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The effect of an educational garden on environmental attitudes and knowledge

Weston Miller
San Jose State University

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**THE EFFECT OF AN EDUCATIONAL GARDEN ON ENVIRONMENTAL
ATTITUDES AND KNOWLEDGE**

A Thesis

Presented to

The Faculty of the Department of Environmental Studies

San José State University

In Partial Fulfillment

Of the Requirements for the Degree

Master of Science

By

Weston Miller

December 2001

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APPROVED FOR THE DEPARTMENT OF ENVIRONMENTAL
STUDIES

Dr. Rachel O'Malley, Assistant Professor of Environmental Studies

Dr. Gary Klee, Professor of Environmental Studies

Dr. David Asquith, Associate Professor of Sociology

APPROVED FOR THE UNIVERSITY

ABSTRACT

THE EFFECT OF AN EDUCATIONAL GARDEN ON ENVIRONMENTAL ATTITUDES AND KNOWLEDGE

By Weston Miller

Considerable informal evidence supports the efficacy of educational gardens as teaching tools. There is, however, little academic research to substantiate these claims. This research project aimed to determine the effect of an educational garden on the general knowledge and attitudes of students toward the environment. This study assessed the Edible Schoolyard garden project at Martin Luther King Middle School in Berkeley, California using parts of the Children's Environmental Response Inventory (CERI) and additional survey questions constructed by the author. This test was administered to both an experimental and a control group. Demographic information about students including gender, ethnicity, previous gardening experience, and previous plant knowledge was also collected and analyzed. Results unexpectedly show that the control group scored significantly higher than the experimental group on the attitudinal scale. A trend indicates that the program may have had a positive effect on the environmental knowledge of students, particularly African Americans.

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PROBLEM STATEMENT

The anecdotal evidence about the effectiveness of gardens as educational instruments is substantial (Bowen 1989; Login 1998; Trust 1991; Van Der Ryn and Holmes 1998). However, little academic research is available on the subject of Educational Garden Programs (EGPs). This study aims to address the following research question: what are the effects of the Edible Schoolyard garden project at Martin Luther King Middle School in Berkeley, California on the environmental knowledge and attitudes of students who participate in this educational program?

Background

Schools contribute toward many factors including environmental attitudes (Waliczek and Zajicek 1997). Conventional education programs, however, do not currently foster the responsible environmental behavior that is needed to solve the plethora of environmental problems that are emerging in modern society (Skelly and Zajicek 1998). The irresponsible use of natural resources, pollution, habitat destruction, and urban sprawl, among other environmental challenges, are all contemporary environmental issues that need to be addressed. These issues are interrelated and require complex problem-solving skills to find creative solutions that do not produce more problems than they solve.

The goals of Environmental Education (EE) programs are to create students who have the knowledge and attitudes necessary to behave responsibly toward the environment (Hungerford and Volk 1990) and to create an environmentally literate citizenry (NAAEE

1996). Another goal of environmental education is to foster environmental problem-solving abilities.

Environmental education accomplishes these goals by engaging students in real-world issues that help them to construct concepts and skills (Klein and Merritt 1994). Learning is based on the students' construction of knowledge through research, discussion, and the application of concepts and skills. These activities elicit conceptual understanding (NAAEE 1996).

Students can learn these attributes in traditional, teacher-centered classroom settings where lectures and demonstrations inform the students of facts and the nature of science (Klein and Merritt 1994), or in constructivist, student-centered learning environments. Constructivism is a teaching philosophy that encourages students to solve real-life problems through productive group interaction with authentic assessment and demonstration of students' progress (Klein and Merritt 1994). This philosophy asserts that individuals make meaning of situations through the dynamic interaction of previous knowledge, new knowledge that is presented to them, social interaction, and personal reflection and experience (NAAEE 1996). Constructivism acknowledges the different learning styles of individuals and accommodates the different needs of the students (NAAEE 1996). Research shows that students taught with constructivist methods show deeper, more comprehensive understanding of material than control groups who are taught the same material in traditional settings (Lord 1999).

Constructivism is emerging as the preferred educational philosophy of EE (Klein and Merritt 1994). This philosophy suits EE well because it attempts to foster awareness

about the interdependence of economic, social, political, and ecological systems (NAAEE 1996). Environmental education using constructivist methods also encourages understanding of environmental issues by focusing on subject areas with which the students have direct contact (NAAEE 1996).

Educational garden programs serve as appropriate teaching tools for EE because they can help foster awareness about the interdependence of ecological, economic, and social systems (Skelly and Zajicek 1998). They are also part of both urban and rural landscapes, are easily accessible, and can teach students about environmental issues that directly affect their lives. There is little academic research, however, that tests the effectiveness of integrating EGPs into environmental education programs and schools.

The focus of this study is the Edible Schoolyard in Berkeley, California. This program has created a half-acre production garden that is integrated into the curriculum and lunch program of Martin Luther King Middle School. The descriptive literature of this program reads,

It involves the student in all aspects of farming the garden--along with preparing, serving, and eating the food--as a means of awakening their senses and encouraging awareness and appreciation of the transformative values of nourishment, community, and stewardship of the land (Mission Statement and Guiding Principles of the Edible Schoolyard 1999, 1).

Specifically, sixth and seventh grade students at this school participate in weekly two-hour sessions for an eight-week block each semester. The students alternate between gardening activities and kitchen activities each week during the block. Students are taught hands-on skills through these activities, which are also incorporated into the curriculum of the school.

Importance

Educational gardens can provide a “down to earth,” hands-on approach to environmental education and foster a direct connection to nature in a society where it is increasingly difficult for children to contact nature (Skelly and Bradley 1998).

Educational Garden Programs are different from many current educational practices because they support interdisciplinary activities centered on a single, hands-on tool--the garden (Skelly and Zajicek 1997). They can be integrated into the curricula to help teach math, general science, geography, economics, art, writing, and other subjects. Also, EGPs can be used as a tool to teach ecological concepts including photosynthesis, decomposition, nutrient cycles, biodiversity, and food webs.

There is a need to evaluate EGPs as a tool for environmental education. This research on the Edible Schoolyard project could provide educators with information needed to improve existing programs, establish standards, and design new programs (NAAEE 1996). Evaluation of EE programs provides: 1) guidance for subsequent stages of programs, 2) an assessment of effectiveness, 3) a determination of what has gone wrong, or right, 4) promotion of the program, and 5) compliance with the requirements of funding bodies (Thomas 1990).

This study assessed the general environmental attitudes and knowledge gained by students who participated in the Edible Schoolyard. The measurement of these factors in this research is comparable to the existing body of research in EE because it used a pre-existing assessment instrument to determine the environmental attitudes gained through participation in the Edible Schoolyard. Research can efficiently use pre-existing

measurement instruments to provide continuity and comparability with other research that has employed the same instrument (Leeming et al. 1993).

Information generated by this research could be useful to the non-profit agency that supports the Edible Schoolyard as well as other agencies such as Hidden Villa in Los Altos Hills, San Francisco League of Urban Gardeners (SLUG), Food from the Hood in Los Angeles, and the Life Lab Program in Santa Cruz, California. These organizations are currently using gardens as vehicles to teach environmental education. Other schools that have established garden projects can also use this research. Additionally, schools contemplating the establishment of a garden may consider the results of this research in the design of their programs. The results of this study may also be compared to other educational garden programs such as Project Green (Skelly and Zajicek 1997) in other parts of the country to enhance the generalizability of this research throughout the country and internationally.

This research also contributes to the larger community of environmental educators because it adds methodologically sound and useful information to the body of research in environmental education. Such research is invaluable as environmental education gains importance in the national educational curricula. Specifically, it is timely and important to evaluate the efficacy of educational garden programs in educating the youth of today to be environmentally responsible citizens for the future.

LITERATURE REVIEW

Conceptual Views of Environmental Education

The overriding goal of any educational program is to develop citizens who will behave in desirable ways (Hungerford and Volk 1990). Modern societies educate in order to establish skills in reading and mathematics as well as more complex traits such as responsible behavior. Particularly, environmental education seeks to create an environmentally responsible citizenry (NAAEE 1996).

The history of environmental education, as an internationally recognized field of education, can be traced to the *Belgrade Charter* (1976) of the United Nations Environmental Science and Culture Organization (UNESCO). This conference provides a widely accepted goal of environmental education:

The goal of environmental education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of the current problems and the prevention of new ones (UNESCO-UNEP 1976).

UNESCO's *Tbilisi Declaration* (1978) additionally established three goals for environmental education. These goals are: 1) to foster awareness about the interdependence of economic, social, political, and ecological systems, 2) to provide people with the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment, and 3) to establish new patterns of behavior of individuals, groups, and society toward the environment (UNESCO 1978).

