Applied Environmental Education and Communication, 6:97–104, 2007

ISSN: 1533-015X print / 1533-0389 online
DOI: 10.1080/15330150701319438

The Growing Phenomenon of School Gardens: Measuring Their Variation and Their Affect on Students' Sense of Responsibility and Attitudes Toward Science and the Environment

Sonja M. Skelly, *Cornell Plantations and Department of Horticulture, Cornell University, Ithaca, New York, USA*
Jennifer Campbell Bradley

This article summarizes a 2000 study of school garden programs and their variation and the impact of such variation on 427 third-grade students' sense of responsibility and attitudes toward science and the environment. A teacher questionnaire was developed to gain insight into how teachers use school gardens with their students and in their curriculum. The information gathered from 28 third-grade teachers was used to develop a classification framework or typology of garden types that served as the independent variable of analysis. Data on school garden program variation was simplified into a typology based on intensity, measured by the number of garden-related activities students participated in prior to and while in the garden (high, medium, and low), and the form of school gardens (flower, vegetable, or combination flower/vegetable), resulting in nine garden types. Analysis of covariance tests were used to determine if there were significant differences in the nine types of school gardens. Significant differences were found in the school garden types and students' attitudes toward science and attitudes toward the usefulness of science study. Although there were no significant differences in school garden types and students' responsibility scores and environmental attitudes, scores for each of these elements were very high (indicating a sense of responsibility and a positive environmental attitude) with little variation.

Address correspondence to **Sonja Skelly**, Cornell Plantations, Cornell University, One Plantations Road, Ithaca, NY 14850, USA. E-mail: sms92@cornell.edu

INTRODUCTION

"A garden is a wonderfully interesting and exciting place in which children can play, work, and learn" (Herd, 1997, 6). Schools and teachers have been using gardens to teach their students since the early 1900s (Subramaniam, 2002). Throughout the past 200 years, school gardening has been championed by many teachers who believe school gardens provide the best way to enhance classroom lessons (Becker, 1995; Berghorn, 1988; Braun et al., 1989; Canaris, 1995; Gwynn, 1988; In Virginia, 1992; Neer, 1990; Stetson, 1991). Today the practice is becoming more widespread. For example California has implemented a "garden in every school" initiative so that every one of the 8,000 public schools in the state of California either has a school garden, has one being installed, or has plans to install a garden (Peyser & Weingarten, 1998).

Research with teachers has shown that they use school gardens to enhance the learning of their students, promote experiential learning, and teach environmental education (DeMarco, 1999; Skelly & Bradley, 2000). Studies have also found that using school gardens to teach does in fact improve students' learning (Sheffield, 1992) and environmental dispositions (Alexander et al., 1995; Barker, 1992; Skelly & Zajicek, 1998; Waliczek, 1997; Wotowiec, 1975). The research exploring the benefits of school gardens has not, however, examined the role of school garden variation in the students' development of responsibility, and the garden's impact on attitudes toward science and environmental attitudes.

To further understand school gardening programs and their potential impact on students participating in them, researchers conducted a 2000 study of Florida elementary school garden programs. The objectives of the study were to understand the variation in school garden programs, classify the variation and use the classification of between group covariance to assess the impact, if any on students' sense of responsibility and attitudes toward science and the environment.

METHOD

Participants for the study were drawn from elementary schools in Florida participating in the Florida School Garden Competition, a program hosted by the University of Florida's Department of Environmental Horticulture and the EPCOT® International Flower and Garden Festival, and the Project SOAR (Sharing Our Agricultural Roots) school gardening program, an agricultural outreach program of the University of Florida's Everglades Research and Education Center. The participant group for this study consisted of 28 teachers and 427 third-grade students. The average age of students was 9.01 and all students were enrolled in the third grade. Of the participants, 47.2% were male and 52.8% were female. The majority of the students were white (73.6%), with a small percentage of African American (15.6%), Native American (3.7%), Hispanic (6.0%), and Asian (1.1%). Most schools were located in residential areas (85.7%) with fewer in rural areas (14.3%). No other social or cultural data on schools were collected.

