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The integration of a formal garden curriculum into Louisiana public elementary schools

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**THE INTEGRATION OF A FORMAL GARDEN CURRICULUM INTO
LOUISIANA PUBLIC ELEMENTARY SCHOOLS**

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Science

in

The Department of Horticulture

By
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ABSTRACT

School gardens have been and are in use today at schools around the United States to supplement their curriculum. Very little research, however, has been conducted to quantify the benefits that gardening provides to students. The first four chapters of a hands-on gardening curriculum (Junior Master Gardener Handbook Level One) were introduced into three East Baton Rouge Parish elementary schools the fall semester of 2002. Science achievement tests developed at Texas A&M University specifically for the Junior Master Gardener program, were given both before and after the students participated in the gardening activities to determine whether or not the activities helped improve achievement scores. The curriculum was introduced as an informal education program conducted by East Baton Rouge Parish Master Gardener volunteers and Louisiana State University students once a week for two hours during regular school hours. The results were significantly different ($P \leq 0.0167$) between the experimental classes' pre- and posttest scores, while no significant difference was found between the pre- and posttest scores of the control classes. No significant difference was found between the experimental and control classes due to treatment. Several variables may have affected the outcome of the study, but the results show that even once weekly use of gardening activities and hands-on classroom activities help improve science achievement test scores.

CHAPTER 1

INTRODUCTION

Gardens are used in schools around the country to educate students in many different subject areas. Gardens may be in containers, they may be large natural habitats, or they may be flower or vegetable gardens in beds, but they all serve the same basic purpose as a living laboratory for student experimentation and observation. As educators and administrators are once again realizing the need for hands-on activities in the science classroom, gardens are coming into the forefront of education. Educators also realize that gardens can provide a link between science concepts and everyday life for all ages, even at the college level.

Even though it seems logical that gardens provide many benefits to students and positive results have been seen by educators, there have been relatively few studies conducted to quantify the benefits. Most of this research has been conducted only in the last ten to fifteen years. Research areas have included studying the effect of gardening on students' environmental attitude (Skelly, 1998), nutrition (Lineberger, 2000), interpersonal relationships and attitudes toward school (Walzicek, et al., 2001), and science achievement (Klemmer, 2002). These studies have shown positive effects on students due to the use of school gardens, but there is still a need for further research.

The objective of this study was to quantify the effects on science achievement test scores of 5th grade students participating in a gardening program using the Junior Master Gardener curriculum. This study was meant to increase the available data on the effects of a school garden on students. For gardening to become part of a school curriculum, researchers

must provide evidence that gardens benefit students and that the benefit is worth the time and effort spent outside the classroom.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

The concept and application of school gardening is not new. In fact, it has been used for over a century. It has only been recently, however, that an attempt has been made to quantify the effects that a school garden have on children. Some research has been conducted not only on educational benefits, but environmental awareness, interpersonal relationships and attitude toward school, and science achievement. In order to better understand how the integration of school gardening can benefit children; this chapter will look at science education, different theories on how children learn, and previous studies on and examples of the implementation and effects of school gardens.

In his study of the early school garden movement in the United States, Bachert (1976) found that school gardens originally began in Europe in the mid 1800's, the school garden movement in the United States, however, did not really begin until the 1890's. It wasn't until the early 1900's that school gardens gained in popularity. "The United States Department of Agriculture estimates there were about 75,000 school gardens maintained during 1906 (Bachert, 1976, pg. 28)." Just as it is today, most of the early school gardens were located in elementary schools and those located in upper level schools were used primarily for the study of agriculture. Even in the early years of school gardens the connection between the garden and all areas of the curriculum was apparent.

2.2. Science Education

It is hard to understand how a school garden can benefit students educationally if we do not first understand how science is currently taught in the public school system. First of all, teachers are required by the state to teach certain standards in each subject area. There are national standards and there are state standards, which vary from state to state. Students are tested with standardized tests, such as the Louisiana Educational Assessment Program for the 21st Century (LEAP 21) test in Louisiana, to determine the knowledge of students pertaining to the state standards from school to school and statewide. Science standards being tested on the LEAP 21 test include science as inquiry, physical science, life science, earth and space science, and science and the environment (Louisiana Department of Education, 2002). How teachers actually teach the standards is up to them, so long as students learn the required skills.

The National Assessment of Educational Progress (NAEP) is a survey of student performance in core subject areas (O'Sullivan et al., 2003). The Nation's Report Card is published by NAEP and reports to the public on educational progress. In the year 2000, the report card for science showed that only 29% of students in the 4th grade performed at the proficient level (determined by the National Assessment Governing Board), 32% in the 8th grade, and 18% in the 12th grade. Compared to 1996, the percentage of 8th graders at the proficient level increased, but the percentage of proficient 12th graders decreased. The report also indicated that in 2000 the average scores for 4th and 8th grade students were higher in the Northeast and in the Central regions than in the Southeast and West.

In 1985, the American Association for the Advancement of Science (AAAS) founded Project 2061 to bring about reform in science education (AAAS, 2003). Their

publication in 1989 of *Science for All Americans* “set out recommendations for what all students should know and be able to do in science, mathematics, and technology by the time they graduate from high school (AAAS, 2003).” This publication and their *Benchmarks for Science Literacy* published in 1993 set out their science literacy goals for public knowledge. Project 2061 conducts research and develops materials to help make their goals a reality.

Teaching science as inquiry is once again gaining popularity nationwide with many teachers and administrators. Some teachers, however, are reluctant to move away from traditional textbook centered science and many elementary teachers may not believe they have an adequate background in science and are therefore unable to answer questions and explain concepts and processes. Often, teachers don’t realize that they need not always have an explanation of why something occurs in a scientific investigation (Beisel, 1991). It can actually help the children learn a concept and the scientific process if the teacher guides them in making objective observations and encourages them to share their findings with others. This method of teaching science encourages inquiry and helps develop problem-solving skills and puts less focus on always having the right answer. In addition, when teachers investigate with their students, the students can begin to understand that to be knowledgeable in a subject does not necessarily mean that you know everything about it.

The textbook is a good resource, but it should not be the only one. Through textbook centered learning students learn merely the content of science without the process scientists follow. In his article on the role of inquiry, Rutherford (1964) states that when scientific content and scientific inquiry are separated, it is very likely that

students will truly understand neither. Finding the right proportion of textbook work and inquiry activities is a challenge for every concerned teacher.

Bredderman (1982) summarized the results of 57 different studies looking at activity-based curriculum versus traditional textbook based curriculum for 13,000 students in 1,000 classrooms. The summary reports that activity based science curriculums were more effective in teaching certain areas compared to textbook based curriculums. Twenty-eight studies examined the difference in the knowledge of science processes. The average gain between these 28 studies was 20 percentile units. When looking at science content the gain was much lower, but the 14 studies still had a gain of 6 percentile units. Nine studies looked at students who were disadvantaged, either academically or economically, or both. These students gained an average of 34 percentile units in knowledge of science processes. This is compared to 14 percentile unit gains among average or cross-section students from 13 studies and a 17 percentile unit gain among advantaged students in 9 studies. In 3 studies disadvantaged students gained 20 percentile units in knowledge of science content compared to a 1 percentile unit gain in 7 studies looking at average or cross-section students and a 4 percentile unit decrease in five studies with advantaged students.

A curriculum should be designed to involve the students, not just teach to them. When students have choices and can choose their learning activities according to their own needs and interests', learning becomes more productive (Fredericks, 1993). Children will only learn what they have an interest in learning. If a child can be motivated to ask questions and wonder about outcomes and possibilities that is when

teaching occurs (Reinsmith, 1993). Interest in a subject is a necessary key to learning, and allowing children to be involved in how they learn facilitates that interest.

Through questioning students can become active in thinking about how a science concept relates to their everyday life. Some methods through which inquiry can be brought into the classroom are through questions, scientific processes, discrepant events, inductive activities, deductive activities, gathering information and problem solving (Chiappetta, 1997). Hands-on activities can facilitate inquiry-based learning and can be used in both inductive activities where students discover a concept through a situation or experiment and deductive activities where students study a concept and then experience it through an event such as an experiment. Illustrating discrepant events where students think one outcome will happen in an activity, but the outcome is entirely different is another way to get students to question. Gathering information about a concept is important because understanding that professional scientists spend quite a bit of time researching previous works and background information, not just completing experiments is important in learning about scientific processes. Finally, the problem solving method of bringing inquiry into the classroom allows students to think of real problems in the world and the process through which they could be solved. This method also involves having students create and perform their own scientific experiments.

Edwards (1997) points out that many older children have gotten out of the habit of asking questions due to an educational system that often promotes memorized answers. In his article, three strategies are given for helping teachers to get students back to asking questions. He suggests that teachers provide their students with an event to ask questions about, have the students read articles about things that are happening in science that

might interest the students, and/or provide possible topics for investigation through questioning about the topic being studied. Lumpe and Oliver (1991) define hands-on science as any science lab activity that allows the student to handle, manipulate or observe a scientific process. Hands-on activities can provide the catalyst for questioning to occur.

Sometimes finding good hands-on activities can be difficult and this may not be due to a lack of activities, but a lack of ones that work. An article by Feldkamp-Price et al. (1994) provides teachers with some questions to ask themselves when finding new hands-on activities and recommends several key things to consider. The first consideration is whether or not the activity will provide meaningful, accurate science learning, and that this will not lead to possible misconceptions by being too simplified or abstract. Also, if the activity is time consuming, is it really worth the time? Is the activity so technical that students lose the concept in the construction or application? Another consideration is cost; is the activity worth the money put into it? Educators must also think about safety and difficulty level. Finally, the activity must be tried prior to introducing it in class to determine whether or not the activity works.

Wasserman and Ivany (1996) advocate the use of “sciencing” versus just teaching science. “Sciencing” promotes investigating and not just memorizing facts. The traditional method of teaching science puts emphasis on what is known. Often laboratories consist of experiments where students already know the outcome and if somewhere in the process of the experiment the outcome turns out differently, they have not completed the lab correctly. “Sciencing” emphasizes adjusting the variables to see what happens. Basically, the students design the experiment and ask the questions. The

experiments are not lined out for them in neat little packets. With “sciencing”, children actively learn the scientific process and how to think about problems and ask questions as if they were conducting true scientific research. When doing an experiment that doesn’t turn out as expected, the students aren’t penalized, they learn to ask questions about why the experiment turned out as it did.

Cooperation is an important part of building critical thinking and problem solving skills in the science classroom. Group work is common in the science classroom, but Johnson and Johnson (1979) believe that group work and cooperative learning are two different things. According to the authors, “...the essence of cooperative learning is positive interdependence where students see themselves as tied together in a ‘sink or swim’ situation (Johnson and Johnson, 1979, pg. 26).” The authors present a model of a lesson taught by using cooperative learning and suggest steps from assigning heterogeneous groups through how to evaluate students.

Research has shown that a student’s attitude toward science is important in the learning of science (Koballa and Crawley, 1985). According to this author, a consensus has been reached on the meaning of the term attitude as referring to a general and enduring positive or negative feeling about science. Attitude is thought to be important because, “attitudes toward science are thought to fulfill basic psychological needs, such as the need to know and the need to succeed... and attitudes toward science are thought to influence future behaviors, such as interest in working on a science project at home and in visiting a science museum (Koballa and Crawley, 1985, pg. 224).” The author points out several factors that work toward a student’s attitude regarding science, one of which is the teacher’s attitude toward science. Educators may not be able to fix the social

factors that influence science attitude, but they can contribute to a positive science attitude in their students by having a positive attitude toward science themselves.

Teaching across the curriculum is one way self-contained elementary school teachers choose to teach in order to cover all subject areas efficiently and effectively. Mechling and Kepler (1991) gave six reasons that support the idea that science should be the base of a cross-curriculum plan. They suggest first that children love science, and research shows experience based science improves not only science understanding, but content area and process knowledge in other subjects as well. The authors even provide a table of process skills across the curriculum showing the connection between science, reading, math and social science. This table shows that interpreting data skills in science go along with organizing facts and recognizing cause and effect in reading, as well as analyzing in math, and interpreting data in social science.

Teaching with thematic units is another way to integrate subjects while teaching. “A thematic approach to learning combines structured, sequential, and well-organized strategies, activities, children’s literature, and materials to expand a particular concept (Fredericks, 1993, pg. 6).” The author suggests that both science and social studies are active subjects and that thematic units allow for dynamic learning as opposed to the passive, textbook based learning that takes place in many classrooms.