Based upon the work of UNESCO, the North American Association for Environmental Education (NAAEE) provides guidelines to use in environmental education programs. The NAAEE recommends that EE programs contain: 1) factual accuracy, 2) appropriate depth for different skill levels, 3) an emphasis on skill building, 4) an

orientation toward problem solving and action, 5) an emphasis on effective instructional techniques, and 6) usability (NAAEE 1996).

Educators must recognize both the interdisciplinary nature of environmental problems and the different learning styles of students and incorporate these concepts into appropriate instructional techniques in order to foster an effective learning environment. Constructivist (learner-centered) teaching techniques serve as a viable means of fulfilling the goals set out by UNESCO and NAAEE. This concept is in juxtaposition to traditional, objectivist education that teaches science through lecture and demonstration and assumes that students learn because teachers teach (Klein and Merritt 1994).

Constructivist learning is based on the concept that individuals make meaning of new situations through a dynamic combination of knowledge that they already possess, new knowledge presented to them, social interaction, and personal reflection and experience (NAAEE 1996). Constructivists believe that the processes of perception and interpretation elicit a mental model of reality that is meaningful to the learner (Jonassen 1990).

Klein and Merritt (1994) outline four main components of successful classroom teaching using constructivist principles: 1) introduction of a real-life problems for the students to solve, 2) student-centered instruction facilitated by the instructor, 3) productive group interactions, and 4) authentic assessment and demonstration of the students' progress. Wheatley (1991) further dissects problem-centered learning into tasks, cooperative groups, and sharing. This model of group learning nurtures constructivist cognitive development and is consistent with both UNESCO and NAAEE.

The traditional model of behavioral change assumes that if individuals become more knowledgeable, their awareness of issues will increase, thereby creating behavioral change (Hungerford and Volk 1990). Hines et al. (1987) provide a more complex model

of behavioral change. This meta-analytical study finds the following variables associated with responsible environmental behavior: 1) knowledge of action strategies, 2) locus of control attitudes, 3) verbal commitment, and 4) an individual's sense of responsibility. The locus of control variable is defined as the extent to which learners are empowered to change his or her own behavior.

Research shows that there is currently a focus on the affective rather than the cognitive domain in environmental education (Iozzi 1989). In other words, there is an emphasis on teaching values rather than knowledge and behavior (Ballantyne and Packer 1996). These researchers call for the application of constructivist principles to address the students' knowledge and behavior as well as attitude/value orientations.

Educational Garden Programs

This review of the available research on educational garden programs as part of environmental education shows that EGPs and agricultural education are valuable components of constructivist, environmental education programs (Kamyar 1992). There is, however, a dearth of rigorous academic research about the effectiveness of such programs.

Harvey (1990) shows that both past and present schoolyard experiences with vegetation make a small but significant contribution toward children's development of botanical knowledge and environmental dispositions. This research examined the actual structure of the vegetation in the schoolyard and the botanical knowledge of students. It did not examine any particular learning activities utilizing the landscape of the schools. This study recommends that school grounds be restructured for purposes of environmental education with an emphasis on landscape and vegetative complexity.

Another study initiated and integrated school garden programs into the curriculum of schools. Skelly and Zajicek (1997) evaluated whether school garden programs help students to develop positive environmental attitudes. Project GREEN (Garden Resource for Environmental Education NOW!) provides an interdisciplinary, hands-on approach to EE. The second and fourth grade students involved in this garden project were administered the Children's Environmental Response Inventory (CERI) and data were compared between control and experimental groups. Additional data gathered for this study included gender, age, ethnicity, and time spent in the garden. The results of Project GREEN show a significant positive influence on the environmental attitudes of students that participated in the program compared to a control group of students that did not participate. Additionally, Skelly and Zajicek (1998) conclude that younger students are better able to develop more positive environmental attitudes, and their results indicate that gardening alone does not have a significant impact on the students' environmental attitudes. A formal educational structure may be necessary to impact the students' environmental attitudes.

Jones (1997) assumes that if students can make the connection between agriculture and their own lives, then they will become more interested in agricultural sciences. This study uses informal science programs centered on agriculture to serve racially and economically underserved high school students. Underserved students are those who are not highly represented in the agricultural programs of major universities such as African Americans, Latin Americans, and Asian Americans. This long-term study uses a pre-visit and post-visit survey to assess students' interest in agricultural issues. The high school students will be tracked over time to determine if this program influences their decision to study agricultural sciences. It will take many years to produce results about the effectiveness of this program.

Research has also been conducted concerning plants in general, animals, and the Internet as educational tools in EE. This research may prove useful to EGPs because these educational tools can be incorporated into educational gardens.

Specifically, Smith and Anderson (1984) conducted a case study on the botanical knowledge of plants as primary producers that require light, water, and nutrients to grow. This science program includes an activity-based science curriculum, equipment, materials, and student handbooks focused on the interactions of producers, consumers and, decomposers in biological communities. This case study shows that the specific science curriculum used by the teacher was not sufficient to effectively correct the students' misconceptions about plants. The authors recommend a conceptual change in teaching similar to the concept of constructivism (Smith and Anderson 1984). Teaching about plants is connected to EGPs because plants are an integral component of gardens.

Weeds are plants that are classified as undesirable by humans, but they can be used to help produce environmentally informed citizens. These plants can be used to impart concepts of land stewardship and to teach ideas as varied as genetic diversity, conservation of soil and water, dry land landscaping, inter- and intra-specific competition, and integrated pest management. Peterson and Shipman (1997) studied the efficacy of using weeds as educational tools, but the results of this research are not yet available.

Wandersee (1986) found that catering to the students' interests helps to motivate them to learn about science. He examined the preference of students to learn about plants or animals. Results of this study show that students associate mammals with animals and prefer to study this topic to plants. This preference is based on mammals' ability to move, eat, see, learn, communicate by sound, exhibit behaviors that are fun to watch, interact with humans, have mates, give birth, and raise their young. This study indicates that the

integration of animals into educational gardens could help students to be more interested about learning in the garden.

Additionally, Kellert (1985) shows that children's perception about animals progresses through three stages. Six to nine year olds are primarily involved in affective, emotional relationships with animals. Ten to thirteen year old children develop a cognitive, conceptual understanding of animals. Children from thirteen to sixteen years of age show a broadening in ethical concern and an ecological appreciation of animals and the natural environment. These different stages in the development of children's appreciation of animals might also be applied to their development of relationships to plants and gardens.

Last, a survey on the Internet was conducted to determine children's perceptions of the usefulness of school garden programs (Waliczek et al. 1997). The e-mailed responses to this survey show that 81% of the respondents felt that they learned about the environment by working in the garden. This survey, however, is inherently biased because the survey is found on a gardening web site. So, the children who responded are likely to already have an interest in gardening and may not be representative of the general population of children.

There is clearly a paucity of research about the usefulness of school garden programs in conveying environmental knowledge and attitudes to children. This gap in research creates an excellent opportunity to conduct research on EGPs to provide valuable information about the effectiveness of these programs. The information generated by this proposed research could help to influence environmental educators to incorporate educational gardens into existing EE programs and possibly to create new education garden projects.

Methods for Environmental Education Research

Leeming et al. (1993) performed an analytical literature review of thirty four environmental education studies since 1970 that demonstrate changes in any of the following parameters: 1) environmental knowledge, 2) environmental attitudes, and 3) environmental behavior. They found that most of the studies contained flawed methodologies that limit the use of many of the conclusions brought about by this body of research. The results of this critical review show that thirty-one of these studies have a high probability of Type I errors, which are methodological problems that cause an erroneous rejection of the null hypothesis. Such errors could provide false evidence for educators as they make decisions about EE programs. These studies also do not use assessment instruments designed with rigorous psychometric techniques (Leeming et al. 1993).

Leeming et al. (1993) recommend that future studies use rigorous design standards, including meaningful control groups, controls for expectancy effects, use of reliable and valid dependent measures, follow-up data, and appropriate unit analysis to prevent the occurrence of Type I errors. These parameters, if integrated into the design of new research, should produce valid results that can be used by decision-makers in EE.

Educational research is conducted through qualitative or quantitative methods or a combination of these tools. Qualitative research traditionally uses transcripts from interviews as the data to be analyzed and interpreted (Lythcott and Duschl 1990).

Qualitative, interview-based research is used in case studies (Dresner and Gill 1994; Smith and Anderson 1984; Thomas 1990; Tull 1994). Thomas (1990) shows that the case study model is valuable because researchers can easily tailor it to a specific project. For example, Dresner and Gill (1994) examined the effectiveness of a summer camp in teaching EE. Their results show significant positive impacts of the program.

There is, however, limited applicability of these results to other projects due to the project-specific nature of the case study model.