Measuring the Dependent Variables

Responsibility scores and attitudes toward science and the environment of 427 third-grade students were examined. To measure these variables, a student survey was adapted from several indices. Four statements from the Search Institute's *Profiles of Student Life: Attitudes and Behaviors* measure (Scales & Leffert, 1999) were used to assess responsibility. Ten statements from the University of Iowa's *Attitudes, Preferences, and Understandings* (1988) index were used to measure students' attitudes toward science. Two environmental attitude indices, the *Children's Environmental Response Inventory* (Bunting & Cousins, 1985) and Jaus' (1984) environmental attitude scale were combined to give seven statements to measure students' environmental attitudes. For the single survey, the answer scales for several of the questions from the different indices were changed so that all the questions would have the same answer scale for ease of reading and comprehension. The answer scale used for each question on the student survey was a Likert-type scale with five responses.

Measuring the Independent Variables

The independent variable for this study was school garden variation. To measure and classify such variation data were collected in several ways; observations, interviews including a Delphi Technique, and a teacher survey developed using results from the observations and interviews.

Observations of 2 teachers using school gardens were made and followed by interviews with 10 teachers who participated in the 1998–1999 Florida School Garden Competition. Observation data included location of the garden, type of garden and plants being grown, size of the garden, types of activities students participated in while in the garden, type of instruction that occurred in the garden, and questions being asked by teachers and students in the garden. Interview questions covered how long they had been teaching, if they gardened at home, reasons for using a school garden, type of garden at the school, how the garden was used by students, how the garden was used in and out of the classroom, level of involvement of students, amount of time spent in the garden, and experiences related to the garden.

The data from the observations and interviews were used to formulate the basic questions that were used in a second interview process, known as the Delphi Technique (Dalkey, 1969). An expert panel of eight teachers was identified from a pool of teachers who entered the Florida School Garden Competition and were identified by competition judges to have exemplary school garden programs. This expert panel completed four rounds of interview question sets.

Information gained from the observations, interviews, and the Delphi Technique interviews suggested a number of possible factors for measuring the variation of a school garden program. These factors were organized into a 19-question teacher survey that were distributed to and collected from the 28 participating teachers. The data collected from this survey were used to create a classification system or typology (Lunneborg, 1994) of school gardens based on garden intensity and form; this typology was used as the independent variable of analysis.

To determine the best measure of school garden intensity, a series of analysis of variance (ANOVA) tests were run with seven possible indicators of school garden intensity based on teacher survey responses; these were number of activities students participated in prior to and while in the garden, percent of time the garden was used as an instructional tool in the classroom, number of hours/week students spent in the garden, number of science standards addressed through use of the garden, number of subject areas into which the garden has been incorporated, number of sources and types of material used to support the garden in the curriculum, and the number of years the garden had been part of the curriculum. Analysis showed that the total number of garden-related activities students participated in prior to and while in the garden best explained the variation in the dependent variables of responsibility, science, and environmental attitudes and was chosen as the measure of intensity (high, medium, and low).

The second factor used to form the typology was garden form (vegetable, flower, combination). Garden intensity and form were cross tabulated to form nine categories that constituted the conceptual "types" of school gardens: (a) low-intensity vegetable garden, (b) low-intensity flower garden, (c) low-intensity combination garden, (d) medium-intensity vegetable garden, (e) medium-intensity flower garden, (f) medium-intensity combination garden, (g) high-intensity vegetable garden,

Table 1
Typology of School Garden Programs

	Intensity[a]		
	Low (0–8)	Medium (9–11)	High (12–14)
Garden Form			
Vegetable garden	a) LV	d) MV	g) HV
Flower garden	b) LF	e) MF	h) HF
Combination garden	c) LC	f) MC	i) HC

[a]Intensity is based on the number of garden-related activities students participated in prior to and while in the garden.