2.3. Children and Learning

If we look at the way children learn as defined by Jean Piaget, a Swiss psychologist, then elementary school children are in what he termed “the concrete operational stage.” Renner et al. (1988) explain that in this concrete operational stage, children must be actively involved with the concept being learned. “The presence of

concrete reasoning means that actual experience with those concepts that are to be learned is the only way understanding develops (Renner et al., 1988, pg. 22).” They must be involved in the gathering and evaluation of the data relevant to the concept or in some way have a concrete experience with the data that will lead them to the concept to be learned. Often, in classrooms only memorization of material occurs and true understanding is not achieved. Students should not memorize material just for the sake of taking a test. This knowledge of science needs to be retained for future years. It is widely believed in the education community that children must be active participants in the learning process. McCormick et al. (1989, pg. 10) expressed the need for students to be actively involved and have experience while learning state, “experience is necessary and essential for permanent learning to occur”.

The elementary level is where the basis of future learning occurs. It is for this reason that educators must strive for as much retention of knowledge as possible. Chance (1988) explains that the way in which we originally learn something can play a part in forgetting and that material we consider meaningful is better recalled than something which we find useless. By increasing the original learning of material in the elementary school, teachers in upper grade levels will be able to reduce the amount of time they spend reviewing and re-teaching. It is up to the educator to make the material to be learned as meaningful to the student’s life as possible. Unless students can understand how a subject relates to their everyday life, real learning cannot occur (Reinsmith, 1993). Furthermore, when students cannot apply what they have learned in one subject to another, their learning has become ‘pigeonholed’ (Nelson, 1988). In their minds, they don’t see a connection to what they learn and what they do and see everyday. Fusco

(2001) discusses a study which created a “practicing culture of science learning” where urban teenagers helped to create a community garden (pg. 860). Situations such as this create relevant science where children feel that what they are learning, or have learned, is being put to use and they are making a difference through its use.

Many educators acknowledge that not everyone learns best in the same way. One theory suggests that there are multiple intelligences and that everyone has some level of each. The multiple intelligence theory according to Armstrong (2000) is a theory of cognitive functioning. It suggests that every person has abilities in all eight intelligences, only every person’s level of ability in the individual intelligences is different and these intelligences function together distinctively in each person. The multiple intelligence theory does not suggest that teachers create a different assignment for each child according to his/her more dominant intelligence. This way of thinking merely makes the suggestion that when teaching a concept, to appeal to a wider range of students, several ways of teaching should be involved, not just written or verbal.

Current neuroscience research is giving educators insight into how the brain functions and how this will affect the way students learn. McGeehan (2001) gives three examples of what neuroscientists have learned and how these results can be applied in the classroom. These results suggest that emotions play a large role in the classroom and can be referred to as “the gatekeepers to learning.” One way to keep emotions at a level where learning is possible is to create a community atmosphere in the classroom where students don’t feel threatened and there is a feeling of team spirit. Also, it has been found that new experiences physically change the brain. The best new experiences for causing this physical change in the brain would be the first-hand experiences that are rich in

sensory input. The author also suggests that for information to be remembered, the learner must have a personal connection to that knowledge. By connecting the concept to be learned to students' lives there is a better chance that the knowledge will be retained.

2.4. Factors that Affect the Implementation and Use of School Gardens

In a study conducted to determine different factors that had an influence on whether or not elementary school teachers used a school garden, Mirka (1970) used a survey to canvas fourth, fifth, and sixth grade teachers from the greater Cleveland, Ohio area. This study found that in teachers who did use school gardening; the value of the experience to children was a great influence in their decision. Both teachers who had used gardening and teachers who had not, responded that the principal and science supervisor played no significant role in their decision to teach or not teach outdoors. Some of the teachers who had not used a school garden stated some of their reasons as being that they were unable to recognize areas around their school as teaching areas, they lacked knowledge in instructional activities that could be taught outdoors, they were unable to obtain curriculum guides and curriculum materials, and they had a lack of knowledge of how to apply what they were teaching in the classroom to the outdoors, just to name a few. As for those teachers that had used school gardens, in addition to the benefit to school children, their ability to find areas of the school grounds that can be used as teaching areas, their ability to connect classroom material to the outdoors, and their understanding of the planning needed to conduct lessons outdoors, were reasons they indicated for using gardens.

A little over twenty-five years later, a study conducted at Virginia Polytechnic Institute and State University also focused on the factors that influence elementary school

teachers' use of school gardens (DeMarco et al., 1999). The study involved surveying teachers in the nation who had received a Youth Gardening Grant from the National Gardening Association in the 1994 to 1995 or 1995 to 1996 school years to find out what factors were important to the teachers in their decision to use gardening in their curriculum. Within the state of Virginia, 28 teachers who had been sent surveys were also interviewed. Several factors were found to be "essential/crucial" in the decision to use school gardening. These factors include, someone who is responsible for the school gardening, support from the principal, and the student's sense of ownership in their learning through using the garden. Also very important were the availability of physical resources; such as a site to garden, funding for the garden, equipment to garden with, and a water source. Many teachers felt that being able to integrate gardening into the curriculum was also a major factor. Those teachers who were interviewed mentioned that the garden must have a clear purpose and they felt that the availability of adequate instructional time was important. These are just a few of the major factors teachers brought up when surveyed, but they are of major importance in the decision of gardening at school. The teachers also commented on their goals in using gardening with their classes. In comments written to clarify these goals, 91.5% of surveyed teachers specified that they used gardening for students' academic learning. Approximately 83% of teachers indicated that they used gardening as a forum for expanding the students' learning through social experiences, 61.9% expressed that they used the garden for expanding the students' learning through recreational experiences, and 51.7% said they used gardening to expand students' learning through therapeutic experiences.

In the spring of 1995, a survey was conducted on the use of horticulture or gardening in K-6 classrooms throughout Virginia (Dobbs, et al., 1998). This survey sought to find out how many teachers were using horticultural activities in their classrooms, had access to resources that could help them use horticultural activities and what things could be done by the industry to help them use horticultural activities. Responses from the survey indicated a high level of interest in integrating gardening or horticulture into the classroom. Conclusions from the survey responses for materials that would help teachers to incorporate horticultural activities included the need for teaching aids and horticultural-based lesson plans which could be presented to interested teachers at a workshop. At this workshop the teachers could review the materials and any questions or concerns by the teachers could be addressed. Teachers surveyed showed a willingness to attend a local in-service training workshop for information on using school gardens.

The interest of the children participating in the garden is a big factor in the success of a school garden program. A study conducted at Michigan State University dealt with what preschoolers felt were necessary characteristics in a garden (Whiren, 1995). Sixty children between the ages of three and five were asked what they would like to have in a garden. Their responses included general ideas such as flowers, trees, grass, and plants, as well as more specific kinds of plants. These answers are to be expected due to the fact that preschoolers have very limited experience in garden areas, both public gardens and home gardens. Other things these children expected to find in a garden were fantasy characters and objects based upon their experiences with literature and television. Knowing what will gain children's attention in a garden is very

important. If the environment is pleasing to the children, they become more open to learning. This should hold true with older children as well, though their expectations of what a garden should have would probably differ quite a bit from the preschoolers questioned in the study.

A feature story by Boss (2001) provided examples of several successful school gardens, two in Portland, Oregon and one in Boise, Idaho. This article indicates the importance of having parents involved. In one example, the parents volunteered to set up a worm composting bin so that cafeteria waste could be composted. The author reminds readers that teachers have many other things to do besides caring for extra projects, so knowing that the compost bins would be built and maintained by volunteers, would allow the teachers to develop lessons and projects built around the bins, without having to spend time worrying about the upkeep. Parents can also provide necessary maintenance during the summer months, which helps keep the teacher from feeling overwhelmed.

An article by Coffee and Rivkin (1998) pinpoints some practical issues that must be addressed for the smooth creation and use of a school garden or habitat. One of the main points discussed is contact with maintenance personnel. These are the people who know where utilities are buried under the school yard and are knowledgeable in other areas such as drainage. It is not a good idea to surprise maintenance with a newly created garden or habitat. Safety is another issue that is mentioned. Educators must consider possible safety issues prior to garden establishment, not only of the students but of the school neighbors as well. Making sure to let the school neighbors know what is happening, especially if the project affects their view, can be of importance as well.

Finally, educators planning such a project should build bridges, not burn them, by realizing that community support is essential.

2.5. Using School Gardens to Teach

Friedrich Froebel, the father of the kindergarten, believed that nature and education were closely connected. Downs (1978) in his book on Froebel explains that the kindergartens started by Froebel involved the children spending much time in the garden. Each child had a plot that was part of a larger garden and it was hoped that the child would realize that like their plot they themselves were part of a larger garden. Froebel saw the kindergarten teacher as the gardener tending the growth and development of children.

Mohrmann (1990, pg. 25) makes a good argument for school gardens in an article which states that gardens are “perfect laboratories where scientific concepts literally come to life. Lessons in biology, the scientific method, interdependence, and meteorology take place in an authentic environment that stimulates curiosity in a way textbook learning simply can’t.” This is perhaps one of the best explanations of why school gardening can and should be used to teach elementary science. Mohrmann asks readers of her article to picture students growing the plants of their favorite fictional book characters, and think about how meaningful activities would be with students using plants they produced in their own garden for activities and lessons. Potentially, gardens can provide a wide range of teaching opportunities across the curriculum. Braun et al. (1989) provide a breakdown of concepts and skills that could possibly be learned in a garden, from social studies to physical education.

In South Carolina a project was developed to integrate butterfly gardens into science activities in elementary schools (Culin, 2002). The project began in 1997 with 74 teachers from 43 schools in South Carolina and in 1998 another 92 teachers from 47 schools joined. After three years, 61 of the original teachers from 32 schools remained active in the project. In this project, butterfly gardens were designed and built by local volunteers at schools which did not have a garden. Nurseries that were corporate sponsors provided butterfly-attracting plants. In the beginning, the participants were primarily science and math teachers but later projects involved teachers in other subjects as well. The project's objectives were to assist kindergarten through eighth grade teachers in all the aspects of using a butterfly garden specifically as an outdoor classroom and to assist these teachers in their curriculum by helping to teach content in the state standards in an inquiry based manner.

In Texas, 3rd, 4th and 5th grade students participated in school gardening for a study conducted to determine whether or not the use of gardening improved science achievement test scores (Klemmer, 2002). Teachers in the experimental classes used the Junior Master Gardener Handbook Level One as their gardening curriculum, and more specifically chapters one through four. For this study, the degree to which the teachers used both the curriculum and garden was left up to the teacher. Test results showed higher scores for students in the experimental group of combined 3rd through 5th grades. Statistical analysis indicated the fifth grade students to be the source of most of the differences. No significant difference was found between gender for the 3rd through 5th grade experimental group. Within males in all three grades, however, statistical difference was found between the experimental and control groups at each grade level.

For females, statistical significance was only found between the 5th grade experimental and control groups.

A study conducted in South Carolina is a prime example of an integrated garden curriculum in an elementary school (Sheffield, 1992). Conducted during the summer, the five-week study took a select group of underachieving elementary students and used a heritage garden with a curriculum that was interdisciplinary, child-centered, and activity-based. The garden site consisted of four 4' x 4' beds with each bed representing one of four continents, Africa, Europe, South America and native North America. The curriculum was student-based which allowed the children to do activities that appealed to them and the interdisciplinary nature of the curriculum allowed all subject areas to be covered in this way.

Teachers have thought of wonderful ideas of how to integrate gardening into a part of or the entire curriculum. Marturano (1995) explained how 4th grade students planted a garden similar to those of four regional Native American tribes. The different classes were assigned one of four Native American tribes and conducted research on the individual gardening practices of each. The students also learned a lesson in heirloom seeds since the garden was supposed to be as authentic as possible. Through this garden the students received a very large dose of history as well as other subjects and they practiced their researching skills all with a very real purpose and a result that was tangible. In Texas, a class of first-graders grew a garden and through the garden studied several different subjects (Monk, 1995). Starting with a children's story they began a nine-month study of wheat and along the way planted a variety of other plants as well. Herbs are the focus of one article on integrating gardening in a Washington D.C. area

school (Thompson and Marcoux, 1996). As one of eight science units developed to integrate science into a year long study of colonial America, second graders learned what herbs are and how they can be used by creating their own herb garden.