The theories of constructivism are also integrated into some qualitative educational research itself (Robertson 1994). This type of qualitative study informs our understanding of people's conceptualization of the environment, environmental issues, and the human-environment relationship. Incorporation of freeform interviews about how students organize their knowledge enables such researchers to investigate the complex frameworks of knowledge construction (Driver and Erickson 1983) and how this knowledge is transformed into responsible environmental behavior.

Educational researchers who use quantitative methods create scales of knowledge and attitudes that can be statistically analyzed. Scales can be constructed for individual studies (Bradley et al. 1999), or universal scales can be used to measure environmental characteristics in a variety of situations. The Children's Attitudes Toward the Environment Scale (CATES) (Musser and Malkus 1994), Children's Environmental Response Inventory (CERI) (Bunting and Cousins 1985), and Children's Environmental Attitude and Knowledge Scale (CHEAKS) (Leeming et al. 1995) are examples of tests created to provide a general measure of environmental attitudes and knowledge over a wide range of situations. Preliminary results from these surveys indicate that all three are valid assessment instruments. Use of such previously utilized instruments allows researchers to compare results across different studies.

Armstrong and Impara (1989) make an important point about the order of test administration in tests with both attitudes and knowledge scales. They observed that the order of administration of attitudes (values) tests relative to knowledge tests influences outcome. Specifically, these authors discovered that students who took a knowledge test before an attitude test scored significantly lower on the attitude test than did students who

took the test in reverse order. The implication of these results for test administration procedures is that attitudes tests should be administered before knowledge assessment.

Smith-Sebasto and D'Costa (1995) also created an instrument to predict environmentally responsible behavior that focuses on the students' internal locus of control, an important variable in evoking such responsibility (Hines et al. 1987). This evaluative instrument can help educators to assess the ability of EE programs to empower students to behave responsibly toward the environment. The results of this research instrument are not yet available.

Many researchers using quantitative research methods utilize the pre-test/post-test model of survey administration (Bogner 1998; Bradley et al. 1999; Dresner and Gill 1994; Leeming et al. 1995; and Muser and Malkus 1994). Participants are given the same test prior to participation in an educational program and then after the program (Bradley et al. 1999). The follow-up studies are generally conducted shortly after participation, but Dresner and Gill (1994) note that it would be valuable to extend the evaluation in a series over time to assess the long-term changes in knowledge, attitudes and behavior of participants.

OBJECTIVES

This study was designed to address to following null hypotheses and specific hypotheses:

H₀1: The average attitude score of students who participate in the Edible Schoolyard project is equal to the average attitude score of students who do not participate in the program.

H1: The average attitude score of students who participate in the Edible Schoolyard project is higher than the average attitude score of students who do not participate in the program.

H₀2: The average knowledge score of students who participate in the Edible Schoolyard project is equal to the average knowledge score of students who do not participate in the program.

H2: The average knowledge score of students who participate in the Edible Schoolyard project is higher than the average knowledge score of students who do not participate in the program.

There are also related sub-hypotheses concerning the combined attitude and knowledge score of the participants:

H₀3: The average combined attitude and knowledge score of students who participate in the edible schoolyard project is equal to the average combined attitude and knowledge scores of students who do not participate in the program.

H3: The average combined attitude and knowledge score of students who participate in the Edible Schoolyard project is higher than the average combined attitude and knowledge score of students who do not participate in the program.

METHODS

Study System

The background is unique. The schools that participated in this project are both located in Berkeley, California. This urban setting is the home of the University of California and contains many well-educated families with relatively high median family incomes mixed with working-class families with lower economic status. This community is politically liberal and it is very ethnically diverse.

The Edible Schoolyard is the garden project examined by this research. This educational program is a non-profit agency closely affiliated with Martin Luther King Middle School in Berkeley, California. This agency has created a half-acre organic garden on the school grounds as well as a kitchen to prepare food harvested from the garden. This program attempts to involve students in all aspects of growing and preparing food for consumption in the school lunch program. The Edible Schoolyard program is integrated into the curriculum of the school, so academic lessons are taught through hands-on garden and kitchen activities. For example, students are taught about ecological principles such as decomposition by making compost that is monitored over time and eventually used in the garden as fertilizer and mulch.

Sixth and seventh grade students at Martin Luther King Middle School spend two hours each week in either the garden or kitchen for an eight week block of time during both semesters of the school year. They alternate between these two hands-on learning environments each week for the duration of the eight-week block. Activities in the garden include preparing planting areas, planting seeds and transplants, watering, construction,

composting, and harvesting food. Activities in the kitchen include washing, preparing, and eating food in a community-like setting. Some of the produce from the garden is also sold locally.

There was also a control group in this research consisting of sixth grade students from Longfellow Middle School in Berkeley. Students at this school did not participate in a school garden program during the fall semester of the 2000 – 2001 school year. This group of students was chosen as a control group because the age, economic status, and ethnic background of this group were similar to that of the experimental group. Students from both schools, additionally, were exposed to the cultural and political intricacies of Berkeley.

The research design was the pre-test/post-test method. The initial intent of this study was to administer the survey according to the pre-test/post-test method of survey research recommended by the literature in environmental education (Bogner 1998; Bradley et al. 1999; Dresner and Gill 1994; Leeming et al. 1995; and Muser and Malkus 1994). The survey would have been given to both the experimental and control groups at the beginning of the fall semester of the 2000 – 2001 school year and then again after the fall semester. The design of this method of survey administration is as follows:

Proposed Administration of Survey

	Experimental Group:	Control Group:
Pre-test	x	x
Post-test	x	x

However, logistical problems between the researcher and Martin Luther King Middle School and Longfellow Middle School prevented a pre-test survey administration to both the experimental and control groups (APPENDIX 1). The actual administration of the survey was as follows:

Actual Administration of Survey		
	Experimental Group:	Control Group:
Pre-test	o	o
Post-test	x	x

The pre-test/post-test method of survey research would have enabled a comparison within both the experimental and control groups. This method would have measured for changes in the environmental attitudes and knowledge within the experimental group through participation in the Edible Schoolyard curriculum for one semester. Such data might have given more insight about the effects of the Edible Schoolyard program on the environmental attitudes and knowledge of the experimental group. Including the control group in this experimental design controls for unexpected events such as a highly publicized oil spill or release of toxic waste during the testing period, which could influence the environmental attitudes and knowledge of the research subjects.

The actual administration of the survey, however, did not contain within treatment group comparisons, but did provide for comparisons between treatment groups. Despite the lack of pre-test data, the data from this project could plausibly give reliable results because of the similarities between the experimental and control groups. These treatment groups consist of students that are the same age and from the same city. Both groups have similar ethnic and socioeconomic characteristics (www.census.gov). Additionally,

both groups perform above the fiftieth National Percentile Rating (NPR) on the Stanford 9 standardized tests (<http://star.cde.ca.gov>)(Table 1).

Data Collection

The research instrument was a survey. The hypotheses were assessed using 10 attitudinal questions from the Children's Environmental Response Inventory (CERI) (Bunting and Cousins 1983) and 14 environmental knowledge questions created by the author with help from educators at Martin Luther King Middle School and San Jose State University. Biographical questions were combined with these attitudinal and knowledge-based questions to form a survey with two subscales: 1) attitude and 2) knowledge (APPENDIX 2). A third scale (combined scale) was created by adding the mean attitude and knowledge scores.

The biographical questions were similar to those used by Skelly and Zajicek (1998). These independent variables included: gender, ethnicity, previous knowledge about plants, previous knowledge about gardens, and zip code. The zip code was used to determine median family income for each postal zone with 1990 US census data (www.census.gov). Also, the students were asked to self-assess their own knowledge about plants and gardens with two Likert-type variables. The biographical questions were followed by attitude questions, which were followed by knowledge questions. This order adheres to the sequence of survey question administration recommended by Armstrong and Impara (1989).

TABLE 1
STUDY SYSTEM STATISTICS BY TREATMENT GROUP

Variable	Experimental Group	Control Group
School	Martin Luther King	Longfellow
Number of Classrooms	8	6
Number of Students	180	150
Number of Respondents	106	74
Percentage Respondents	59%	49%
Percentage Female Respondents	54%	66%
Percentage African American Respondents	25%	30%
Percentage Asian American Respondents	14%	9%
Percentage Latino Respondents	11%	14%
Percentage Other Respondents	31%	32%
Percentage European American Respondents	19%	15%
Average Mean Family Income*	\$41,131	\$38,085
Stanford 9 Standardized Test Scores**		
Reading	65	53
Math	68	59
Language	61	58
Spelling	59	55

* Average Mean Family income obtained from the census website (www.census.gov).