(h) high-intensity flower garden, and (i) high-intensity combination garden (Table 1). After this typology was created, correlation analysis showed that it significantly correlated with other possible typologies and was effective in explaining school garden intensity and type.

Once the suitable typology was found, analysis of covariance (ANCOVA) analyses were run to determine if there were significant differences in the dependent variables of responsibility and students' science and environmental attitudes by garden type. The covariate used in the analyses was the number of years the school garden had been a part of the curriculum. It was hypothesized that the number of years the garden had been a part of the curriculum could affect the intensity of the garden experience.

RESULTS

A goal of this study was to understand the variation in school garden types. This variation was classified in a typology matrix using the factors of intensity (the number of garden-related activities students participate in prior to and while in the garden) and form (vegetable, flower, combination). Table 2 shows the number and percentage of classes and students in each of the garden categories.

Responsibility

Table 3 shows that students' responsibility scores were all high and very little variation in garden types was found. The typology explained .34% of the variation in the scores and was not statistically significant. These high scores indicate that all students, regardless of garden type, possessed a sense of responsibility. No trend in scores relative to intensity and form was apparent. Approximately half (57.1%) of the teachers in this study reported using the garden to help teach ethics including responsibility and nurturing. However, until a comparative study of gardening students and non-gardening students is conducted, it is cautioned against inferring that the school garden is the reason for students' high sense of responsibility.

Table 2
Number and Percentage of Classes and Students in the Typology Matrix

		Intensity		
		Low	Medium	High
Garden Form				
Vegetable	Classes	1 (3.8%)	2 (7.7%)	1 (3.8%)
	Students	22 (5.2%)	23 (5.4%)	28 (6.6%)
Flower	Classes	2 (7.7%)	5 (19.2%)	3 (11.5%)
	Students	28 (6.6%)	97 (22.7%)	80 (18.7%)
Combination	Classes	4 (15.4%)	4 (15.4%)	4 (15.4%)
	Students	43 (10%)	43 (10%)	63 (14.8%)

Class n = 26.
Student n = 427.

Table 3
Typology of Responsibility Scores[1] and Analysis of Responsibility Scores

	Intensity		
	Low	Medium	High
Garden Form			
Vegetable garden	4.42	4.61	4.29
Flower garden	4.59	4.45	4.46
Combination garden	4.42	4.33	4.57
Dependent variable	**Explained variance**	**Cases**	**Grand mean**
Responsibility	.43%	427	4.46

$F = 1.448$, $p = .175$.
[1]Scores ranged from 1 (low) to 5 (high).

Table 4
Typology of Attitudes Toward Science Scores[1] and Analysis of Science Attitude Scores

	Intensity		
	Low	Medium	High
Garden Form			
Vegetable garden	3.20	4.64	3.50
Flower garden	4.24	3.88	4.12
Combination garden	3.83	4.00	3.91
Dependent variable	**Explained variance**	**Cases**	**Grand mean**
Attitudes toward science	3.6%	427	3.94

$F = 4.222$, $p = .000$.
[1]Scores ranged from 1 (low) to 5 (high).

Table 5
Typology of Attitudes Toward the Usefulness of Science Study Scores[1] and Analysis of Usefulness of Science Study Attitude Scores

	Intensity		
	Low	Medium	High
Garden Form			
Vegetable garden	3.39	4.31	3.08
Flower garden	3.96	3.84	3.82
Combination garden	3.76	3.58	3.72
Dependent variable	**Explained variance**	**Cases**	**Grand mean**
Attitudes toward the usefulness of science study	3.0%	427	c3.75

$F = 4.707$, $p = .000$, $^* p < .001$.
[1]Scores ranged from 1 (low) to 5 (high).