Some schools, especially in urban areas, have very limited green space, but they can still use plants and gardening in the classroom. Grow Labs, developed by the National Gardening Association, are one way that schools with limited green space and those in climates with short growing seasons can use classroom gardening (Gwynn, 1988). An adaptation of a construction plan for a type of growing table from the American Gardening Association is given in an article by Hanscom and Leipzig (1994) on their experiences with gardening in a northern climate.

While science is probably the most natural subject to teach using a garden, almost all other subjects can be taught as well. From language arts to mathematics, a garden can provide a fun way to learn meaningful skills. The areas of learning should not stop at school subjects though; leadership, communication, nutrition and environmental education can also be taught in a garden.

Health and nutrition among children is important especially since the American population is being told that we are an overweight nation. In many elementary classes, the Food Guide Pyramid is discussed with students and to some extent the National 5-A-Day program is mentioned. What happens to students' attitudes toward nutrition when they are allowed to grow their own food and have the experience of eating it right out of the garden? A study was conducted from the spring of 1998 to the spring of 1999 to determine whether or not a school garden and gardening curriculum would affect students' attitudes and behaviors towards fruits and vegetables (Lineberger and Zajicek,

2000). The sample population consisted of one hundred and eleven third and fifth grade students from classes at five Texas elementary schools. Data was taken from pretest and posttest questionnaires and before and after journals. Analysis of the data showed a significant improvement in vegetable preference participating in the garden program. Fruit preference, on the other hand, did not show a significant improvement. The lack of a significant improvement in fruit preference may be explained in part to high pretest attitudes toward fruits and that students mainly grew vegetables in their gardens. Snack preference for the students showed a significant improvement; after gardening the students were more likely to choose a fruit or vegetable as their preferred snack item. In regards to fruit and vegetable behavior, no significant difference was found.

In Westminster, Vermont, a public school integrated gardening into a class of 40 children that consisted of grades one through four (Canaris, 1995). Through this garden the students participated in an integrated curriculum that encouraged hands-on, inquiry-based learning in a cooperative setting. The students were involved in every aspect of the garden. Each child drew up a plan for the garden and from the individual plans a master plan was drawn. Through parent and community support, the garden was prepared, planted, and cared for even during the summer months. The garden was originally developed to teach students about nutrition and improve the quality of their mid-morning snacks. The garden taught not only nutrition, but science and math as well. The author states that the outcomes went far beyond the nutritional goal and helped to increase the quality and meaningfulness of the student's learning.

For many years people have been concerned with environmental awareness. Environmental education even has its own specific class and curriculum in some schools.

Recycling and growing foods organically have become popular and to some degree an effort has been made to instill a renewed love of the earth into children. One way this has been approached is in the use of school gardens and schoolyard habitats. At an elementary school in Phoenix, Arizona, students and teachers created an urban wildlife habitat in the middle of the city. “This natural environment has increased the likelihood of the students becoming environmentally responsible citizens. They are taking personal responsibility for creating and protecting this habitat and are having a positive impact on their environment (Bradley, 1995, pg. 245).” Pivnick (1994) expresses that though a school garden in itself teaches valuable environmental lessons, it is the actual feeling of being closely connected to nature that instills a deep environmental ethic in students. It will be the actual responsibility of caring for the plants and seeing them as they are affected by nature that will instill the awareness of the environment. The continuous nature of a garden also allows the students to see short term and long term effects in a type of continuing experiment.

During the 1996-97 school year, the Project GREEN Activity Guide: Book 2, Interdisciplinary Activities, was introduced into four elementary schools in Texas and testing was performed to determine whether or not participation in Project GREEN activities made a difference in students’ environmental attitudes (Skelly and Zajicek, 1998). The testing instrument used was the Children’s Environmental Response Inventory. After analysis, the data showed a significant difference in environmental attitudes between the combined experimental groups and control groups. Also compared were the scores for each individual school. Analysis showed that the experimental group

scores were significantly higher than the control scores at the individual schools and that 2nd graders scored significantly higher than 4th graders.

One aspect of environmental education is sustainability. Moore (1995) discussed a ten year project, during the 1970's and 1980's, in the San Francisco Bay Area of California to re-naturalize a desertified urban schoolyard and make it into a natural habitat for school and neighborhood use. Through this project several generations of students were able to participate in gardening and restoration activities. The early generations learned how to reclaim an area and make it productive and the later generations continued the harvests from the gardens and learned about garden upkeep. This author believes that gardens are excellent tools for interdisciplinary environmental education "because they are a constantly changing, highly attractive, interactive, motivational setting (Moore, 1995, pg. 230)."

In this country called a melting pot of cultures, a garden can be used to teach valuable lessons about ethnic diversity. Gardens are present in almost every culture's traditions and folklore. Coupling storytelling with garden activities allows children to experience the literature and examine the natural processes described in the stories (Bowles, 1995). Through myths and folklore, children can realize the similarities in various cultures and hopefully gain an appreciation for differences. In many urban schools there are children of very diverse backgrounds and gardens can be a way of getting students from different cultures to work together and learn that everyone must work together in order for things to work in the world.

Along with educational subjects, the idea that a garden could affect students' social interaction and attitudes has also been brought forward. During the 1995 to 1996

school year, a study was conducted on the effects of the integration of the Project GREEN school garden program on interpersonal relationships and attitudes toward school of participating students (Waliczek et al., 2001). This study used the Project GREEN Activity Guide: Book 1, Math and Science at schools in both Texas and Kansas. In total there were seven schools and 598 students ranging in age from grades two through eight that participated in the study. The testing instrument used was the Behavior Assessment System for Children and both a pretest and a posttest were given. The data showed no statistically significant differences in comparisons of the experimental and control groups, but in doing demographic analyses, statistically significant differences were found in posttest comparisons using pretest scores as covariates. In the area of gender, it was found that the attitudes of female students toward school became more positive at the conclusion of the program compared to males. When looking at grade demographics, there was statistical significance in the variable of interpersonal relationships between the grade levels. Seventh grade students (12 to 13 years old) had the most positive interpersonal relationship scores of all grades. Finally, in looking at the results based on school demographics, there were statistically significant differences between schools.

Not only can school gardens be used for teaching, they can become centers for community activity and involvement. Community involvement can help teach students the benefits of working together as a group to achieve a common goal. This is evident in several cases. At the J.W. Fair Middle School Life Lab in California, the community plays an important part in the garden (Nelson, 1988). Local businesses and neighbors

donate needed supplies and knowledge and having the community involved has helped cut down on vandalism, which can be a major problem for school gardens.

Mainstream students are not the only children who can benefit from the experience of a school garden. Sheffield (1992) found that underachieving students who participated in a five-week inter-disciplinary gardening program during the summer experienced an increase in academic success as well as an increase in self-esteem. Neer (1990) indicated children with severe physical and other disabilities who became gardeners in an area just outside of Chicago experienced a positive change in their school work and self-esteem. The beds they worked in were built so that handicapped children could work in them easily.

A pilot program implemented by a teacher with her learning-disabled students showed definite benefits in several areas (Sarver, 1985). In a garden environment, children with poor verbal skills can have their chance to excel, because the demand to verbalize material is not as prominent as in the classroom. In this author's experience, the inability to communicate well played a major role in her students' failures in school. In the garden, it was what the children did and not what they said that made the difference. Another problem learning disabled student's face is that they often learn slower than others in their classes. The experience in the garden with the vegetables maturing at different times showed the children that variations in growth and development are common in nature and there is no real reason to be concerned. Through this garden lesson the students could generalize that just because they were slower in doing their work than some of their other classmates, it did not mean that their work was less important. Progress was also made in the areas of cooperation with others and

gaining positive relationships with adults. While this teacher did not expressly test for educational benefits, there is a probability that academic achievement did occur. Going back to the theory that children only learn what they are interested in, the garden in this example increased the children's desire to be at school, therefore affecting their interest in learning and possibly making them more receptive to educational concepts.

Many of the previous examples have focused on elementary schools using gardening. Upper level schools sometimes use horticulture as well. When upper level schools use a garden it is not usually to teach basic subjects, but more often to teach a specialized science topic or vocational skill. An article by Gordon (1987) focused on a particular vocational horticulture program in a New York City High School. Students trained in several areas of horticulture preparing them to enter the workforce in entry level jobs. Located in the inner city, this project gave students an opportunity to work with plants and gain skills that they might not have had.

Hands-on horticulture is even used in teaching college non-science majors at a small liberal arts college in New York (Bouthyette, 1992). To some degree, the lack of a clear need for understanding science concepts and processes is present through all levels of science education from the elementary school to college. In order to help non-science major students understand the need to be educated in science topics and the scientific process a series of courses were designed with practical applications in mind. The courses are based on practical topics such as fermentation, horticulture and the environment, but this article specifically discusses the horticulture course. There are two primary course goals for the horticulture course; emphasizing the need for scientific discovery in horticulture and familiarizing students with the scientific method, scientific

methodology, and basic principles of chemistry, botany, and physiology. The course is broken down into four sections to work toward the two goals and each section requires practical and scientific lab experiments.

The South Carolina Botanical Garden at Clemson University is another example of using horticulture and hands-on activities at the college level. Through their program *Garden Explorations*, the South Carolina Botanical Garden reaches university students, classroom teachers, parents, and children (Wagner and Fones, 1999). *Garden Explorations* is a set of programs offered by the garden all year long which offer opportunities for garden-based hands-on science and mathematics activities. These programs include a summer science camp, family science Saturdays and family and community outreach programs. These programs offer undergraduate and graduate students the opportunity to use their education to promote science and mathematics learning in school age children even if their major is not in education. Overall, the program has seen positive results from its participants.

2.6. The Future of School Gardening

Recently the state of California officially recognized the benefits of school gardening in nutrition awareness, multiple subject education, and community appreciation (California Education Code, 2000). A bill was passed in the California state legislature and approved by the governor in 1999 that recognizes school gardens as beneficial to students and provides for the promotion, implementation, and support of instructional gardens by school districts and county education offices provided funding becomes available from areas other than state funds. Education code section 51795-

51798 provides an official acknowledgement of the benefits of school gardens and encourages schools to include gardens as an instructional tool.

With the state of California recognizing the benefits of school gardens to aid in nutritional education, the Department of Nutrition at the University of California, Davis campus developed a garden-based nutrition curriculum for fourth, fifth, and sixth grades (Morris and Zidenberg-Cherr, 2001). This curriculum includes nine lessons with corresponding handouts and tables listing preparation activities. Each lesson has a related gardening activity and an appendix showing how each lesson meets state content standards. The California Department of Education has developed a book for educators of grades two through six outlining how activities from popular gardening curriculums correlate with state standards in English/Language Arts, Science, Mathematics, and History/Social Science (A Child's Garden, 2002).

Texas A&M University located in College Station, Texas, has developed a program called Junior Master Gardeners. Using this program they have developed a teacher's guide and student handbooks to teach lessons about gardening, the environment, and community service (Whittlesey et al., 1999). The teacher's guide has a reference in the back that specifies which activities can be used to help teach toward the Texas benchmarks. Even in other states these handbooks could be useful tools in the implementation of gardening into school curriculum, and the Texas benchmarks could be converted to any state's benchmarks.

In Minnesota, a small study was performed to find out if there was an interest with children and teachers in using the Junior Master Gardener Handbook Level 1 (Meyer et al., 2001). This study was conducted in two parts, one at an elementary school

and another in an after-school program. No tests were conducted to quantify educational results; only evaluations were made to determine the response of children and teachers to the material. The elementary school part of the study used 12 selected 4th grade students who were pulled aside to meet with two Master Gardeners for 60 minutes once a week for 12 weeks. In the after-school part of the study, the participants were seventeen children from grades Kindergarten through 3rd grade. These children met for an hour and a half at three different sessions conducted by an extension agent and a parent volunteer. In both parts of the study, positive results were found in the response of the children to the Junior Master Gardener Handbook Level 1.

The Junior Master Gardener program is not the only school gardening curriculum. Many books have been written on gardening with children and a few thorough curriculums have been published. For educators beginning to think about using a garden there are several books available. Grant and Littlejohn (2001) compiled a set of articles entitled, *Greening School Grounds*, that cover a wide variety of topics from the process of starting a garden all the way through examples of activities that educators have tried and liked. The University of California Cooperative Extension Service Common Ground Garden Program has developed a field guide to developing gardens for children (Bremner and Pusey, 1999). This book covers the whole process of creating a garden, has a section on activities to do with children in the garden, provides a guide to resources for the materials needed in the garden, and a bibliography of selected books.