** Stanford 9 test scores reported in percentage above 50th National Percentage Rating (NPR) (<http://star.cde.ca.gov>). The experimental group had higher Stanford 9 scores than did the control group in each (Reading, Math, Language, and Spelling) category.

A pilot study of the survey was conducted during May and June of 2000 on sixth grade students at Martin Luther King Middle School. Permission letters were sent home to two separate classes of approximately thirty students for a total of sixty potential participants. Sixteen students returned their permission forms and were able to participate in the pilot study. These sixteen surveys were analyzed to determine if the wording of the questions was understandable to students and if the content of the questions was covered by the Edible Schoolyard curriculum. Three attitudinal questions were eliminated that were answered incorrectly by more than 80% of the respondents. Also, one knowledge question was dropped from the survey for the same reason and the wording of several questions was changed for increased clarity. The reliability and validity of the survey were not statistically measured. Rather, the author and several advisors from San Jose State University determined the face validity of the survey before it was administered to the experimental and control groups in the actual research.

The survey was administered to the study population. The entire survey was administered to two separate treatment groups: 1) an experimental group consisting of sixth grade students from Martin Luther King Middle School who participated in the Edible Schoolyard project for one semester and 2) a control group consisting of sixth grade students from Longfellow Middle School who did not participate in a school garden project during that semester.

The study population of the experimental group consisted of 106 sixth grade students at Martin Luther King Middle School in Berkeley, California. All of the approximately 180 sixth grade students were given permission letters to take home to be

signed by their parents or guardians and then return to their science teachers (APPENDIX 3). An additional letter was sent to parents to specify the nature of the research at the request of a concerned parent who desired further explanation of the study (APPENDIX 4). The students were offered an edible treat as an incentive to return the permission letters to their teachers. Thus, 106 of 180 students (59%) returned the permission letters from eight separate classes enabling these students to participate in this study.

The students in the experimental group participated in one eight-week block of activities organized by the Edible Schoolyard during the fall semester of the 2000 - 2001 school year, their first semester at the school. Each week during this block of time, the students spent two hours either working in the garden or the kitchen. They alternated between these two areas of focus for the entire block of time.

The control group of this study consisted of 74 of the approximately 150 sixth grade students from Longfellow Middle School in Berkeley. This group also received permission letters to be signed by parents or guardians and were given an edible incentive to return the letters to their teachers. These students did not participate in an educational garden project during the fall semester of the 2000 - 2001 school year. Thus, 74 of 150 students (49%) from six separate classes returned permission letters enabling these students to participate in this study.

Data Analysis

The data collected with the survey was analyzed with Statistical Package for the Social Sciences (SPSS) (Version 9.0 and Student Version 10.0) with an alpha value of

0.05 ($p < 0.05$). A complete multivariate statistical model was constructed including the two treatment groups (experimental and control) and all of the independent variables (gender, ethnicity, median family income, previous plant knowledge, and previous garden knowledge). These variables were compared to the attitude, knowledge, and combined scores of participants with Multiple Analysis of Variance (MANOVA).

The mean attitude, knowledge, and combined scores were also compared between the experimental and control groups with t-statistics. Individual attitude and knowledge questions that contained material most likely to be covered by the Edible Schoolyard curriculum were also compared between treatment groups.

Each of the independent variables was also individually contrasted to the mean attitude, knowledge and combined scores of the entire study population. The sex of the participants was analyzed with t-statistic and the remaining variables were tested with Analysis of Variance (ANOVA). The variables that revealed significant differences were then tested with Tukey's Honestly Significant Difference (HSD) to determine significant patterns within each independent variable.

Additional *post hoc* analysis was also performed. The attitude, knowledge, and combined scores of each of the different ethnic groups (African American, Asian American, Latino, European American, and Other, which includes such ethnicities as: Jewish American, Persian American, and Russian) were compared between treatment groups. This analysis was performed with a series of t-statistics and as a multivariate system using Analysis of Covariance (ANCOVA).

RESULTS

Analysis of the Hypotheses

Analysis of the hypotheses in the complete statistical model reveals that there were not significant differences between the experimental and control groups for the mean attitude scores ($p = 0.981$), mean knowledge scores ($p = 0.861$), or mean combined scores ($p = 0.979$). Significant patterns, however, did emerge when each of the dependent variables (attitude, knowledge, and combined scores) were contrasted to the treatment group as an individual variable outside of the full model.

Hypothesis 1 (H1), for example, predicts that the average environmental attitude score of the experimental group will be significantly higher than the average score of the control group. Interestingly, analysis of the data shows, on the contrary, that the mean attitude score of the control group was significantly higher than was the mean score of the experimental group, $p < 0.05$ (Figure 1). Individual attitude questions 4 and 9 were also compared between treatment groups because these particular questions contain material that is likely to be covered by the Edible Schoolyard curriculum. The control group scored significantly higher than the experimental group on both of these questions, $p < 0.05$ (Table 2).

Hypothesis 2 (H2) predicts that the average knowledge score of the experimental group will be significantly higher than the average score of the control group. The results suggest, however, that the mean knowledge score of the experimental group was not significantly higher than was the mean score of the control group, $p = 0.085$ (Figure 2). The comparison of mean knowledge scores between groups, however, indicated a trend at a lower confidence level, $p < 0.10$. Individual questions from the knowledge subscale were also chosen for comparison because these particular questions contain material that

FIGURE 1
MEAN ATTITUDE SCORES BY TREATMENT GROUP

The control group scored significantly higher than did the experimental group on the attitudinal scale, $p < 0.05$. Higher scores indicate potentially more positive attitudes toward the environment.

TABLE 2
MEAN ATTITUDE SCORES BY TREATMENT GROUP

Treatment Group	Total Attitude*	Percentage Correct	Question 4*	Question 9*
Experimental	39.06	78%	4.26	3.14
Control	41.58	83%	4.58	3.62

* $p < 0.05$.

FIGURE 2
MEAN KNOWLEDGE SCORES BY TREATMENT GROUP

There was no significant difference in knowledge scores between the experimental and control groups, $p = 0.085$. A trend, however, is evident. The experimental group scored higher than did the control group, $p < 0.10$.

is likely to be covered by the Edible Schoolyard curriculum. Analysis of questions 1, 3, and 8 shows a similar trend as above; the experimental group did not score significantly higher than the control group. The experimental group, however, did score significantly higher than the control group on knowledge question 10 (Organic matter is decomposed by fungi and microbes in the compost pile: True/False/I Don't Know), $p < 0.05$ (Table 3).

Hypothesis 3 (H3) predicts that the average combined attitude and knowledge score of the experimental group will be significantly higher than the average score of the control group. Analysis shows that there was not a significant difference in the combined attitude and knowledge scores between treatment groups. This result is consistent with the opposing results obtained in the attitude and knowledge scales above (Figure 3).

TABLE 3
MEAN KNOWLEDGE SCORES BY TREATMENT GROUP

Treatment Group	Total Knowledge**	Percentage Correct	Question 1	Question 3	Question 8	Question 10*
Experimental	6.63	47%	0.75	0.75	0.35	0.58
Control	5.86	42%	0.68	0.66	0.26	0.38

* $p < 0.05$. ** $p < 0.10$.

FIGURE 3
MEAN COMBINED SCORES BY TREATMENT GROUP

There was no significant difference in combined scores between the experimental and control groups, $p = 0.162$.

Analysis of the Independent Variables

The full statistical model compares all of the independent variables to the survey scores (dependent variables) in one complete analysis. The data show that none of the independent variables influenced the attitude scores of participants, $p > 0.05$ (Table 4). Ethnicity and previous plant knowledge, by contrast, are factors that possibly influenced the knowledge scores of participants, $p < 0.05$. This model also reveals that the interaction between ethnicity and median family income significantly affected the knowledge scores of students. A slight trend also emerged; the interaction of the treatment group and ethnicity seemed to be correlated with knowledge scores, $p = 0.177$.

Analysis of each of the independent variables individually also revealed some significant results and eliminated other variables as plausible alternative explanations for patterns in the data. The gender of the students in this study, for instance, did not appear to affect the mean attitude, knowledge, or combined scores of the participants, $p > 0.05$.

There was not a significant difference in the frequencies of individuals in the different ethnic groups between treatment groups, $p = 0.597$. The ethnicity of the participants, however, does appear to have a significant effect on the environmental attitude scores of the survey participants, $p < 0.01$. Additional analysis with Tukey's Honestly Significant Difference reveals that there were significant differences in attitude scores between the relatively high scores of European Americans and the relatively low scores of African Americans and Latinos (Figure 4).

The ethnicity of the research subjects also had a significant effect on their environmental knowledge scores, $p < 0.01$. Further analysis with Tukey's HSD reveals significant differences between the relatively high knowledge scores of European Americans and the relatively low scores of African Americans and Latinos. The Other category also scored significantly higher than did African Americans (Figure 5).