Table 6
Typology of Environmental Attitudes[1] and Analysis of Environmental Attitude Scores

	Intensity		
	Low	Medium	High
Garden Form			
Vegetable garden	4.83	4.72	4.68
Flower garden	4.85	4.85	4.83
Combination garden	4.88	4.67	4.77
Dependent variable	**Explained variance**	**Cases**	**Grand mean**
Attitudes toward the environment	.3%	427	4.80

$F = 1.518$, $p = .149$.
[1]Scores ranged from 1 (low) to 5 (high).

Science Attitudes

The ANCOVA analysis showed statistically significant differences in the science attitude (science is fun, exciting, boring, likeable) scores ($F = 4.222$, $p = .000$) and the usefulness of science study (learning, using, testing) scores ($F = 4.707$, $p = .000$) when placed in the typology; the typology explained 3.6% and 3.0% of the variation in scores respectively (Tables 4 and 5). Inspection of the typology showed that students with the highest scores were in medium-intensity vegetable, low- and high-intensity flower gardens. Students with the lowest scores were in low- and high-intensity vegetable gardens.

A plausible reason for the significant differences in science attitude scores and garden type is that, according to Simpson and Oliver (1990), the school, and more specifically, the classroom, has the strongest influence on students' attitudes toward science. Teaching styles, classroom activities, and school/class environment may all contribute to these differences among garden types. Although it is possible to infer any number of reasons for the differences in scores across garden types, data were not collected to account for such plausible explanations such as differences in teaching styles, cultural and social school environments, and other preexisting factors. Additional data are needed to further explain the role of the garden in affecting science attitudes.

Environmental Attitudes

When environmental attitude scores were placed in the typology, ANCOVA analysis showed no significant differences in garden types and the typology only explained .3% of the variation (Table 6). Environmental attitude scores across all garden types were high; the highest scores were found in the low-intensity combination and medium- and low-intensity flower gardens. The lowest scores were in the high- and medium-intensity vegetable gardens. Again, no trend in scores relative to intensity and form was apparent.

Although this finding is consistent with previous studies (Skelly & Zajicek, 1998; Waliczek, 1997), which showed that school gardens can promote positive environmental attitudes in students that participate in the gardens, until a comparative study of gardening students and non-gardening students is conducted, it is cautioned against inferring that the school garden is the reason for students' high environmental attitude scores.

CONCLUSIONS

From the data collected in this study, school garden variation was able to be classified into different types; however, no trend was found with respect to garden intensity and form that might imply the superiority or effectiveness of any particular garden type.

Investigation of the data showed that students in all types of gardens had high responsibility scores, indicating that all students possessed a sense of responsibility. Similarly, students' environmental attitudes were all high, indicating that students in all types of gardens had positive environmental attitudes. Significant differences were found in garden type and students' attitudes toward science, and their attitudes toward the usefulness of science. In general, although there were significant differences in garden type and these attitudes, most students' attitudes were positive. These findings indicate that variation in school gardens does exist and needs to be identified before comparative studies of garden programs and non-garden programs commence.

There was no discernable trend with respect to garden type and students' sense of responsibility, and attitudes toward science and the environment. However, the highest scores for three of the four variables (responsibility, science attitudes, and usefulness of science attitudes) examined were in the medium-intensity vegetable and low-intensity flower garden types. The medium-intesity vegetable garden type was represented by 2 classes and 23 students; the low-intensity flower garden type was represented by 2 classes and 28 students or approximately 1 teacher and 11–14 students per class. As mentioned earlier, Simpson and Oliver (1990) have suggested that the classroom, has the strongest influence on students' attitudes toward science. This low teacher/student ratio may allow for more quality instruction in the garden and related use of the garden in the classroom, which may thus positively affect students' sense of responsibility and science attitudes. There was no clear pattern of garden type and the low scores for the variables.