Starting in 1990 Master Gardeners in Bexar County, Texas participated in a Classroom Garden Project (Alexander et al., 1995). Within three years 105 schools were involved and more than 10,000 children (70% minority) were gardening each week. An

evaluation of the project was performed and interviews of 52 third grade students, teachers, parents, and Master Gardeners revealed the following results. From the interview data taken, several themes emerged. All the participants commented in some way on moral development and learning life lessons through the gardening activities. Academic learning was also an area commented on and one teacher expressed that the garden related to all of the subjects they taught. Through the gardens students received definite experiences with parent/child/community interaction and many pleasant experiences. The influence and support of the Master Gardeners was an integral part of the project and the experience affected not only the students and teachers but also the Master Gardeners themselves. When participants were asked about perceived problems they had to look hard to find any. There were very few gardens vandalized or destroyed by maintenance workers and one principal commented that the only thing negative thing they could think of was that all the students in the school were not able to participate.

Interviewing participants is one way of evaluating the benefits of gardening with children. With the increasing use of technology comes the possibility of reaching a wider population by using the internet. At Texas A&M University a web-based survey was used to research the benefits of children gardening (Waliczek et al., 2000). Three hundred and twenty responses indicated working with a total of 128,836 children. Approximately 68% of the respondents were parents gardening with their children and maybe one or two others, but they accounted for only 3% of the total number of children who were involved in gardening. About 19% of the respondents were teachers and the children they work with accounted for 96% of the 128,836 children. This survey gives

researchers basic information on the type of people involved with children and gardening and some of benefits perceived by those working with the children.

The United States is not the only country that is participating in school gardens, school landscaping, and school agricultural activities. In the United Kingdom, Learning Through Landscapes (LTL) is an independent national organization, which promotes the development of school grounds (Lucas, 1995). This organization has been around since 1990 and its goal is to promote the widespread development and most imaginative possible use of the educational estate. LTL recognizes that the school grounds can play an important part in the education and development of children. They have developed many publications to help school administrators and teachers use school grounds to the fullest extent possible. In addition, they have also developed projects to interest educators and to encourage a large number of schools to participate. Two such projects have been Esso Schoolwatch and the BT/LTL Urban Challenge. Esso Schoolwatch began in 1992 and consists of a national school grounds survey project. The BT/LTL Urban Challenge is a grant scheme with the emphasis on the quality of the process by which schools develop their grounds rather than on the end product. LTL also carries out research and delivers training to teachers on how to successfully develop their school grounds.

In Japan, and specifically Shiga Prefecture, agricultural activities such as planting and harvesting crops are encouraged for kindergartens, elementary schools and junior high schools (Konoshima, 1995). These activities have been supported by the local self-governing bodies. In 1978 43% of kindergartens, primary schools, junior high schools

and handicapped children's schools participated in agricultural activities in Shiga Prefecture. By 1992, that number had increased to 76%.

School gardens have been popular for over a century in Germany (Groening, 1995). In 1920, after World War II, the national elementary school act was established. The author gives a history of *kleingaertens* throughout the 20th century. Originally begun in the late 19th century and early 20th century due to stimulation by state interest in the improvement of agriculture, *kleingaertens* continued throughout the 20th century and have proved to be a beneficial addition to schools.

2.7. School Gardens and Children's Gardens

There are gardens designed specifically for children either for play or education or both. At this point, a determination should be made about the difference between school gardens and children's gardens. Children's garden is the broad term for gardens designed specifically for children no matter where their placement. Quite often these children's gardens tend to be located as a specific garden in botanical or public gardens. School gardens are technically children's gardens, but they are located on school grounds and their express purpose is for curriculum education.

Lownds (2000) discusses the aspects of children's gardens both in schools and in public areas. Among some of the most notable children's gardens located in public gardens are the ones at Longwood Gardens, The New York Botanical Garden, the American Horticultural Society's River Farm headquarters, the Atlanta Botanical Garden, and The Cleveland Botanical Garden. A series of essays by administrators from public gardens with children or family garden areas speaks to the need for such gardens and current and future trends of children's gardens (Eberbach, 1996).

Public gardens do not have to have a specific area designed for children in order to facilitate their learning. A good example is the South Carolina Botanical Garden's Garden Explorations program, where public gardens and school groups meet can be exciting territory (Wagner and Fones, 1999). This is just the case at the State Arboretum of Virginia and their Science Explorations program (Olien, 2001). A program for middle and high school age students, this five hour long journey takes the students from brainstorming for an investigation all the way through to a 10 minute presentation on their experiment findings. With a public arboretum for a laboratory, learning can take place as informal, nonformal, or formal education or a combination of two or all three.

In Bloomington, Indiana, at the Hilltop Youth Garden, children have been gardening in the summer for over 41 years (Berghorn, 1988). Here, children ranging in age from seven to twelve participate in a summer long program where they have their own garden plot and participate in a variety of activities that immerse the children in nature. While not designed to teach specific science concepts, it serves to orient children into the natural world.

In 1993, the American Horticultural Society saw the need for a gathering of people interested in children's gardens and with the W. Atlee Burpee Seed Company held an international symposium entitled 'Children, Plants, and Gardens: Educational Opportunities' (Heffernan, 1994). Heffernan's article which discusses the high points of this symposium also details eight of the twelve children's garden designs that were selected as winners from a design competition. Photographs and design plans of the gardens which range in theme from a dinosaur footprint garden to a ditch garden are provided.

2.8. Summary of Review

The education of children has long been a concern in America. Science is an area that many students find unappealing due to bad experiences in the classroom in early childhood. Knowing this, research must be conducted to find a better way of assisting teachers in teaching science and currently, research is pointing to hands-on science and teaching science as inquiry. Hands-on experience rather than memorization of laws and facts out of a textbook will hopefully become more common in the future as educators once again focus on inquiry-based learning.

One option to help teachers integrate hands-on learning and inquiry-based science into their classroom is a garden. Gardens provide a “living laboratory” in which students can create experiments and explore scientific questions and concepts. Although much of the literature discussed involved elementary age students, it should be noted that gardening can be used with students of all ages. Gardens off school grounds can be used for education as well. Many public gardens have created, or are in the process of creating, children’s gardens. These gardens are intended both for learning and for play. Many offer educational programs throughout the school year and during the summer months.

Several foreign countries have officially recognized the benefits of school gardening and have been integrating gardens into schools for many years. In the United States, the only state to give official backing to school gardens is California and this was only recently. Most school gardening efforts in the United States occur in specific locations or individual schools throughout different states with no central organization throughout that state. With quantification of the benefits to students through gardening, it

is possible that more materials to assist educators in planning and implementing a school garden will become available through research.

The few studies previously conducted to quantify effects of school gardening and numerous teacher accounts of school gardens have shown the likelihood of great benefit for students. More research, however, is needed. A school garden can give students hands-on experience not only in biological science, but science reasoning, and physical and earth science as well. In order to obtain full benefit from a school garden, all curriculum subject areas (e.g. social studies, language arts, math) should be integrated into its use creating connections in the students' minds between the subjects. Hopefully, gardening experiences will not only benefit the children in increased test scores but will increase their overall enjoyment of school and better prepare them for the future.

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CHAPTER 3

THE INTEGRATION OF A FORMAL GARDEN CURRICULUM INTO LOUISIANA PUBLIC ELEMENTARY SCHOOLS

3.1. Introduction

Gardens have been utilized in schools in the United States since the late 1890's and early 1900's (Bachert, 1976). Research to quantify the effects of school gardens, however, is relatively new. Many articles have been written by educators relating the qualitative effects of school gardens on students (Bradley, 1995; Canaris, 1995; Hanscom and Leipzig, 1994; Marturano, 1995; Monk, 1995; Neer, 1990; Nelson, 1988; Sarver, 1985; Thompson and Marcoux, 1996), but few studies have been conducted. To quantify their benefits, studies have been conducted to examine the wide range of effects such as a garden's effect on environmental attitude (Skelly and Zajicek, 1998), on nutrition (Lineberger and Zajicek, 2000), on social interaction and interpersonal skills (Walzicek, et al., 2001), and science achievement (Klemmer, 2002). More studies such as these are needed to enforce the benefit of having a garden in schools.

Studies have been conducted to assess the factors which influence teacher use of gardens (DeMarco et al., 1999; Dobbs et al., 1998; Mirka, 1970). One factor is having the available space, but gardens do not have to be in large areas (Braun et al., 1989). Gardening can be brought inside by the use of Grow Labs or similar structures (Gwynn, 1988; Hanscom and Leipzig, 1994) which facilitates gardening activities in northern climates and areas with little outdoor green space. The purpose of a school garden is not to have an elaborate landscape, but to create a "living laboratory" for student observation of science concepts in the real world and experimentation in an unpredictable environment. Students need to feel

that what they are learning in the classroom has a function in their everyday life (Fusco, 2001; Nelson, 1988; Reinsmith, 1993).

Educators have found that school gardens and science can be used to teach across the curriculum (Mechling and Kepler, 1991) which can be particularly helpful in self-contained classrooms. Concepts and skills from virtually every subject can be learned through a garden (Braun et al., 1989). Gardens also provide a link between concepts learned in the classroom and real life applications (Mohrman, 1990). California legislators believed in the effectiveness of school gardens to specifically teach nutrition so much that they passed a bill which recognizes school gardens as beneficial to students and provides for the promotion, implementation, and support of instructional gardens by school districts and county education offices provided funding becomes available from areas other than state funds (California Education Code, 2000). The objective of this study was to increase the available data on the effects of school gardens on science achievement by testing 5th grade students both before and after participation in a gardening program. Observations were also made on the factors which influence the effectiveness of school gardens.

3.2. Materials and Methods

An experiment was conducted to quantify the effects of a school garden and garden curriculum on the science achievement of 5th grade students in three inner city East Baton Rouge Parish elementary schools. The study from inception to end lasted from September 2001 to December 2002. The testing period lasted from August of 2002 to December of 2002.

A survey was conducted in the fall of 2001 to identify schools in the East Baton Rouge Parish School system that used school gardens. This study allowed an informed

decision on the schools chosen to participate in the integration of the garden curriculum. An informal phone survey was used to determine those elementary schools that had gardens in the past, or at the present time, and what classes or grade levels used the gardens. In most cases, the principal was unavailable to answer the questions so the school secretary was the source of information. Of the 62 elementary schools in East Baton Rouge Parish 33 responses were obtained and it was found that 13 schools had gardens at the time and 6 schools had gardens in the past. This information along with information provided by Volunteers in Public Schools (VIPS) provided an idea of the schools that would be willing to implement a garden curriculum.

After narrowing the choice of schools, several schools were visited and the principals met with us to determine their interest in integrating a school garden curriculum into one of their fifth grade classes. In the end, three elementary schools in East Baton Rouge Parish were chosen to participate in the program. Several factors played a part in the final selection process, such as having enough green space for a garden area, cooperative principal and teacher, two self-contained, mainstream, fifth grade classrooms and a location close to downtown Baton Rouge. The original goal was to use schools that already had gardens, but the other selection criterion of two self-contained fifth grade classrooms and location in proximity to the downtown area made it necessary to eliminate several schools.

All three of the chosen schools were very similar in their demographics. According to the 2000/2001 numbers (Ersys, 2003), the populations of the schools ranged from 377 to 507 students. Each school was primarily African-American in racial make-up with a 15:1 or less pupil to teacher ratio. University Terrace Elementary, which was located in close proximity to the Louisiana State University campus, had a very diverse ethnic make-up due

to a large refugee population and foreign graduate student population in the neighborhood. Bernard Terrace Elementary had a magnet program or gifted and talented program, but these classes were not used in the study, only mainstream classes participated. At two of the three schools, both the experimental and control classes were primarily African-American. The third school's experimental and control classes contained students from a wide range of ethnicities.

Table 3.1. Demographics for the selected schools.