TABLE 4
COMPLETE STATISTICAL MODEL SUMMARY DATA

Independent Variable	Dependent Variable		
	Attitude	Knowledge	Combined
Treatment Group	0.981	0.861	0.979
Gender	0.583	0.752	0.587
Ethnicity	0.701	0.009*	0.323
Median Family Income	0.994	0.272	0.984
Previous Plant	0.918	0.006*	0.626
Knowledge			
Income and Ethnicity	0.858	0.040*	0.653
Ethnicity and Treatment Group	0.610	0.177**	0.653

*p < 0.05 and ** indicates slight trend

The complete statistical model reveals that ethnicity and previous plant knowledge significantly affected the knowledge scores of survey participants, $p < 0.05$. This model also shows that the effect of income and ethnicity combined influenced knowledge scores, $p < 0.05$, and that there is a slight trend linking the combined influence of ethnicity and treatment group and knowledge scores, $p = 0.177$.

FIGURE 4
MEAN ATTITUDE SCORES BY ETHNICITY

European Americans (A) scored significantly than did African Americans (B) and Latinos (B). The Other category (AB) also scored significantly higher than did African Americans (B), $p < 0.05$.

FIGURE 5
MEAN KNOWLEDGE SCORES BY ETHNICITY

European Americans (A) scored significantly higher than did African Americans (B) and Latinos (B). The Other category (AB) also scored significantly higher than African Americans (B), $p < 0.05$.

The combined attitude and knowledge scores of the students was influenced by ethnicity as well, $p < 0.01$. Further analysis with Tukey's HSD reveals significant differences between the relatively high scores of European Americans and the relatively low scores of African Americans and Latinos (Figure 6).

Additional *post hoc* analysis was performed to compare the mean scores of each individual ethnic category (African American, Asian American, Latino, European Americans, and Other) between the experimental and control groups. Those comparisons that show significant differences shall be discussed and those that do not show significant differences shall not be reported (Table 5).

The mean knowledge score of African American students in the experimental group was significantly higher than the mean score of African American students in the control group, $p < 0.01$. This analysis also reveals that Latino students in the control group had a higher mean attitude score than did Latinos in the experimental group, $p < 0.05$. Last, the mean attitude score of European American students in the control group was significantly higher than was the mean attitude score of this ethnicity in the experimental group, $p < 0.05$.

Also, the students were asked to assess their previous knowledge about plants on a scale from 1 – 5 (1 = lowest, 5 = highest). This independent variable was compared to the attitude and knowledge scores of the entire study population. There was not a significant difference between this variable and the mean attitude score of participants, $p = 0.859$. There was a significant difference, however, in the mean knowledge score of students compared to previous plant knowledge, $p < 0.05$. Further analysis with Tukey's HSD shows that students with relatively high knowledge about plants (score = 4) scored significantly higher than did students with a relatively low (score = 2) previous knowledge about plants (Figure 7).

FIGURE 6
MEAN COMBINED SCORES BY ETHNICITY

European Americans (A) scored significantly higher than did African Americans (B) and Latinos (B), $p < 0.05$.

TABLE 5
COMPARISON OF INDIVIDUAL ETHNIC GROUP MEAN
SCORES BY TREATMENT GROUP

Ethnicity	Scale	Experimental Group Mean Score	Control Group Mean Score	Significance Level
African American	Attitude	37.04	38.01	. . .
	Knowledge	6.40	4.10	0.05
	Combined	43.44	42.20	. . .
Asian American	Attitude	39.79	42.00	. . .
	Knowledge	7.21	6.67	. . .
	Combined	47.00	48.67	. . .
European American	Attitude	41.65	44.62	0.05
	Knowledge	8.03	7.57	. . .
	Combined	49.68	52.19	. . .
Latino	Attitude	35.18	41.44	0.05
	Knowledge	4.91	5.11	. . .
	Combined	40.09	46.56	. . .
Other	Attitude	40.53	40.80	. . .
	Knowledge	6.05	5.90	. . .
	Combined	46.58	46.70	. . .

Note: “. . .” indicates insignificant values.

FIGURE 7
MEAN KNOWLEDGE SCORES BY PREVIOUS
PLANT KNOWLEDGE

Students with a relatively high self-assessed previous plant knowledge (score = 4) had significantly higher knowledge scores than did students who estimated their own knowledge about plants to be relatively low (score = 2), $p < 0.05$.

The students were additionally asked to rate their previous knowledge about gardens on a scale from 1 –5 (1 = lowest, 5 = highest). No significant differences were detected for either environmental attitude ($p = 0.781$) or environmental knowledge ($p = 0.358$) scores.

Students were asked to provide their zip code, which was used to establish median family income for each geographical area. There was no significant difference between the average median family income of the experimental group, \$41,130, and the average median family income of the control group, \$38,084, $p = 0.257$ (Figure 8). The median family income variable was also compared to the attitude and knowledge scores of participants. This analysis did not reveal any significant differences for either the attitude ($p = 0.064$) or knowledge ($p = 0.709$) scores.

Additional analysis between independent variables was performed. For example, there was a significant difference in the median family income between ethnic groups, $p < 0.05$. Further analysis with Tukey's HSD reveals that the median family income of European Americans was significantly higher than the median family income of both African Americans and Latinos (Figure 9) (Table 6). The income variable was also compared to previous plant knowledge and previous garden knowledge. Neither of these comparisons was significant, $p > 0.05$

Also, ethnicity was compared to previous plant knowledge and previous garden knowledge. There was a slightly significant difference in self-assessed previous plant knowledge between the ethnic groups, $p < 0.05$. Analysis with Tukey's HSD shows that

FIGURE 8
MEDIAN FAMILY INCOME BY TREATMENT GROUP

There was no significant difference in median family income between treatment groups, $p = 0.859$.

FIGURE 9
MEDIAN FAMILY INCOME BY ETHNICITY

European Americans had significantly higher median family income than did African Americans and Latinos, $p < 0.01$.

TABLE 6
MEDIAN FAMILY INCOME BY ETHNICITY

	<u>Ethnicity</u>				
	African American	Asian American	European American	Latino	Other
Median Family Income	\$34,290	\$35,975	\$47,175	\$30,088	\$39,744

the Other category had a statistically higher self-assessed previous knowledge about plants than did Latinos (Figure 10).

Multivariate analysis was also performed with the treatment group held as a fixed variable, ethnicity as a covariate, and the attitude and knowledge scores as dependent variables. This analysis reveals significant values for both the attitude (Figure 11) and knowledge scores (Figure 12), $p < 0.01$.

Summary

Analysis of the complete statistical model, in conclusion, indicates no significant differences in attitude, knowledge, and combined scores between the experimental and control group. Individual analysis of the hypotheses reveals, however, that the control group had a significantly higher mean attitude score than did the experimental group. There was not a significant difference between the experimental and control groups for the mean knowledge scores and mean combined scores at the standard confidence level.

The full statistical model additionally shows that none of the independent variables influenced the attitude scores of participants. Ethnicity, however, appears to have affected the attitude scores of participants when analyzed outside of the full model. The scores of European Americans were significantly higher than the scores of both African Americans and Latinos. Also, both European Americans and Latinos in the control group had higher attitude scores than did European Americans and Latinos in the experimental group. Multivariate analysis also showed significant difference in attitude scores between

FIGURE 10
PREVIOUS PLANT KNOWLEDGE BY ETHNICITY

The Other category (AB) reported a significantly higher knowledge about plants than did Latinos (B), $p < 0.05$.

FIGURE 11
MEAN ATTITUDE SCORES BY ETHNICITY AND TREATMENT GROUP

The treatment group was held as a fixed variable and ethnicity is a covariate. Significant differences were detected, $p < 0.01$. Both European Americans and Latinos in the control group scored higher than European Americans and Latinos in the experimental group.

FIGURE 12
MEAN KNOWLEDGE SCORES BY ETHNICITY AND TREATMENT GROUP

The treatment group was held as a fixed variable and ethnicity as a covariate. Significant differences were detected, $p < 0.01$. African Americans in the experimental group scored higher than African Americans in the control group.

treatment groups when the effects of ethnicity were masked. Ethnicity and previous plant knowledge are factors that influenced the knowledge of students in the full statistical model.

The interaction of ethnicity and median family income also affected the knowledge scores of participants in the full model. The significance of these independent variables was also corroborated by individual analysis of these variables. The mean knowledge score of African Americans in the experimental group was significantly higher than the score of African Americans in the control group. There was also a slight difference in the previous plant knowledge variable between ethnic groups. Students in the Other category reported significantly higher previous knowledge about plants than did Latinos. Multivariate analysis also shows that there were significant differences in attitude and knowledge scores when the effects of ethnicity were masked.

