartoon in their book.*

*I learned that when working actively with the students, we teach each other a lot and have fun
getting to know each other.*

I learned that when working with students, one has to direct the students in the right direction.

Fig. 3. Examples of ITEP student reflections on each *Tomorrow's Scientists* activities.

Each ITEP student also was required to conduct self and group assessments after each project was completed and on their own written lesson plans. Their responses were honest and straight forward. The majority of the ITEP students were proud of what they had accomplished. Some students did not participate as well within their group as others, but all students appeared to be honest about their individual contribution to the project. Figure 4 shows the self and group assessment for the project portion of the activity.

A science attitude survey was designed for the middle schoolers and included questions where they had to draw a scientist, describe what a scientist does, and describe where a scientist works. On the pre-attitude survey, most of the middle schoolers described scientists as people (some said men) who worked in a lab, wore a white lab coat, and glasses. Two students noticed that a scientist could look like anyone. Most of the middle schoolers assumed a scientist finds cures and answers questions. The labs were usually described as having microscopes, books, and machines. Half of the middle-schoolers thought all scientists make a lot of money. All the middle-schoolers recognized that there is still plenty to discover in science. Seventy-two percent of them acknowledged that not all scientists tell the truth.

Self and Group Assessment for Service Learning Project Activity

Name _____ Partner _____ Partner
_____ Partner _____

Project title _____

A. Did my partners and I include all of the criteria necessary for the project? Comment on how you did this and note who did what in the process.

1. Presentation was organized and flowed well.
2. Presentation content:
 - a. Did the students seem to understand the concepts?
 - b. How did you judge their understanding?
3. Quality of the presentation:
 - a. Did the students think the activities were fun?
 - b. Was the activity at the appropriate level for these students? Did you challenge them or was it too easy or too hard?
 - c. Did the activity make sense to the student?
4. Did you follow the allotted time schedule?
5. Did you and your partners come to the scheduled meetings with Dr. Vandergon?
6. Further comments:

B. What did you learn about science content in doing this assignment?

C. What did you learn about service learning in doing this assignment?

D. What was the most challenging part of the assignment?

E. What went more smoothly than you thought it would?

F. I put _____% effort into this project and my partners each put:

Name _____	_____ % effort into the project.
Name _____	_____ % effort into the project.
Name _____	_____ % effort into the project.

G. If I were to redo this assignment, I would ...

H. Of what are you most proud concerning this project?

Fig. 4. Self and group assessment form for the activity portion of the service-learning project.

On the last day of the club, these students were asked these same questions again. Their answers were very similar: they still thought of a scientist as someone that wears a lab coat and glasses, and as one student remarked that a scientist "*is a person who looks tired, has glasses to see closer and investigate, does not have the greatest hair and a white suit.*" When asked what a scientist does, one student commented, a scientist "*tries to discover solutions to problems whether for the good of man or for an evil plot to take over the world.*" Most of the students described a scientist as working in a laboratory and, as one student put it, "*with a lot of gzymoes. Like microscopes, computers and x-ray machines.*" The post-attitude survey revealed that a few students recognized not all scientists work in labs, that some work in schools and outdoors. In the post-survey, only 23% of the students thought that scientists make a lot of money. Again, all

the middle-schoolers realized that there is still more to discover in science. Notably, only 41% of the students now thought that scientists do not tell the truth. The last part of the post-attitude survey also included questions about which units they liked best, which ones they liked least, and why. Only two students listed a unit they did not like and the rest of the students liked them all. All of the middle-schoolers had fun and would invite their friends next time. Many students remarked that the *Tomorrow's Scientists* club "was cool."

Use the following scale to respond to the statements below:						
1	2	3	4	5		
strongly agree	agree	undecided	disagree	strongly disagree		
					Pre-test	Post-test
___1.	I will continually try to find better ways to teach science.				1.5	1.4
___2.	I know the steps necessary to teach science concepts effectively.				3.7*	2.0*
___3.	Even when I try hard, I will not teach science as well as I will teach most subjects.				3.4	3.7
___4.	The inadequacy of a student's science background can be overcome by good teaching.				1.6	1.7
___5.	I understand science concepts well enough to be effective in teaching elementary science.				3.1*	1.9*
___6.	I will find it difficult to explain to students why science experiments work.				3.6	3.4
___7.	Given a choice I will not have the principal evaluate me while I am teaching a science lesson.				2.9	3.2
___8.	I will typically be able to answer students' science questions.				2.5	2.0
___9.	I can teach science without mathematics.				4.1	4.0
___10.	I can teach mathematics without science.				3.5	2.9
___11.	Science should be taught straight from a textbook.				4.6	4.5
___12.	Science should be taught as completely hands-on or inquiry based exercises.				3.9*	2.7*
___13.	Science should be taught both with hands-on exercises and a textbook.				1.3	1.4
___14.	Science can be taught to students as "real" in other words so that it relates to their world.				1.5	1.4
___15.	Science can be taught so that students have fun.				1.4	1.2
___16.	If a student has a negative attitude about science I cannot change his/her mind.				4.1	4.1
___17.	By the time a student is in 5 th grade most of them don't like science.				3.4	3.0
___18.	By the time a student is in 5 th grade most of them don't like math.				3.1	2.9
___19.	I think that all science should be taught based on the science standards.				3.3	3.0
___20.	I am not comfortable with the content presented in the science standards.				3.0	3.4
___21.	Science should be taught as fact based.				3.2	3.3