School	No. students	White	Black	Hisp.	Asian	Indian	Pupil/ Teacher Ratio
	%					
Bernard Terrace Elementary	377	11.7	83.3	0.3	4.0	0.8	13.00
Park Elementary	507	0.8	98.8	0.4	0.0	0.0	15.00
University Terrace Elementary	455	14.1	71.2	5.7	8.6	0.4	13.00

In April of 2002 grant applications were submitted on behalf of the three participating elementary school teachers to the Louisiana Learn and Serve Commission to provide funding for the project. As a result, each school was awarded \$2,917.00 to use in the purchase of garden supplies and teaching materials for the school gardens with the understanding that the students would participate in service-learning activities based on the garden. Through gardening the students would participate in activities that would use what they had learned in the garden to benefit their community. These activities included donating the food produced in the garden to the Greater Baton Rouge Food Bank and creating arts and crafts from natural materials to give to local nursing homes and hospitals.

After the process of choosing schools, permission was obtained from the Institutional Review Board (IRB) at Louisiana State University to perform research with human subjects.

Although the research would cause no harm to the subjects and would be completely anonymous, formal permission still had to be obtained from the university. An application for exemption from review was submitted giving all relevant information about the study and the procedures for testing. Copies of all the permission forms (Appendix A) to be used were provided as were copies of the testing instruments (Appendix B). At the beginning of the study, permission forms were sent home with the 5th grade students in both the experimental and control classes to obtain parental permission for the use of the children's test scores anonymously. Student assent forms were also distributed to obtain the students' permission for the use of their test scores.

In the months prior to beginning the project, a training session with the participating teachers was attempted. Due to teacher in-service days and the close proximity to the beginning of school, a formal day of training was not possible. However, a meeting was set up with two of the teachers, one of which was moved to a different grade level during the first week of the program. A new teacher at that particular school was selected for us by the principal. During this meeting, a brief overview of the project was presented and teacher expectations were discussed. Due to lack of time, no activities were attempted.

In mid June of 2002, several East Baton Rouge Parish Master Gardeners who were interested in the school garden program set up a propagation meeting to prepare plant materials for the school gardens. Several hours were spent preparing cuttings and divisions of plants to be ready for fall planting. The Master Gardeners brought in herbs and flowering plants from their private collections and donated plants left over from their spring plant sale.

The Junior Master Gardener (JMG) Handbook Level 1 (Whittlesey et al., 1999) for grades 3 through 5 developed at Texas A&M University was the hands-on gardening

curriculum chosen for classroom integration. This program targeted the age group selected and was chosen due to its thoroughness and interesting activities. Only the first four chapters out of the total eight were used in this study as they were introduced in the informal education program. Select activities were chosen and implemented in a fourteen week period (Appendix C). The majority of the activities were taken from the first chapter.

Approximately four hours were spent on activities from the first chapter (Plant Growth and Development), a little less than three hours on the second chapter (Soils and Water), a little over three hours on the third chapter (Ecology and Environmental Horticulture), and approximately two and a half hours on the fourth chapter (Insects and Diseases). While the number of hours spent on the activities was approximately the same, the number of activities performed in that time span was quite a bit different. In addition to the hands-on science activities, garden activities were performed. These were not specified in the JMG program, but were supplemental to the formal activities. Each week, approximately the first hour and a half was used for the JMG program activities and the last half hour was used for garden time.

This program was implemented as an informal education program due to the fact that the activities and concepts were not integrated into the lessons of the students during the week when our volunteers were not present. Volunteers to assist in teaching were from a Louisiana State University horticultural science service-learning class set up to implement the program and East Baton Rouge Parish Master Gardeners. Volunteers from these two groups went into the schools for two hours each week to lead the lessons and work in the gardens. Most of the volunteers had never taught children before and had to be guided in leading the lessons in the beginning. The schools varied in the number of volunteers

assigned; there were three volunteers at Bernard Terrace, five at University Terrace and six at Park Elementary. The presence of the volunteers allowed the classes to be divided into small groups which provided more of a one on one type atmosphere. The presence of the adult volunteers for supervision also allowed for greater management of the fifth grade students while out in the garden. One class had 33 students at the beginning of the year and the presence of the approximately six adult volunteers made working outside very manageable.

The Louisiana State University volunteers were students in a service-learning class developed to support this project. The class met for one hour at the beginning of the week to discuss the lessons to be presented in the schools and to talk about the students' experiences from the previous week. The students were from various backgrounds and varied in age. Most had worked with children in some capacity such as little league sports, but only two had any formal teaching experience. The course material consisted of horticultural science education and learning more about how gardens can fit into the classroom, factors involved in creating school gardens and the effects of gardens on different areas such as nutrition, environmental awareness and interpersonal skills. This was accomplished through the reading of refereed journal publications on the subject and classroom discussion.

The gardening space for each school was standardized with each school having three 4' x 10' garden beds for the students to work in. At two of the schools, the beds were raised and at the third they were in-ground. Prior to the first week of the program, several volunteers went to the schools and built and prepared the beds for use. Students planted herbs such as mint (*Mentha x piperita*), rosemary (*Rosmarinus officinalis* L.), parsley (*Petroselinum crispum*) and basil (*Ocimum basclicum* L.) as well as cool season vegetables such as broccoli (*Brassica oleracea* L.), radishes (*Raphanus sativus*), lettuce (*Lactuca* spp.),

carrots (*Daucus carota* L.), and potatoes (*Solanum tuberosum* L.). The classrooms bought watering cans and were given fish emulsion for fertilizer. It was the responsibility of the teacher and students to make sure the garden was properly watered and fertilized.

Testing for the study consisted of a pre-test at the beginning of the semester on the first day of activities and then a post-test at the end of the fall program. A forty question test developed at Texas A&M University, based on the Junior Master Gardener program, was used for the evaluation (Klemmer, 2002). The testing instrument showed reliability and validity as reported by Klemmer. The test was divided into four, ten question sections covering the first four chapters of the program. Students were given as much time as needed to finish the test, and approximately 50 minutes was the longest duration. For each experimental class there was a corresponding control class within the school. Pre-testing for the control class did not take place until eight weeks into the semester due to time conflicts and the lack of ability to get permission forms returned promptly. Posttesting for the control class was conducted one week after the experimental classes.

The data obtained from the pre and posttest scores of the 62 fifth grade students in the experimental classes and the 57 students in the control classes was analyzed in several different ways. The test results were subjected to an analysis of variance (ANOVA) using the Statistical Analysis System (SAS, 1999) version 8 for Windows. Scores for the 40 point test were multiplied by 2.5 to transform the scores to a 100 point scale. Pretest and posttest scores were compared for both the experimental and control classes to determine a significant difference caused by the treatment of the garden program. A paired t-test was performed on the scores in the experimental classes to compare their pretest scores to their posttest scores and determine if there was a significant difference in the means. The same

paired t-test was performed on the scores from the control classes. Paired t-tests were also performed to determine differences in chapter scores. Upon completion of the program, the LSU students and East Baton Rouge Parish Master Gardeners were given an activity assessment survey for the specific activities performed in the schools to determine their opinion on the activities effectiveness and ease in teaching (Appendix D).

3.3. Results and Discussion

3.3.1. Science Achievement Overall Results

An analysis of variance indicates the effect of the treatment and genders on test scores were not significant (Table 3.2.). The variable pre vs. post is a comparison of the pretest scores and the posttest scores of each student regardless of treatment to determine if there was a difference in the two scores. Analysis indicates there is a significant difference in the increase between the pretest scores and posttest scores of the students. An interaction between the treatment, gender, and the pre vs. post variable was also indicated ($P < 0.0219$). The cause of the interaction between treatment and gender and the pre vs. post variable can be seen in figure 3.1. where the control group females remain level in their pre to posttest scores. When analyzed separately, an increase in mean test scores for the experimental group was found (3.40), while the difference in control group pre and posttest scores (1.18) was not significant (Table 3.3.). Gender was not found to be significant either between or within the genders (Figure 3.1.).

Scores on the blocks of questions derived from material of each chapter were analyzed separately. Analysis of chapter one (Plant Growth and Development) scores using a paired t-test showed a significant difference between the pre and posttest means of the

experimental classes (Table 3.3.). This was expected due to the number of activities performed from chapter one. Almost all of the topics of the chapter one questions had been covered by an activity from the JMG curriculum in the classroom, unlike the other three chapters. No significant difference was found between the pre and posttest means of the control classes. Analysis of chapter two (Soil and Water), chapter three (Ecology and Environmental Horticulture), and chapter four (Insects and Diseases) showed no significant difference between pre and posttest means of either the experimental classes or the control classes. In a previous study, Klemmer (2002) indicated that significant difference in chapter subscores were only found in chapter three.

Table 3.2. ANOVA results of Type III tests of fixed effects showing main effects and interactions between variables.

Effect	df	Den df	F value	Pr > F
gender	1	113	0.39	0.5353
treatment	1	113	3.06	0.0832
treatment*gender	1	113	0.07	0.7924
pre vs. post	1	115	5.86	0.0171*
gender*pre vs. post	1	115	1.46	0.2291
treatment*pre vs. post	1	115	0.20	0.6594
treatment*gender*pre vs. post	1	115	5.40	0.0219*

*significant at 0.05 level

Table 3.3. Science achievement pre- and posttest averages for the experimental and control groups.

Group	N	Pretest^a mean	Posttest mean	df	t value	Level of^b Significance
Experimental	62	38.95	42.35	61	1.9996	0.0167*
Control	57	36.45	37.63	56	2.0032	0.3924

^a scores had a range of 0-100 points

^b two-tail paired t-test

*significant at 0.05 level

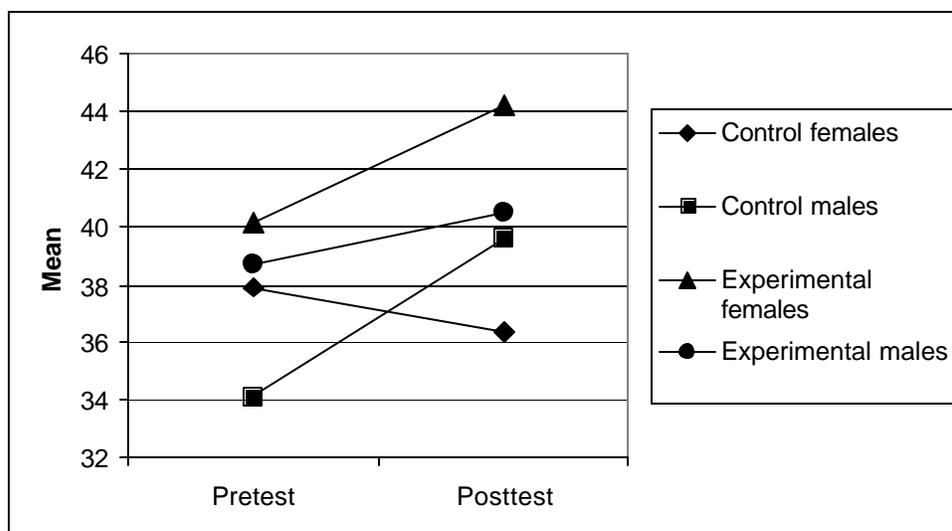


Figure 3.1. Plot of pre and post science achievement test means within experimental and control groups by gender.

Table 3.4. JMG pre- and posttest subscores by chapter for the experimental and control groups.

Chapter	Treatment	N	Pretest ^a mean	Posttest mean	df	t value	Level of Significance ^b
1	Experimental	62	4.23	5.19	61	1.9996	0.0001*
	Control	57	4.34	4.39	56	2.0032	0.9461
2	Experimental	62	3.69	3.90	61	1.9996	0.4087
	Control	57	3.21	3.47	56	2.0032	0.3343
3	Experimental	62	4.10	4.18	61	1.9996	0.7287
	Control	57	3.46	3.90	56	2.0032	0.2078
4	Experimental	62	3.56	3.66	61	1.9996	0.7240
	Control	57	3.33	3.30	56	2.0032	0.8917

^a scores range from 0-10 points

^b two-tailed paired t-test

*significant at 0.01

3.3.2. Science Achievement Test Results of Individual Schools

A paired t-test of the pre and post scores of the science achievement test revealed that the only significant difference in the experimental classes' means occurred at University Terrace Elementary ($P \leq 0.016$) (Table 3.4.). All of the control classes had no significant difference in the pre and posttest means. The highest pre and posttest scores occurred at Bernard Terrace in the control class. The somewhat higher pre-test scores could possibly be explained by the late date at which the test was given at this particular school. All control tests were given eight weeks into the fall semester which is roughly mid-way through. At this point in the year, the class at Bernard Terrace had already completed their science kit about ecology and how ecosystems interact; this subject matter relates directly to the chapter one activities.