DISCUSSION

Hypothesis 1- Effects of the Edible Schoolyard on Attitude Scores

There was no difference in environmental attitude scores between the experimental and control groups based on the complete statistical model. This lack of significance can possibly be attributed to the fact that there was not pre-test data for either treatment group. Thus the comparison was limited to the post-test data from only two schools (Martin Luther King and Longfellow Middle Schools). This limited data set may have created the insignificant results on the attitudinal scale. It also is possible that this analysis was not representative of the environmental attitudes of the two treatment groups. The true environmental attitudes of the participants may not have been measured by the survey. The data may reflect this trend and the complete model does not thereby reveal significant results for the attitude scale.

Analysis of independent variables outside of the complete model, by contrast, reveals some significant trends concerning the environmental attitude scores of participants. The data show, for instance, that there was a significant difference in the environmental attitude (H1) scores between the experimental and control groups. However, the control group scored significantly higher than the experimental group. Thus, Null Hypothesis 1 (H_01) is rejected and the results do not support Hypothesis 1 (H1). The control group even scored higher on individual attitude questions 4 and 9, which are clearly garden related questions. This unexpected result appears to be driven by the fact that both Latinos and European Americans in the control group scored significantly higher than did Latinos and European Americans in the experimental group.

It is possible that there is a component of the Edible Schoolyard, which motivated students in the experimental group to be more expressive about their mixed feelings toward the environment than students outside of the program. The program might have given the students a forum to discuss their true feeling about environmental issues, which included negative perceptions. This factor might have been detected by the survey and account for the results on the attitude scale.

Also, exposure to the Edible Schoolyard could have created a degree of apathy and cynicism in the experimental group instead of inspiring positive affect toward the environment. It is plausible that this factor was detected by the attitude survey. This apathy might have developed in students because they were exposed by the Edible Schoolyard to the multitude of environmental problems faced by modern society. This experience could have overwhelmed the students mentally and emotionally to the point that they felt like there was nothing that they can do to help. The students, in other words, could have been exposed to many serious environmental problems and may not have realized their own locus of control about such issues. They might not have felt empowered to address the environmental problems that are part of everyday life.

Another possible explanation for the unexpected attitudinal results is that the students simply did not like the Edible Schoolyard program. The students may not have liked participating in the garden and kitchen activities because they felt like it was “work.” The students possibly had a negative perception about the program because they were engaged in activities that they did not consider as fun. This factor could account for the results of the attitude scale.

The effects of the Edible Schoolyard on environmental attitudes, additionally, may take more time to develop than the short period of time (one semester) that the students participated in the program before the survey was administered. Plausibly, the hands-on nature of the program takes a several years or longer to be assimilated by the students. The Edible Schoolyard may, however, “plant seeds” of positive environmental attitudes in the students that will develop latter in life.

The attitude scale for this project was taken from CERI (Bunting and Cousins 1983) and was used by Skelly and Zajicek (1998) to test the environmental attitudes gained from a school garden project in second and fourth graders. The pre-existing attitude scale used in this survey was used to provide comparability to work performed by Skelly and Zajicek (1998) who conclude that Project GREEN, a school garden program, had a positive influence on the environmental attitudes of participants. The positive effect of this program on children’s environmental attitudes contrasts the results detected by this research.

These researchers also conclude that a formal structure might be necessary for students to develop positive environmental attitudes in school gardens. Such structure may be missing from the Edible Schoolyard project, which could account for the results on the attitude scale of this survey. A more formal structure of activities in the Edible Schoolyard might help students to better assimilate positive attitudes.

Skelly and Zajicek (1998) also conclude that their school garden program was more effective for younger students than older students. Plausibly, the actual research instrument (CERI) used by that study and this research might be more effective in

measuring environmental attitudes for younger children. The older and more sophisticated students in this study, in other words, might have reacted strongly to the environmental attitude questions presented in this survey. This reaction might explain the low attitude scores in both the experimental and control groups.

Hypothesis 2- Effects of the Edible Schoolyard on Knowledge Scores

The complete statistical model shows that the treatment group was not significantly correlated with the environmental knowledge of students. This model did show, however, that both ethnicity and previous plant knowledge affected the knowledge scores of participants. Additionally, the combined effect of median family income and ethnicity did appear to influence knowledge scores. These results indicate that the survey used in this research was not intrinsically flawed and that significant results did emerge in the complete statistical model.

Individual analysis of the treatment group variable also shows that there was no significant difference in mean knowledge scores between the control and experimental group thereby maintaining Null Hypothesis 2 (H_02) and disproving Hypothesis 2 (H_2). This comparison, however, reveals a trend toward higher knowledge in the experimental group at the $p < 0.10$ confidence level. The experimental group's performance on individual knowledge questions 1,3, and 8 evidently influenced this tendency as the experimental group scored higher than did the control group on these questions. This trend is affected even more by knowledge question 10 in which the experimental group scored significantly higher than did the control group. Thus, there seems to be a trend

toward increasing knowledge in the experimental group, possibly a result of participation in the Edible Schoolyard project.

This trend became a significant difference for African American students in the experimental group, who scored significantly higher on the knowledge scale than did African American students in the control group. This result is important because it indicates that the Edible Schoolyard program may disproportionately help these traditionally underserved students to become more knowledgeable about the environment.

It is possible that the hands-on nature of the Edible Schoolyard curriculum enabled African American students to assimilate environmental knowledge better than others. This type of learning environment may help students who have difficulty learning in traditional classrooms where students are less kinesthetically engaged. This factor could also possibly explain the trend of increasing knowledge in the experimental group among all students.

The lack of overall significance on the knowledge scale could possibly be attributed to the short time period of participation in the project before the survey was administered. The curriculum of the Edible Schoolyard might take longer than one semester to influence the knowledge of students.

The nature of the knowledge section of this survey, additionally, could have possibly influenced the results of this study. The actual questions on the survey might not accurately reflect the knowledge presented by the Edible Schoolyard curriculum. The author created the knowledge questions with assistance from science and math teachers at Martin Luther King Middle School. The author, however, is outside of the Edible

Schoolyard program. Therefore, the knowledge of students may not even be addressed by this survey. Individual knowledge questions 6, 9, 12, and 14, for example, are questions that address ecological principles and are not explicitly about garden related knowledge. The survey might have measured for general ecological concepts and environmental knowledge rather than specific garden related knowledge delivered by the Edible Schoolyard.

This factor could possibly account for the low average scores in both the experimental (47 % correct) and control groups (42% correct) and the lack of significant difference between groups. In other words, the knowledge scale used in this study may not actually have measured knowledge gained through participation in the Edible Schoolyard and could have produced a Type 2 error in which Null Hypothesis 2 (H_02) was not rejected despite differences in knowledge between groups.

Hypothesis 3- Effects of the Edible Schoolyard on Combined Scores

There is no significant difference in the combined scores between the experimental and control groups. Therefore, Hypothesis 3 (H_3) is also disproved. This departure from expected results is most likely due to the fact that the combined scale was created by taking the sum of the attitude and knowledge scales. There are 50 possible points on the attitude scale and 14 possible points on the knowledge score for a total of 64 possible points on the combined scale. The trends in the attitude and knowledge scales were opposing. The control group scored higher on the attitude scale and the experimental group scored higher on the knowledge scale. Thus, these trends could have canceled out any potential differences between treatment groups on the combined scale.

Influences of the Independent Variables and Other External Factors

Ethnicity seems to have had a major impact on the results of both the attitude and knowledge scales of this survey. The attitude and knowledge scores significantly differed between the ethnic groups in this study. European Americans scored higher than did African American and Latino students on both scales. This result reflects national standardized test scores, which show that European Americans generally score higher than African Americans and Latinos. The ethnicity of participants in this study may have been such a strong factor that it masked the effect of the Edible Schoolyard on the environmental attitudes and knowledge of students in the experimental group.

Significant results were obtained for both scales, for instance, in the multivariate analysis when the effects of ethnicity were controlled for. This factor illustrates the potential of this educational garden to impact the environmental attitudes and knowledge of traditionally underserved students. The Edible Schoolyard may have positively influenced underserved students to develop more environmentally responsible attitudes and knowledge. This effect may have been masked by the powerful influence of ethnicity.

The ethnicity of students in the experimental and control groups could have predisposed their environmental attitude scores. It is possible that there were differences in the attitudes of the parents of these students between the different ethnic groups. European Americans students, for example, might have been exposed to more environmental issues at home than were African Americans and Latinos. Such differences in exposure might have produced the disparate results in attitude scores between the ethnic groups.