**denotes an attitude shift of at least one level.*

Fig. 5. Results of the first and last day Science Attitude Survey given to the ITEP.
A different science attitude survey (Fig. 5) was given to the ITEP students during the first

week of class and on the last class day. Although most of the ITEP students did not have significant shifts in attitude, there were a few comments where attitudes of the ITEP students changed at least one level from the pre- to post-attitude survey. They shifted from slightly disagreeing to agreeing with the comment, "I know the steps necessary to teach science concepts effectively." Another positive shift was seen for the comment, "I understand science concepts well enough to be effective in teaching elementary science." The responses to these questions demonstrated a change in attitude that reflected a bit more confidence in their science knowledge and willingness to teach science.

Another interesting comment that shifted levels in a positive way was that science should be taught completely with hands-on or inquiry-based exercises. This might be due to the fact that they were teaching the middle school students with entirely hands-on activities and were successful. They also agreed strongly that science should be taught with both hands-on exercises and textbooks. This is the ultimate goal in the elementary classroom so it was encouraging to see that they agreed with this comment. They strongly agreed with several other comments both before and after the service-learning component, including that they felt that science should be fun and that the inadequacy of a student's background can be overcome by good teaching. The latter comment indicates a strong belief that they can make a difference if they teach effectively. This is also positive from the college educator's perspective, because it indicates a willingness and desire by future teachers to improve student performance in science. One survey comment that resulted in a small shift in the negative direction was confidence in their knowledge of the science standards. This could be a result of the ITEP students' reflections on the fact that not all science standards address lessons on life science, or that when the ITEP students addressed the standards for their projects, they were more in-depth than the ITEP students originally thought. It also means that in the lecture, more time should have been spent demonstrating how the concepts they were learning reflected the content in the standards.

The Service-Learning survey (Fig. 6) taken by the ITEP students did not have any significant changes in attitude. The ITEP students appear to view service-learning with a positive attitude, probably because they had been exposed to service-learning in a previous course. Most students agreed that the course helped them with the course content. They also strongly agreed that they were comfortable working in a diverse community. This might be due to the fact that they themselves were a diverse group of women. They also agreed that community work was important. Both pre- and post-surveys the ITEP students took revealed that they felt strongly they were on the correct career path. Though the survey had no strong attitude shifts, there were a few questions for which they shifted at least half a level. One of these was that they would volunteer in the community even if not for school credit. They also agreed that the CSUN campus promoted personal engagement in the community. They felt it was important to volunteer their time in the community. They became more aware of the importance of doing work in the community and how it taught them more about the community's diversity. They felt that doing work in the community helped them solve problems as well as understand the course material. They did not know whether students should be required to take a service-learning course, though they all seemed to have had positive experiences with the course and the service-learning component. Many strongly agreed that they could make a positive difference in the community.