Table 3.5. Pre- and posttest science achievement results for each school in both the experimental and control classes.

School	Treatment	N	Pretest ^a Mean	Posttest Mean	df	t value	Level of Significance ^b
Beranard Terrace	Experimental	21	40.73	44.75	20	2.0859	0.1140
	Control	18	44.58	47.78	17	2.1098	0.0738
Park Elementary	Experimental	27	37.50	39.18	26	2.0555	0.4743
	Control	25	35.00	34.10	24	2.0639	0.7366
Universtiy Terrace	Experimental	14	39.10	44.83	13	2.1604	0.0162
	Control	14	28.58	30.90	13	2.1604	0.2790

^a scores ranged from 0-100

^b two-tailed paired t-test

*significant at 0.05 level

Analysis of each of the individual chapter subsections made up of ten questions was also performed on an individual school basis. The chapter one experimental class pre and post scores for individual schools were significant only at Park Elementary (Table 3.6.) Bernard Terrace, however, was significant at the 6% level. While University Terrace was not significant they had the highest pretest score of all on this section and their posttest score

was the highest of all three, but the change was not enough to be significant. None of the control classes had significant differences for chapter one. The results for chapter two (Table 3.7.) and three (Table 3.8.) were not significant for the either control or treatment classes

Table 3.6. Chapter one (Plant Growth and Development) subscores in individual schools for both the experimental and control classes.

School	Treatment	N	Pretest ^a Mean	Posttest Mean	df	t value	Level of ^b Significance
Beranard Terrace	Experimental	21	4.05	4.90	20	2.0859	0.0644
	Control	18	5.11	5.00	17	2.1098	0.7769
Park Elementary	Experimental	27	4.11	5.26	26	2.0555	0.0034*
	Control	25	4.36	4.12	24	2.0639	0.6316
Universtiy Terrace	Experimental	14	4.71	5.5	13	2.1604	0.1107
	Control	14	3.50	3.93	13	2.1604	0.2722

^a scores ranged from 0-10 points

^b two-tailed paired t-test

*significant at the 0.01 level

Table 3.7. Chapter two (Soils and Water) subscores in individual schools for both the experimental and control classes.

School	Treatment	N	Pretest ^a Mean	Posttest Mean	df	t value	Level of ^b Significance
Bernard Terrace	Experimental	21	3.33	4.00	20	-1.6990	0.1048
	Control	18	4.05	4.00	17	0.1124	0.9117
Park Elementary	Experimental	27	3.70	3.93	26	-0.5928	0.5585
	Control	25	3.12	3.12	24	0	1.0000
University Terrace	Experimental	14	4.21	3.71	13	0.8335	0.4196
	Control	14	2.43	3.21	13	-1.3878	0.1886

^a scores ranged from 0-10 points

^b two-tailed paired t-test

Fewer activities (6) were completed from chapter two which covered soil and water. This along with the individual activity assessment results from the volunteers may explain why there were no significant increases. The volunteers responded to the assessment of the activities from chapter two with comments and scores reflecting their beliefs that these activities were not very effective. Average effectiveness scores from the activities ranged

from 3.6 to 4.6 out of 5 with anywhere from 4 to 14 of the 15 volunteers responding (Appendix D).

A limited amount of activities were conducted from chapter three (7) which covered ecology and environmental horticulture. Although seven activities were used from this chapter, only two were actually used to teach concepts. Five of the activities were arts and crafts projects that the students used for their service-learning projects. This could possibly account for the lack of significant change in the chapter three scores from the pre to posttests.

Table 3.8. Chapter three (Ecology and Environmental Horticulture) subscores in individual schools for both the experimental and control classes.

School	Treatment	N	Pretest^a Mean	Posttest Mean	df	t value	Level of^b Significance
Bernard Terrace	Experimental	21	4.67	4.24	20	1.1828	0.2508
	Control	18	3.95	2.71	17	-1.7453	0.4554
Park Elementary	Experimental	27	3.85	4.07	26	-0.6051	0.5503
	Control	25	3.32	3.60	24	-0.5244	0.6048
University Terrace	Experimental	14	3.71	4.29	13	-1.1698	0.2631
	Control	14	3.07	2.71	13	0.7694	0.4554

^a scores ranged from 0-10 points

^b two-tailed paired t-test

University Terrace Elementary had a significant positive difference in the pre and post means for chapter four. Park Elementary, however, was significant with a negative change in pre and post scores. As an addition to the gardening curriculum, an entomologist was brought into two of the three schools during the time Chapter 4 (Insects and Diseases) activities were being covered. The entomologist brought in live specimens for the students to see and touch and also presented an entertaining lecture. Park Elementary was the one school where an entomologist did not visit the class due to scheduling conflicts.

Table 3.9. Chapter four (Insects and Diseases) sub scores in individual schools for both the experimental and control classes.

School	Treatment	N	Pretest ^a	Posttest	df	t	Level of ^b
			Mean	Mean			value
Bernard Terrace	Experimental	21	4.24	4.76	20	-1.4712	0.1568
	Control	18	4.37	4.42	17	-0.1095	0.9140
Park Elementary	Experimental	27	3.33	2.41	26	2.0894	0.0466*
	Control	25	3.20	2.80	24	0.9341	0.3595
University Terrace	Experimental	14	3.00	4.43	13	-3.3333	0.0054*
	Control	14	2.43	2.50	13	-0.1324	0.8967

^a scores ranged from 0-10 points

^b two-tailed paired t-test

*significant at the 0.05 level

** significant at the 0.01 level

Individual students' pre and posttest science achievement scores were ranked in six categories of change in scores (Table 3.9.). The six categories were; no change, increased 1-4 points, increased 5-9 points, increased 10-14 points, decreased 1-4 points, decreased 5-9 points, and decreased 10-14 points. Ranking changes in pre/posttest scores assists in evaluating students' response over time. For the total experimental student population, the highest percentage of students (37%) increased their pretest score by one to four points. While comparing the experimental and control populations, both groups have similar percentages in each range with the exception of those students who had no change. In the no change range, the control population (16%) had a higher percentage than the experimental population (6%).

The ranking of changes in test score ranges for individual schools indicates that the majority of experimental class students at Bernard Terrace elementary school changed one to four points upward (43%) or downward (29%). At Park Elementary the ranges of pre to post-test change were more evenly distributed. The highest percentage of students (30%), increased their posttest score by five to nine points, while 26% of the students decreased by

one to four points. Sixty-four percent of students at University Terrace elementary school increased their score by one to four points from pretest to posttest. The trends show that a higher percentage of students in the control classes decreased their scores by larger numbers than those in the experimental classes and that the control classes had a higher number of students that had no change between pre and posttest scores. These numbers also show that the most common ranges of change either up or down are from one to four points.

Table 3.10. Student test score change between pre and post science achievement tests.

School	Treatment	No Change	Up 1-4	Up 5-9	Up 10-14	Down 1-4	Down 5-9	Down 10-14
	%.....						
Total	Experimental	6	37	21	3	23	10	0
	Control	16	32	18	2	21	11	2
Bernard Terrace	Experimental	5	43	10	10	29	5	0
	Control	17	44	17	0	22	0	0
Park Elementary	Experimental	11	19	30	0	26	15	0
	Control	12	24	16	4	16	24	4
University Terrace	Experimental	0	64	21	0	7	7	0
	Control	21	29	21	0	29	0	0

3.3.3. Discussion

There was a significant increase ($P \leq 0.0167$) in the experimental group pre and posttest scores while the control group had no significant differences. The results from the ANOVA showed no significant difference in test scores due to treatment, but several factors could have attributed to this. Two of the variables that possibly influenced the test results were the experience of the volunteers in formal education and the level of teacher

participation and follow-up during the week. In all but five out of fifteen cases, the volunteers that went into the schools to work with the students had no formal training in education. It is possible that the students, even though engaged in hands-on activities, did not receive the full benefit due to lack of proper teaching techniques and the inability of the volunteers to explain concepts at the 5th grade students' level. Another variable, teacher participation, could also have played a role in the posttest outcomes. In this study, there was very little, if any, continuity between the gardening activities and the normal curriculum activities. Only one of the three teachers reported to have used concepts introduced through the JMG curriculum activities into the classroom during the remainder of the week.

A study conducted in Virginia asked teachers what factors played a role in the decision to use a school garden (DeMarco, et al., 1999). Among the factors listed by the teachers as extremely important were someone who was responsible for the garden and students' ownership in their learning through the garden. In this study, it sometimes may have seemed unclear who was responsible for the garden. In at least one school, students were not allowed to check their garden during the week so watering was not done until "gardening time" during the once a week session with the volunteers. The lack of teacher involvement also led to a minimal amount of student ownership in the garden. The program was sometimes seen by the students more as something fun to do, than a time to learn.

The teachers used the garden to different degrees, but the overall lack of continuity between the garden and the everyday classroom was most likely the greatest disadvantage to this study. Butts and Hofman (1993) expressed the need for hands-on activities to be followed with discussion and explanation of what has been experienced. The authors specifically discussed helping children address or change misconceptions, but their ideas can

also be applied to learning situations in general. To help them unlearn, educators must provide a hands-on example as well as engage the mind to make science ‘brains-on’ too. The authors suggest that it is the discussion and what is said after the hands-on activity that produces the true learning of the concept. Educators simply cannot give the students hands-on activities and expect them to learn the concept. Unfortunately, there was little or no discussion or reinforcement of concepts introduced through the gardening curriculum and activities in the classroom in this study.

Another factor would be the lack of incentive for the students to answer to the best of their ability on the achievement test. The students knew that the test would have no effect on their science grade and was purely for our research purposes. It is very possible that this factor is the reason for the increase in male, control class test results from pre to posttest. During the pretesting, it was observed in some control classrooms that because there were no incentives for accuracy and completeness, they would just rush through the test so that they could play on the computer or finish other class work. The only rewards provided for taking the test included a bookmark donated by the American Society of Plant Biologists after the students finished the pretest and cupcakes after completing the posttest. These bookmarks explained one of seven of the twelve principles of plant biology that they have developed as basic plant biology concepts for the kindergarten through twelfth grade levels.

The only study similar to the current study was conducted by Klemmer (2002) at Texas A&M University. Klemmer’s population sample was much larger with a total population of 647 students, 453 in the experimental classes and 194 in the control classes, compared to our 62 students in the experimental classes and 57 students in the control classes. Klemmer’s population consisted of 3rd, 4th, and 5th grade students while our study

focused solely on 5th grade. Where Klemmer did only posttesting at the end of the year long use of a garden program, our study did pre and posttesting over a semester long garden program. The use of a garden and the degree to which the JMG curriculum were used depended upon the teacher. The current study utilized community volunteers, specifically East Baton Rouge Parish Master Gardeners and Louisiana State University students, to present the program with varied, but minimal participation of the teachers. Klemmer's study reflected the use of a school garden in a normal setting with the classroom teacher as the leader and integration of the gardening curriculum into normal classroom curriculum. Significant differences were found between control and experimental populations in Klemmer's study overall, and most of the change was found at the 5th grade level. In analyzing differences between genders, Klemmer found statistical significance between males in the experimental and control groups at all three grade levels and in females in the experimental and control groups only in the 5th grade. Our study showed a trend of increases between pre and posttest scores in experimental and control group males and in experimental class females; control class females remained almost the same.

Despite the limited amount of research that has been conducted to quantify the benefits of a school garden, many educators are convinced that a garden is worth the effort. Responses to a Florida survey in 1998 (Skelly and Bradley, 2000) indicate that while most of the respondents used their garden only about one hour per week, many of these educators realized the benefits of gardening to their students. This survey and the many articles written by educators on the positive effects seen in their students attest to the limited documentation of benefits to students.

3.4. Conclusions

Our study looked specifically at predominantly African American students in low-income area, inner-city schools, with some of the students being from disadvantaged backgrounds. We felt that these are the students who truly need educators to find new ways of engaging their students in science learning activities. This study shows that even with instructors who had little background in teaching methods and a once weekly amount of gardening time for the students, some improvement in science achievement test scores can be made. Positive results have been seen in other studies and accounts of gardens; however, more research needs to be conducted in this area before researchers can definitively say that gardens increase science achievement or achievement scores. Hopefully, in the future, more states will follow California, which formally recognized a garden's benefit to nutrition education in 2000, in formally accepting the benefits of school gardens.