It is difficult to attribute the disparity in attitude scores between ethnic groups to any specific characteristic of each group. Socioeconomic factors, for instance, likely affected the scores of minority students on both this survey and standardized tests in

general. There was a significant correlation in the data between ethnicity and median family income, although there was not a direct correlation between attitude scores and socioeconomic status. European Americans had significantly higher median family incomes than both Latinos and African Americans. Thus, European American students who participated in this study likely have many of the educational advantages associated with higher family income. This disparity in income paralleled the attitude scores of these ethnic groups in this research though there was not a significant correlation between these variables.

There was a significant correlation between ethnicity, median family income, and the mean knowledge scores of participants. This association was possibly driven by the educational advantages associated with higher economic status. European American students, in other words, might have more educational opportunities than African Americans and Latinos due to their families' relative affluence. It is plausible that such opportunities affected the environmental knowledge scores between the different ethnicities.

The effects of the Edible Schoolyard on environmental knowledge may also have been influenced by the fact that sixth grade students at Martin Luther King Middle School, the experimental group, scored significantly higher on Stanford 9 standardized tests than sixth grade students at Longfellow Middle School, the control group. So, the higher knowledge scores in the experimental group could have been influenced by their test taking ability rather than the Edible Schoolyard program.

It is also possible that the location of the two schools studied, Berkeley, California, could have influenced the scores of students. Berkeley is well known for its liberal tendencies, which could predispose the environmental attitudes and knowledge of students. This location, in other words, could attract people with a high regard for

environmental issues, which could have influenced the students' scores on this survey. The environmental attitudes and knowledge of the entire community, then, could have affected the scores of students in both treatment groups. This factor could explain the relatively high knowledge scores in both the experimental and control groups.

Limitations

The study system. Ideally, students would be randomly assigned into the experimental and control groups and the entire group would be considered a single, cohesive population (Evans 1996). This scenario, however, could not be implemented. Both the experimental and control groups were chosen based on each schools' willingness to participate in this research. It was assumed at the onset of this study that students at Martin Luther King Middle School were similar in ethnicity, socioeconomic status, and level of education to students at Longfellow Middle School, but there were differences between these two groups.

Sixth grade students at Martin Luther King Middle School, for example, had higher Stanford 9 standardized test scores in reading, math, language, and spelling than did sixth grade students at Longfellow Middle School. Also, the control group could been exposed to an effective environmental education curriculum at Longfellow Middle School or feeder schools that could have influenced this groups scores on this survey. Such an external factor could be responsible for the control group receiving significantly higher scores on the attitudinal scale. The author is not aware, however, of any such program.

Lack of pre-test/post-test method. The initial intent of this research was to administer the survey according to the pre-test/post-test method of survey research. This strategy, however could not implemented due to logistical complications with the survey delivery. Thus, the only analysis that could be made with the data collected is the

comparison of post-test scores between the two treatment groups. It cannot be determined if the experimental group's scores improved as a result of participation in the garden program. Analysis of the post-test data for both of the two treatment groups is not as powerful as comparing the pre-test to post-test scores within each of the two treatment groups.

The purpose of including the control group in the pre-test is help to ensure that a highly publicized environmental issue did not affect the environmental attitudes and knowledge of students. Such an event could influence teachers to investigate environmental issues with their classes. This scenario, then, could potentially have exposed the control group to environmental curriculum and complicated the comparison of test scores between treatment groups. There were, however, no such events during the fall semester of the 2000 – 2001 school year.

Nature of the survey. The lack of pre-test data in this research, then, puts tremendous weight on the reliability and validity of the survey used and on the assumption that the two treatment groups can be considered statistically one population. The reliability and validity of the survey as a whole were not statistically measured after the pilot test was administered. Rather, questions were simply dropped if 80% of the respondents answered them incorrectly and the wording of several survey questions was altered. The investigator and several advisors then assessed the face-validity of the survey before it was administered to the experimental and control groups. The survey itself, then, could have influenced the data as previously discussed.

Longevity of research. Also, this survey was administered to the experimental group after only one semester of participation in the Edible Schoolyard project. It is plausible that the specific curriculum of the Edible Schoolyard could take more time to be assimilated by the students. Students at Martin Luther King School participate in the

Edible Schoolyard program for three consecutive years. Thus, the one semester of participation before taking the survey could have been too short of a time period for the curriculum to significantly influence the environmental attitudes and knowledge of the participants. If the survey were administered again in subsequent years, it might show an increase in the environmental attitudes and knowledge of the experimental group and not the control group. Such longevity of research is recommended by Dresner and Gill (1994) who call for longitudinal studies of environmental education projects. However, such longevity was not within the scope of this project.

CONCLUSION

It is timely to research the effects of the Edible Schoolyard garden program. This important and well-known project is anecdotally very successful in teaching environmental education to students (Wilson 1997, Burress 1998, and Bahar 1999). Ultimately, many believe that this project accomplishes the goal of any environmental education program: it positively influences the behavior of its participants. This research aimed to substantiate these claims with quantitative research methods.

The results of this research indicate the following points:

- Interestingly, the control group scored higher than did the experimental group on the attitude scale. This finding suggests that further research is needed to assess the effects of the Edible Schoolyard on the environmental attitudes of students.
- The Edible Schoolyard program appeared to have increased the environmental attitudes of African American students, a traditionally underserved group. This effect could be due to the hands-on nature of the program.
- The Edible Schoolyard project also appeared to positively influence the environmental knowledge of students in the entire experimental group.
- However, the interaction of the independent variables may have diluted the effects of the program on knowledge scores as follows:
 - The ethnicity of students affected their knowledge scores.
 - Previous plant knowledge also influenced the knowledge scores on this survey.
 - Last, there was a correlation between knowledge scores and the combined effect of ethnicity and median family income.

These results also illuminate several noteworthy points to be made for future research. Future studies of the Edible Schoolyard garden project should include qualitative as well as quantitative research. Structured interviews of students and teachers

could be particularly appropriate measures of environmental attitudes and could help put a framework to the anecdotal evidence of the effectiveness of this program on students' attitudes.

It is also important to further assess this project quantitatively. Future research should ensure the use of the pre-test/post-test method of survey administration. Use of this method would enable more comparisons than afforded by the data collected in this research.

Also, a longitudinal study should be implemented in the future to track a group of incoming sixth graders through graduation in eighth grade. This type of research would provide a long-term investigation of environmental disposition (Dresner and Gill 1994) rather than the "snapshot" view produced by this study.

The data from this research could also be used to refine the survey, which could be used in future projects. For instance, altering the wording of questions could help a higher percentage of students to understand the questions and potentially answer them correctly.

The data collected in this research indicate that ethnicity influences students' survey scores and that there is a connection between ethnicity and mean family income. Future studies should provide a more detailed method of controlling these factors so that other independent variables (treatment group and gender) are not masked by these powerful factors. Also, the specific effect of the interaction of ethnicity and median family income should be assessed.

Additionally, future research should attempt to investigate the mechanism that drove the results of this research. Specifically, researchers should determine what factor helped African American students to develop higher knowledge scores and what factors about the program seemed to negatively affect the attitudes of European Americans and Latinos.

The validity of this research needs to be substantiated by future studies. Further research should be performed to determine if this program creates environmentally responsible citizens to be future leaders of an environmentally conscious society.

APPENDIX 1

Explanation of Logistical Difficulties

The delivery of pre-test survey to both the experimental and control groups did not occur due to logistical difficulties between the author and school representatives at both Martin Luther King Middle School and Longfellow Middle School. The contact person who helped with the pilot study at King Middle School took a leave of absence during the fall semester of the 2000 – 2001 school year. Thus, contact with the new representative was delayed during the first month of the fall semester. By the time contact was made in mid October, the students were already over half way through their eight-week block of activities in the Edible Schoolyard. Thus, a pre-test was not possible.

In regards to the latter school, the principal of the school changed over the summer and contact with the new principal and representative did not occur until October of 2000, which prevented administration of the pre-test.

APPENDIX 2

Survey for Educational Garden Projects

Please do not mark this survey!

BIOGRAPHICAL INFORMATION

1) What is your gender?

A. Male B. Female

2) What is your ethnicity?

A	B	C	D	E
African American	Asian American	Latino	European American	Other (Specify)

3) On a scale of 1-5, how much do you know about plants?

A. 1	B. 2	C. 3	D. 4	E. 5
Very little	Little	Medium	Alot	Very much

4) On a scale of 1-5, how much do you know about gardening?

A. 1	B. 2	C. 3	D. 4	E. 5
Very little	Little	Medium	Alot	Very much

5) What is the zip code at your home address? _____

ATTITUDE SCALE

Please rate your attitude on the following questions on a scale from 1-5 as indicated.

There are no right or wrong answers to these questions.