	Pre-	Post-test
PROFESSIONAL SKILLS		
I keep up with local community issues.	3.1	2.7
I have been responsible for a group of people through coordinating activities, completing projects, and/or other experiences.	1.9	1.4
I am confident that I am on the right career path.	1.4	1.4
I have been involved in activities outside of the classroom that have helped me decide on a career.	1.5	1.4
I receive feedback about my professional skills from faculty members outside of the classroom.	2.3	2.0
I receive feedback about my professional skills from community members outside of the classroom.	2.3	2.5
I have opportunities to network for making connections in possible careers.	1.9	2.0
CIVIC RESPONSIBILITY		
I volunteer in the community even when it is not for school credit.	2.8	1.9
It is important for me to volunteer my time in the community.	2.5	2.0
I take action to positively affect issues in my community.	2.7	2.3
I partner with community groups to accomplish a common goal.	3.0	2.7
CSUN's campus culture promotes personal engagement in communities.	2.8	2.0
VALUES, SELF-AWARENESS, COMMUNITY AWARENESS		
Most people can make a positive difference in their community's goals/outcomes.	1.8	1.4
Doing work in the community helps me to define my personal strengths.	2.2	1.9
Doing work in the community helps me to define my personal weaknesses.	2.4	2.0
I am comfortable interacting with people of cultures different than my own.	1.3	1.3
Community work makes me aware of some of my own biases and prejudices.	2.1	1.7
Doing work in the community helps me understand our community's diversity.	2.1	1.5
Doing work in the community helps me appreciate our community's diversity.	2.4	1.6
All students should have a service-learning experience.	2.2	1.9
I am aware of needs within our community.	2.6	2.3
ACADEMIC SKILLS		
I am willing to volunteer in the community if it is for school credit.	1.8	1.5
The work in this course will help me learn how to plan and reflect on a community activity.	2.3	1.7
The work in this course will help me learn how to implement and reflect on a community activity.	2.2	1.8
Participating in the community will help me enhance my writing skills.	2.8	3.1
Service learning should be a mandatory component of the curriculum.	3.0	3.0
Working in the community helps me to apply skills and concepts discussed in class.	2.2	1.8
Working in the community helps me to improve my problem-solving skills.	2.3	1.8
Working in the community helps me to use new information to make decisions.	2.2	1.9
My experiences in the community will enhance my understanding of course material.	2.4	1.9
I share responsibility in the quality and quantity of knowledge I will obtain from this course.	1.9	1.9

Fig. 6. Results of the service-learning survey taken by ITEP students at the beginning and end of the class. (1=strongly agree, 2=agree, 3=don't know, 4=disagree and 5=strongly disagree)

The greatest changes occurred in the results from the science content pre- and post-tests for both middle school and ITEP students. For middle-schoolers, a ten-question exam was designed by the ITEP students and the instructor to test content from the subjects that the ITEP students were covering in their activities. The results are shown in Table 1. The ITEP students took a different pre- and post-content test that was designed for all sections of BIOL100 by the biology department assessment committee. This exam had ten questions based on specific topics that are expected to be covered in BIOL100. These topics included the topics from the lessons the ITEP students taught the middle-schoolers as well as other important life science topics. As shown in Table 1, the middle-school students and the ITEP students improved their scores by 23% and 28% respectively. Although the sample size is not large, there was a marked improvement in their content knowledge. The average scores have not yet been tabulated for all BIOL100 sections in Fall 2001. The Spring 2001 average score was 48.6 % as compared to 52% for the pilot liberal studies course that semester. The Fall 2001 ITEP students performed by a margin of 17%.

Table 1: Average percent on pre- and post-content assessments for the middle-schoolers and ITEP students. (Note: The middle-schoolers had a different assessment than the ITEP and BIOL100 students).

	Middle-schoolers	ITEP Fall 2001	Liberal studies Spring 2001	All BIOL100 Spring 2001
Pre-test	47.6	41	N/A	N/A
Post-test	70.6	69	52	48.7

Conclusions

All the assessment instruments demonstrated that the service-learning course involving the ITEP students was a success. Both the middle-school and ITEP students showed marked improvement in their science content scores and positive changes in their attitudes about science and science teaching. *Tomorrow's Scientists* provided the opportunity for an education-driven, science-related activity one afternoon a week for eight weeks to 20 students from four local middle schools. The program was a success and many of the students expressed sorrow at its conclusion. Many of the goals were met, primarily that both ITEP and middle school students became more interested in science. The middle school students were also exposed to an experience on a college campus and gained a college-aged mentor/buddy. The ITEP students gained valuable teaching experience at a much earlier time in their teacher preparation process, and they learned the value of volunteerism in the public schools. The program also illustrated how a service-learning program can be successful when faculty members are supported by a university service-learning office to assist with training in curriculum design, assessment, funding and logistics.

The Future

The authors are now in the process of recruiting additional science faculty to incorporate this model into their courses. This would enable the University to offer a year-round after-school program with eight-week components of Biology, Earth Science, Physical Science, and Environmental Science. The Center for Community Service-Learning is supporting this expansion through an award of three-units of release time for Dr. Vandergon to mentor three of her science colleagues. The Center will also be providing mentor training and is seeking additional funds for the project to allow the inclusion of at least one 7th grade teacher per participating school. This will give the ITEP students more contact with professional educators, give the teachers innovative lesson plans to use at their home schools, and increase