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CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

The introduction of a garden program showed no statistically significant difference, but the change in mean science achievement test scores from pre to posttest was significant in the experimental classes while not significant in the control classes. Females in the experimental classes appear to have benefited slightly more than the males, although both increased from pre to posttest. At a time when many young girls begin to dislike science, this is very important and warrants further investigation.

Observations made during the study have led this researcher to propose recommendations for future research:

1. Evaluate long term retention of knowledge gained through the use of a garden through multiyear studies.
2. Match state and national benchmarks and standards to activities provided in gardening curriculums to assist teachers in understanding how the activities help teach the required material.
3. Verify previous research on environmental attitudes, interpersonal relationships, attitude toward school and science achievement.
4. Investigate differences in achievement and attitude between and within genders.
5. Investigate the effects of school gardens at different locales; urban schools versus suburban or rural schools.
6. Evaluate the effects of school gardens on special groups of students (e.g. gifted and talented, disabled, learning impaired, underachieving).

7. Investigate the effects of outside volunteers brought in to work with school gardens and their effectiveness as mentors.
8. Investigate whether or not the level of integration of a school garden across the curriculum has an effect on the students' attitude and/or achievement test scores.
9. Examine the effect of class size on the effectiveness of a garden program.
10. Explore the differences in the type of garden or habitat used to teach (e.g. habitat, vegetable garden, butterfly garden, container garden) on students' attitude and/or achievement test scores.
11. Investigate differences between using solely the Junior Master Gardener teacher's manual as opposed to using the student handbooks along with the teacher's manual.

The study results indicate that even once weekly involvement in gardening activities and hands-on activities helped improved science achievement test scores. This is in spite of many variables which may or may not have influenced the outcome of the study. Further research must be conducted to examine and document the benefits of gardening for students of all ages. There are many areas still yet to be examined in relation to school gardens. Children are our future and they deserve our time to find improved ways for them to learn.

APPENDIX A
PERMISSION FORMS

Parental Permission Form

- Project Title:** The Effects of School Gardening on 5th Grade Science Tests Scores.
- Performance Site:** Brownfields Elementary, Bernard Terrace Elementary, Park Elementary, and University Terrace Elementary
- Investigator:** The following investigator is available for questions, M-F, 8:00a.m. – 4:00p.m.
Leanna Smith
Louisiana State University – Horticulture Department
(225) 578-1037
- Purpose of the Study:** To gather statistical and qualitative data on the effects of a school gardening curriculum in four East Baton Rouge Parish 5th grade classrooms.
- Inclusion Criteria:** Children in the selected 5th grade classrooms at the participating elementary schools.
- Description of the Study:** At the beginning of the school year, participating students will be given three tests; one to determine science aptitude, one to their attitude toward science, and one to determine their attitude toward the environment. The students will also be given a survey to determine the extent of their gardening experience and their idea of a garden. Throughout the first four months of the school year students will participate in weekly gardening activities based on the Junior Master Gardener[®] program. Students from an LSU class and Master Gardeners will be present at each school one day a week for gardening activities. At intervals during the four months of the study, the students will be asked to complete drawing tests and do simple concept mapping to gauge comprehension of the science concepts being taught. At the end of the study, students will be given the same three tests that were given at the beginning and scores will be compared to evaluate any changes. None of these tests will be graded by the teacher or have any influence over the student's grade in science.
- Benefits:** Students will be able to work outside in a fun environment with the possibility of improving their classroom science scores.
- Risks:** There are no known risks.
- Right to Refuse:** Participation in this study is voluntary, and a child will become part of the study only if both child and parent agree to the child's participation. At any time either the child may withdraw from the study or the child's

parent may withdraw the child from the study without penalty or loss of any benefit to which they might otherwise be entitled.

Privacy: Results of the study will be published, but no names or identifying information will be included for publication. Subject identity will remain confidential unless disclosure is required by law. Photographs may be taken of students participating in activities for research presentations, but no names or identifying information will accompany the photographs.

Financial Information: There is no cost for participation in the study, nor is there any compensation to the subjects for participation.

Signatures:

I have read the above information pertaining to the study and all my questions have been answered. I may direct additional questions regarding study specifics to the investigator. If I have questions about subjects' rights or other concerns, I can contact Robert C. Matthews, Chairman, Institutional Review Board, (225) 578-8692. I will allow my child to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Parent's Signature _____ Date _____

The parent/guardian has indicated to me that he/she is unable to read. I certify that I have read this consent form to the parent/guardian and explained that by completing the signature line above he/she has given permission for the child to participate in the study.

Signature of Reader _____ Date _____

Student Assent Form

I, _____, agree to let my answers on a science test, an environmental attitude test and a gardening survey be used in a study conducted by Leanna Smith from Louisiana State University. I understand that my answers will be anonymous and my teacher will not see my grade. I can decide to stop being in the study at any time without getting in trouble.

Child's Signature _____ Age _____ Date _____

Witness _____ Date _____

(Witness must be present for the assent process, not just the signature by the minor.)

Experimental Group

August 24, 2002

Dear Parent(s),

My name is Leanna Smith and I am conducting research on the introduction of school gardens into elementary schools and their effects on science and environmental test scores. To gauge the differences in test scores I must have a control group which does not participate in the gardening. I am asking for your permission to use your child's test scores and survey answers in my study for the control group. While your child will not be participating in the actual gardening activities his/her answers on the tests are still valuable to my research. These tests will not affect your child's school grades in any way and will only be seen by me. Attached is a copy of the parental permission form with a brief description of the project. Included on the form is my contact information at Louisiana State University. Please feel free to contact me with any questions you may have. I would greatly appreciate your cooperation. Thank you.

Sincerely,

Leanna Smith

Student Assent Form

I, _____, agree to let my answers on a science test, an environmental attitude test and a gardening survey be used in a study conducted by Leanna Smith from Louisiana State University. I understand that my answers will be anonymous and my teacher will not see my grade. I can decide to stop being in the study at any time without getting in trouble.

Child's Signature _____ Age _____ Date _____

Witness _____ Date _____

(Witness must be present for the assent process, not just the signature by the minor.)

Control Group

APPENDIX B

**JUNIOR MASTER GARDENER SCIENCE ACHIEVEMENT TEST
GRADE 5**

Science Achievement Test
Grade5

Please fill in the circle next to the response that you think best answers the question.

- 1) Plants are important to all life because they take in _____ and give off _____
- A) oxygen, carbon dioxide.
 - B) carbon dioxide, oxygen.
 - C) ozone, carbon dioxide.
 - D) water, carbon dioxide.
- 2) All of the food that we eat can be traced back, either directly or indirectly to _____
- A) animals.
 - B) people.
 - C) plants.
 - D) minerals.
- 3) A fruit is one of the parts of a plant. From which part of the plant is the fruit generated?
- A) petals
 - B) flower
 - C) root
 - D) stem
- 4) A cotyledon is the part of the seed that stores food for use by the baby plant, or embryo. What do you predict would happen if you removed the cotyledons from a bean seed and then planted it?
- A) The embryo would keep on growing because it's still alive.
 - B) The seed coat would hold the embryo so it could keep growing.
 - C) The embryo would not grow because the stored food was removed.
 - D) The cotyledons would grow back.

- 5) If all of the leaves are removed from a plant, what do you predict will happen?
- A) The plant will grow more quickly because it does not have to support leaves.
 - B) The plant will die because it has no leaves to make food for itself.
 - C) The plant will die because all the sap will run out.
 - D) None of the above statements are correct.
- 6) Plants use solar energy from the sun to do what?
- A) Make their own water through photosynthesis.
 - B) Make their own water through respiration.
 - C) Make their own food through photosynthesis.
 - D) Make their own food through respiration.
- 7) All of the following foods can technically be considered fruits **EXCEPT** _____
- A) cucumber.
 - B) tomato.
 - C) spinach.
 - D) apple.
- 8) Every part of a plant has a function and a purpose. For example, the purpose of a flower is to _____.
- A) to smell good.
 - B) to be pretty.
 - C) to make seeds.
 - D) to be colorful.
- 9) A model representing all the parts of a plant would need to include _____
- A) roots, stems, leaves, flowers, fruits, and seeds.
 - B) roots, stems, leaves, tubers, fruits, and seeds.
 - C) roots, petioles, leaves, flowers, fruits, and seeds.
 - D) roots, stems, leaves, flowers, nodules, and seeds.

- 10) An aquarium is a created habitat, with each component playing a role. How are the fish in an aquarium helped by adding plants?
- A) The plants release carbon dioxide into the water.
 - B) The plants release oxygen into the water.
 - C) The plants release algae into the water.
 - D) The plants make the aquarium look pretty.
- 11) Soil is made up of rock particles, minerals, and decayed _____ and animal material.
- A) rock.
 - B) dirt.
 - C) mud.
 - D) plant.
- 12) Another word for rain is _____
- A) precipitation.
 - B) transpiration.
 - C) evaporation.
 - D) respiration.
- 13) What causes water vapor to condense?
- A) decrease in temperature
 - B) increase in temperature
 - C) precipitation from the clouds
 - D) rise in air pressure
- 14) Garden plants get _____ from the soil and from _____ that we give them.
- A) nutrients, fertilizer
 - B) fertilizer, nutrients
 - C) nutrients, light
 - D) fertilizer, water

- 15) Plants play an important role in preventing soil erosion because their roots _____
- A) channel rainwater away from the plant.
 - B) hold the soil in place.
 - C) create a trench for the rainwater.
 - D) dry the soil around the plant.
- 16) Soil can be improved for use in a garden by adding _____
- A) organic material.
 - B) inorganic material.
 - C) seeds.
 - D) more rocks.
- 17) If you want to examine the tiny particles that make up your garden soil, which of the following tools would you use?
- A) telescope
 - B) compass
 - C) meter stick
 - D) microscope
- 18) Some organisms play an important role in the life cycle of plants by breaking them down and recycling them into organic matter after the plants die. These recycling organisms are called _____
- A) decomposers.
 - B) beneficials.
 - C) pests.
 - D) insects.
- 19) A soil with a large percentage of clay in it will feel _____
- A) gritty.
 - B) slick.
 - C) crumbly.
 - D) soggy.

- 20) Water is taken into a plant through its roots, and is released from the plant through its _____
- A) leaves.
 - B) fruit.
 - C) seeds.
 - D) roots.
- 21) The place where a plant or animal lives is called it's _____
- A) house.
 - B) food chain.
 - C) habitat.
 - D) environment.
- 22) Recycling is an important way to help the environment. A good recycling program has three components, called the "Three R's of Recycling." What are they?
- A) Readin', 'Riting, and 'Rithmetic
 - B) Reduce, Reuse, and Recycle
 - C) Respond, Reproduce, and Regulate
 - D) Repeat, Renew, and Rotate
- 23) A plant is a living organism that needs to take in _____ in order to live.
- A) oxygen
 - B) carbon dioxide
 - C) carbon monoxide
 - D) oxygen monoxide
- 24) All living organisms must eat. Animals, which are living organisms, either eat plants or they eat other animals. Plants, which are also living organisms, make their own food through a process called _____
- A) oxidation
 - B) transpiration
 - C) photosynthesis
 - D) electrosynthesis

- 25) An ecosystem is made up of many organisms that interact with each other in the same environment. What do you think would happen to an ecosystem if all the plants in it were killed?
- A) The ecosystem would stay the same.
 - B) The ecosystem could not survive.
 - C) The ecosystem would survive.
 - D) None of the above things would happen.
- 26) Which of the following components of a garden system could be called a living system in itself?
- A) soil
 - B) water
 - C) plants
 - D) nutrients
- 27) Imagine that you are a gardener and that you live in an area that is dry, with frequent droughts. Based on what you know, which watering schedule below makes the most sense if you want to conserve water?
- A) every day, watering for at least an hour
 - B) twice a week, watering for six hours
 - C) twice a week, watering for a half hour
 - D) once a month, watering for a day
- 28) As plant material is decomposed through composting, it gives off energy in the form of _____
- A) light energy
 - B) heat energy
 - C) food energy
 - D) solar energy

- 29) To measure the rate of growth of the plants that you plant in your garden, which of the following instruments could you use?
- A) meter stick
 - B) thermometer
 - C) stop watch
 - D) calculator
- 30) Which of the following plant traits is **NOT** inherited?
- A) flower color
 - B) fruit type
 - C) leaf shape
 - D) insect damage
- 31) The three body parts of all insects are _____, _____, and _____
- A) head, thorax, abdomen.
 - B) head, cephalothorax, abdomen.
 - C) head, wings, tail.
 - D) head, abdomen, spinnerets.
- 32) Butterflies go through complete metamorphosis, which has four stages, which are:
1) _____, 2) _____, 3) _____, 4) _____.
- A) adult, larva, pupa, egg.
 - B) larva, egg, pupa, adult.
 - C) egg, pupa, larva, adult.
 - D) egg, larva, pupa, adult.
- 33) Carpenter Bees are actually flies that have adapted to look like bumble bees so that birds do not try to eat them. They cannot sting, but they look as if they could! This type of adaptation is called _____
- A) symmetry.
 - B) cheating.
 - C) hiding.
 - D) mimicry.