- 1) Special places should be set aside for animals that are endangered.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

- 2) It is all right to litter if you don't get caught.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

- 3) People should try to recycle as much as possible.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

- 4) People should protect animals and plants.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

- 5) All plants and animals are important.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

6) Plants that grow in parts of the world where there are few people are not important.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

7) Big companies do not have a right to pollute rivers and streams.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

8) People should be able to use their land any way they want.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

9) We should use weed killer to kill the weeds on the roadsides of highways.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

10) It is a good idea to make room for houses by cutting down trees.

A. 1	B. 2	C. 3	D. 4	E. 5
Disagree very much	Disagree	Don't know Don't care	Agree	Agree very much

KNOWLEDGE QUESTIONS

Please answer the following questions as well as you can. This test will not be graded.

1) Organic vegetables are:

A	B	C	D	E
Grown with chemical pesticides.	Grown with chemical fertilizers.	Grown without compost.	Grown without chemical pesticides and fertilizers.	Grown with both chemical pesticides and fertilizers.

2) Carbon dioxide is absorbed by plants during photosynthesis.

A. True B. False C. I don't know.

3) Which of the following resources is necessary for plants to produce food?

A	B	C	D	E
Energy from the sun.	Water.	Nutrients.	Carbon dioxide.	All of the above.

4) In which plant part does photosynthesis occur?

A	B	C	D	E
Stems.	Flowers.	Leaves.	Roots.	None of the above.

5) One creature's waste is food for another creature.

A. True B. False C. I Don't Know

6) Neither plants nor animals depend on the sugar produced by photosynthesis in plants.

A. True B. False C. I Don't Know

7) A population in dynamic balance is one that:

A	B	C	D	E
Increases generation after generation.	Decreases generation after generation.	Goes up and down a little but remains stable generation after generation.	All of the above.	I don't know.

8) Plants can help reduce erosion of soil because they:

A	B	C	D	E
Directly protect the soil from rain and wind.	Hold the soil together with their roots.	Cover the soil with spongy organic matter when leaves fall and when they die.	Letters A, B, and C are all correct.	I don't know.

9) Sustainable resource use by humans means that:

A	B	C	D
Resources are used faster than they are replaced naturally	Resources are not used faster than they are replaced naturally.	Neither of the above.	I don't know.

10) Organic matter is decomposed by fungi and microbes in the compost pile.

A. True B. False C. I Don't Know

11) Feedback loops are an important part of the dynamic balance in the control of plant and animal populations.

A. True B. False C. I Don't Know

12) Biodiversity is highest in which of the following ecosystems?

A	B	C	D	E
The Arctic tundra.	Tropical rainforests.	Deserts.	A large farm in California.	I Don't know.

13) Ecology is the study of the relationships between organisms and the environment.

A. True B. False C. I don't know

14) There is _____ energy available to organisms as energy flows from plants to predators in a food chain.

A. More B. Less C. I don't know.

APPENDIX 3

Agreement to Participate in Research

Responsible Investigator: Weston Miller, Graduate Student in Environmental Studies at San Jose State University

Title of Study: The Effect of an Educational Garden on Environmental Attitudes and Knowledge

Dear Parent,

My name is Weston Miller and I am a graduate student in the Department of Environmental Studies at San Jose State University. I need your child's help to conduct educational research on the Edible Schoolyard project. Please take the time to read this letter and promptly return it to me in the envelope provided.

This research will examine how students respond to the Edible Schoolyard program. The results of this research will be used as part of my Master's Degree thesis project and should also be useful to the Edible Schoolyard, Martin Luther King Middle School, Longfellow Middle School, Berkeley Public School District, and other agencies. This research will also contribute to what researchers know about educational testing in the field of environmental education.

Administration of this research will take place at Martin Luther King Middle School and Longfellow Middle School during the 2000-2001 school year.

Participation in this research is voluntary and choosing not to allow your child to participate in this study, or any other study, will not affect your or your child's relationship with the Edible Schoolyard, Martin Luther King Middle School, Longfellow Middle School, Berkeley Public School District, or San Jose State University.

There are no anticipated risks or benefits to your child associated with their participation in this research. The results of this study may be published, but any information that could result in your child's identification will remain confidential. No child's name will be used in any part of this research. Individual children's scores will not be used but will contribute to group scores, which will be analyzed.

If you have any question about this study, I can be reached at (831) 466-9798. If you have any questions or complaints about this research please contact Les Rowntree, Ph.D., Department Chair of Environmental Studies, at (408) 924-5450. If you have any questions or complaints about research subjects' rights, or in the event of a research related injury, please contact Nabil Ibrahim, Ph.D., Associate Vice President of Graduate Studies and Research, at (408) 924-2480.

The signature of a parent or guardian on this document indicates approval for the child or ward to participate in the study and a statement that the child or ward is freely willing to participate.

Name of Child or Ward

Parent or Guardian Signature

Date

Relation to Child or Ward

Full Mailing Address

Investigator's Signature

11/29/00
Date

The signature of the researcher on this document indicates agreement to include the above named subject in the research and acknowledges that the subject has been fully informed of his or her rights.

Identification Number: _____

Please keep one copy of this letter for your record and send the other back to school with your child. Thank you for your cooperation!

APPENDIX 4

Addendum to Agreement to Participate in Research

Responsible Investigator: Weston Miller, Graduate Student in Environmental Studies at San Jose State University

Title of Study: The Effect of an Educational Garden on Environmental Attitudes and Knowledge

Dear Parent,

My name is Weston Miller and I am a graduate student in the Department of Environmental Studies at San Jose State University. This is a follow up letter to the permission letter that went home with students during December of 2000 and January of 2001. The intent of this letter is to further specify the nature of the survey research that I am conducting.

The survey was administered to students at Martin Luther King Middle School and Longfellow Middle School in December 2000 and January 2001. The survey was administered to the sixth grade students by their science teachers with an accompanying permission letter for the students to take home and return to their teachers. I am using the results of only those surveys that have a letter of permission from parents.

The survey that I am using contains a brief biographical section, which asks students to declare their gender, ethnicity, zip code, and an estimate about their knowledge about plants and gardening. The survey also contains an attitude-based section, which was obtained from previous research on school gardens. Lastly, there is a knowledge-based section of the survey, which I constructed specifically for this project.

Again, I must state that I have used a coding system to keep the names of all students who participate in this project confidential. Also, the scores on this survey of individual students will not be used, but will contribute toward group scores, which will be analyzed.

You now have the option, with this additional information, to withdraw your permission for me to use your child's survey in my research. If you are inclined to do so, please return this letter to me by March 1, 2001.

If you have any further question about this study, I can be reached at (831) 466-9798. If you have any questions or complaints about this research please contact Les Rowntree, Ph.D., Department Chair of Environmental Studies, at (408) 924-5450. If you have any questions or complaints about research subjects' rights, or in the event of a research

related injury, please contact Nabil Ibrahim, Ph.D., Associate Vice President of Graduate Studies and Research, at (408) 924-2480.

The signature of a parent or guardian on this document indicates that you are withdrawing your permission for your child's survey to be used in this research on school gardens.

School Name

Science Teachers Name

Name of Child or Ward

Parent or Guardian Signature

Date

Relation to Child or Ward

Full Mailing Address

Investigator's Signature

2/11/01
Date

**If you are withdrawing consent for this research, please send this form to:
Weston Miller 1516 Seabright Ave. Santa Cruz, Ca. 95062.**

APPENDIX 5

Photographs of the Edible Schoolyard

FIGURE 13

WELCOME TO THE EDIBLE SCHOOLYARD

The Edible Schoolyard, in addition to being a school garden, is open to the public and welcomes volunteers to help in the garden.

FIGURE 14
THE RAMADA

The Ramada serves as a meeting place for students. This structure is covered by edible kiwi fruits, which provide shade for the outdoor classroom. Students meet here with garden instructors and their teachers before and after each session in the garden.

FIGURE 15

THE RAMADA, HERBS, AND HEAVY MULCH

Students in the background are seen in the Ramada. Heavy mulch in the foreground covers pathways to prevent erosion and to keep weeds at bay. The mulch is donated by local tree trimming companies. This gift saves the tree trimmers a trip to the landfill. Rosemary provides olfactory stimulation in the garden.

FIGURE 16
THE BRICK OVEN

The outdoor brick oven is located in the garden. This wood fire oven is occasionally used to prepare food such as winter squash from the garden. It also educates students about indigenous cooking methods.

FIGURE 17
PINEAPPLE SAGE, FENNEL, AND THE GREENHOUSE

Pineapple sage (foreground) attracts hummingbirds to the garden. Fennel provides aromatic delight and a pleasant licorice-like flavor. The greenhouse (background) is used to start young plants from seed to be transplanted into the garden. It also allows the gardeners to extend the growing season earlier in the spring and latter in the fall.

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