- 34) You find a pill bug, or doodle bug, in your garden. It has ten body segments and twenty legs. You know for sure that it is **NOT** _____
- A) an insect.
 - B) an isopod.
 - C) an arthropod.
 - D) a crustacean.
- 35) If you draw a line down the middle of an insect, both sides will be exactly the same. This type of body arrangement is called _____
- A) symmetrical arrangement.
 - B) asymmetrical arrangement.
 - C) unimmetrical arrangement.
 - D) polysymmetrical arrangement.
- 36) Aphids have infested the roses in your garden. You know that aphids are a pest insect that can damage your roses, and there are lots of them. Which of the following methods of control would be the **SAFEST** for the environment?
- A) Spray them with a pesticide to kill them.
 - B) Spray them with oil to suffocate them.
 - C) Spray them with water to try to knock them off the roses.
 - D) Spray them with alcohol to kill them.
- 37) You and your classmates are going to conduct a survey of a nearby park to see what types of insects you can find there. Before going, you need to make a list of safety rules that you will all agree to follow. Which of the following would **NOT** be a good rule to include in your list?
- A) Wear a long-sleeved shirt and pants so that you do not get scratched or bitten.
 - B) Spray yourself with insect repellent to avoid being bitten or stung.
 - C) Feel under logs with your hands to check for insects that might live there.
 - D) Stay with a partner at all times, so that one of you can go for help if needed.

- 38) Although we often think of insects as pest, most insects are actually beneficial. Which of the following is **NOT** a benefit provided by insects?
- A) Many insects are pollinators.
 - B) Insects are food for organisms higher up in the food chain.
 - C) Many insects are beneficial organisms that feed on pest insects.
 - D) All of the above are correct.
- 39) If there is a change in the food chain, the result can affect people as well as the plants and animals lower in the food chain. For example, if you live on a farm, and there is a decrease in the population of birds that feed on an insect that eats your crops, what might be the effect on your crops?
- A) There would be an increase in insects, and you would lose income.
 - B) There would be a decrease in insects, and you would lose income.
 - C) There would be an increase in insects, and you would increase your income.
 - D) There would be an decrease in insects, and you would increase your income.
- 40) You have discovered a new insect called the School Bug. You are trying to describe its life cycle. How many School Bugs will you need to look at to know that you have described it correctly?
- A) None, you can read about it in a book.
 - B) One School Bug insect, because they are all alike.
 - C) Two School Bug insects, so you can look at both males and females.
 - D) As many School Bug insects as possible, in case the individuals vary.

APPENDIX C
CHAPTER SUMMARIES OF ACTIVITIES

Chapter 1 (**Plant Growth and Development**) Summary of Lessons

Activity	Time	Objective
Hamburger Plant	30 minutes	To learn that we depend on plants as the original source of most food.
The Choo-Choo Song	15 minutes	To associate a variety of plants with their food products by learning a rhythm.
The Medicine Plant	30 minutes	To recognize the medicinal properties of the aloe vera plant.
Leaf-and-Seed Information Chart	25 minutes	To be able to classify leaves and seeds as monocots or dicots.
Plant Parts Rap	15 minutes	To learn the main parts of a plant and their roles.
Seed Science	30 minutes	To use the scientific method to determine the effect on plant growth of removing the cotyledon from seeds.
Flower Dissection	30 minutes	To identify the different parts of a flower.
Picture Yourself a Plant	30 minutes	To show an understanding of plant needs through creative arts.
Coconut Float	15 minutes	To illustrate the different ways seeds are dispersed.
Oxygen Factory	25 minutes	To illustrate the process of photosynthesis.
Total Time	4 hours 5 minutes	

Chapter 2 (**Soils and Water**) Summary of Lessons

Activity	Time	Objective
Shake, Rattle and Roll	20 minutes	To identify the amounts of soil particles that makes up a soil's texture.
Making a List (Individual)	15 minutes	To illustrate the various components that makes up soil.
Water Cycle (Individual)	30 minutes	To identify the steps in the water cycle.
Cloud Maker	40 minutes	To use a model to demonstrate the condensation process.
The Cycle Song	15 minutes	To gain understanding of the water cycle through music.
Out of the Spout	40 minutes	To understand how water moves through different soil textures.
Total Time	2 hours 40 minutes	

Chapter 3 (**Ecology and Environmental Horticulture**) Summary of Lessons

Activity	Time	Objective
Nature Class Web	20 minutes	To create a web to understand the interrelatedness of life on earth.
The Food Chain Gang	25 minutes	To play a game that represents the interrelatedness within the food chain between animals and the environment.
Grow Cards	20 Minutes	To recycle newspaper to create plantable greeting cards.
Know & Show Recycling Sombrero	30 minutes	To create wearable works of art that display recyclable materials.
Nature Windows	30 minutes	To create art using natural materials.
Nature Masks	30 Minutes	To create wearable art using natural materials.
Seeds Magnets	30 minutes	To create art using natural materials.
Total Time	3 hours 5 minutes	

Chapter 4 (**Insects and Diseases**) Summary of Lessons

Activity	Time	Objective
The Great Cover-Up!	30 Minutes	To learn and understand the concept of camouflage.
Secret Smells Game	30 Minutes	To discover how insects use pheromones to communicate.
Metamorphosis Bracelets and Belts	30 minutes	To learn the stages of metamorphosis.
Chew on This!	30 Minutes	To learn the four types of insect mouthparts and how they are specialized.
Insect Body Parts (Modification of Insect Predictions and Survey)	30 minutes	To learn the body parts of insects by labeling and discussion.
Total Time	2 hours 30 minutes	

APPENDIX D

POST PROJECT JUNIOR MASTER GARDENER ACTIVITY ASSESSMENT

JMG Activity Assessment

This is an assessment survey of all the activities we have covered at the elementary schools this semester. Your input is very important, so please take the time to think about your answers.

Next to each activity name are two sets of numbers.

The first row of numbers relates to how easy you think the activity was to teach. **One means very hard and five means very easy.**

The second row of numbers relates to how effective you think the activity was for the students, **one being not effective at all and five being very effective.** *If you were not present for an activity or we did not do the activity at your school, please put N/A in the comments section.*

1. Hamburger Plant	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness (1=not effective; 5 = very effective)

Comments:

2. Choo-Choo Song	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness (1=not effective; 5 = very effective)

Comments:

3. Medicine Plant	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness (1=not effective; 5 = very effective)

Comments:

4. Plant Parts Rap	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy) Effectiveness (1=not effective; 5 = very effective)
	1	2	3	4	5	

Comments:

5. Leaf and Seed Info Chart	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy) Effectiveness (1=not effective; 5 = very effective)
	1	2	3	4	5	

Comments:

6. Seed Science	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy) Effectiveness (1=not effective; 5 = very effective)
	1	2	3	4	5	

Comments:

7. Flower Dissection	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy) Effectiveness (1=not effective; 5 = very effective)
	1	2	3	4	5	

Comments:

8. P.L.A.N.T Needs	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy) Effectiveness (1=not effective; 5 = very effective)
	1	2	3	4	5	

Comments:

9. Coconut Float	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy) Effectiveness (1=not effective; 5 = very effective)
	1	2	3	4	5	

Comments:

10. Oxygen Factory		1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy) Effectiveness (1=not effective; 5 = very effective)
		1	2	3	4	5	

Comments:

11. Shake, Rattle, and Roll		1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy) Effectiveness (1=not effective; 5 = very effective)
		1	2	3	4	5	

Comments:

12. The Numbers on the Bag	1	2	3	4	5	Ease in Teaching
						(1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness
						(1=not effective; 5 = very effective)

Comments:

13. The Water Cycle	1	2	3	4	5	Ease in Teaching
						(1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness
						(1=not effective; 5 = very effective)

Comments:

14. Cloud Maker	1	2	3	4	5	Ease in Teaching
						(1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness
						(1=not effective; 5 = very effective)

Comments:

15. The Cycle Song	1	2	3	4	5	Ease in Teaching
						(1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness
						(1=not effective; 5 = very effective)

Comments:

16. Out of the Spout	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness (1=not effective; 5 = very effective)

Comments:

17. Nature Class Web	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness (1=not effective; 5 = very effective)

Comments:

18. The Food Chain Gang	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness (1=not effective; 5 = very effective)

Comments:

19. Grow Cards	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness (1=not effective; 5 = very effective)

Comments:

20. Know and Show Sombrero	1	2	3	4	5	Ease in Teaching
						(1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness
						(1=not effective; 5 = very effective)

Comments:

21. Nature Windows	1	2	3	4	5	Ease in Teaching
						(1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness
						(1=not effective; 5 = very effective)

Comments:

22. Nature Masks	1	2	3	4	5	Ease in Teaching
						(1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness
						(1=not effective; 5 = very effective)

Comments:

23. The Great Cover-Up!	1	2	3	4	5	Ease in Teaching
						(1= very hard; 5 = very easy)
	1	2	3	4	5	Effectiveness
						(1=not effective; 5 = very effective)

Comments:

24. Secret Smells Game	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	

Comments:

25. Metamorphosis Bracelets and Belts	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	

Comments:

26. Chew on This	1	2	3	4	5	Ease in Teaching (1= very hard; 5 = very easy)
	1	2	3	4	5	

Comments:

APPENDIX E

POST-PROJECT ACTIVITY ASSESSMENT RESPONSES

Summary of Responses to JMG Activity Assessment Survey

Activity	# of volunteers responding	Ease in Teaching Average	Effectiveness Average
<u>Chapter One (Plant Growth and Development)</u>			
Hamburger Plant	14	4.6	4.5
Choo-Choo Song	12	4.1	3.7
Medicine Plant	13	4.3	4.5
Plant Parts Rap	14	4.1	3.8
Leaf and Seed Info Chart	15	4.1	4.1
Seed Science	14	4.0	4.1
Flower Dissection	11	3.9	3.9
P.L.A.N.T. Needs	9	4.2	4.4
Coconut Float	7	4.6	4.7
Oxygen Factory	14	4.0	4.1
<u>Chapter Two (Soils and Water)</u>			
Shake, Rattle, and Roll	13	3.9	4.1
The Numbers on the Bag	4	4.5	4.5
The Water Cycle	14	4.1	4.6
Cloud Maker	14	3.4	3.6
The Cycle Song	13	4.1	4.1
Out of the Spout	10	4.4	4.4
<u>Chapter Three (Ecology and Environmental Horticulture)</u>			
Nature Class Web	12	3.9	4.0

Activity	# of volunteers responding	Ease in Teaching Average	Effectiveness Average
The Food Chain Gang	14	4.3	4.3
Grow Cards	8	4.6	4.5
Know and Show Sombrero	11	4.6	4.4
Nature Windows	12	4.4	4.3
Nature Masks	13	4.5	4.2
<u>Chapter Four (Insects and Diseases)</u>			
The Great Cover-Up!	9	4.7	4.8
Secret Smells Game	8	3.6	3.7
Metamorphosis Bracelets and Belts	9	4.1	4.3
Chew on This	12	4.7	4.8

VITA

Leanna Lynn Smith was born in Longview, Texas, in 1979. She spent most of her life in Queen City, Texas, and after high school graduation attended Stephen F. Austin State University in Nacogdoches, Texas. She received her Bachelor of Science in Agriculture degree in May of 2001. In August of 2001, she began graduate studies in horticulture at Louisiana State University in Baton Rouge, Louisiana, under the direction of Dr. Carl Motsenbocker. At the summer commencement in 2003, she will be awarded the Master of Science degree in the field of horticulture.