IMPLICATIONS FOR PRACTICE

Teachers could use school gardens to foster students' sense of responsibility. Students in this study had high responsibility scores and although the garden may not be the cause of such scores, anecdotally teachers using gardens have observed that gardening may foster such responsibility. Teachers could allow students to participate in garden-related activities that advance this sense of responsibility such as nurturing seeds, watering plants, and generally taking care of the garden.

School gardens could be used to assist in the teaching of science. The results of this study show that students participating in school gardens had positive attitudes toward science. In a study carried out by Skelly and Bradley (2000), researchers found that many elementary teachers in Florida were using school gardens to teach science. Yager and McCormack (1989) posited that science education should begin with applications and connections to the real world. Understanding how science relates to the real world helps students realize the need to study the processes and information that pertain to science. Additionally, several researchers contend that if students are to become interested in science and to continue taking more science courses, they must have positive attitudes toward science and these attitudes should be in place at an early age (Catsambis, 1995; Farenga & Joyce, 1998; Simpson & Oliver, 1990; Yager & McCormack, 1989; Yager & Yager, 1985). Farenga and Joyce (1997) suggest several ways science can be taught in a manner that stimulates interest and to promote positive science attitudes: teach out of the classroom, in an informal manner, and through hands-on and inquiry-based activities. Each of these methods of teaching science can be, in theory, and have been achieved with school gardens.

Teachers could use school gardens to teach environmental education and foster positive environmental attitudes. Knowledge of and positive attitudes toward the environment are necessary keys for making informed decisions about environmental issues (Ramsey & Rickson, 1976) and for carrying out environmentally responsible behavior (Ramsey et al., 1992). This study revealed that students in all types of gardens had positive attitudes toward the environment and although the garden may not be the cause of such high scores, anecdotally teachers report using gardens precisely to instill such positive environmental attitudes (Canaris, 1995; Chawla, 1994; Gwynn, 1988; Pivnick, 1994; Stetson, 1991). The ability of school gardens to promote positive environmental attitudes in students may be due to the fact that a large majority of the teachers (67.9%) in this used their gardens to teach environmental education. Research has found that environmental education programs promote positive environmental attitudes in students (Bradley et al., 1997; Bryant & Hungerford, 1977; Dresner & Gill, 1994; Jaus, 1982, 1984; Ramsey & Rickson, 1976). Jaus (1984) found that programs with only two hours of instruction were effective in developing positive environmental attitudes in third grade students. School gardens give students a chance to interact with the environment and nature, which may influence their attitudes toward the environment positively. Additionally, school gardens offer an ideal place to teach environmental education and to inform students about the environment and related issues.

REFERENCES

Alexander, J., North, M., & Hendren, D. (1995). Master gardener classroom garden projects: An evaluation of the benefits to children. *Children's Environments, 12*(2), 256–263.

Barker, S. L. (1992). *The meaning of a youth gardening program: A naturalistic inquiry.* Unpublished doctoral dissertation, Indiana University, Bloomington.

Becker, J. (1995). Our secret garden. *American Horticulturist, 74*(6/95), 9–10.

Berghorn, G. (1988). Tending their own gardens. *Social Studies and the Young Learner, 1*(3), 19–22.

Bradley, J. C., Zajicek, J. M., & Waliczek, T. M. (1997). Relationship between demographic variables and environmental attitudes of high school students. *Journal of Environmental Education, 30*(3), 17–21.

Braun, J., Kotar, M., & Irick, J. (1989). Cultivating an integrated curriculum: The school garden. *Social Studies and the Young Learner, 1*(3), 19–22.

Bryant, C. K., & Hungerford, H. R. (1977). An analysis of strategies for teaching environmental concepts and values clarification in Kindergarten. *Journal of Environmental Education, 9*(1), 44–49.

Bunting, T., & Cousins, L. (1985). Environmental dispositions among school-age children: A preliminary investigation. *Environment and Behavior, 17*(6), 725–768.

Canaris, I. (1995). Growing foods for growing minds: Integrating gardening and nutrition education into the total curriculum. *Children's Environments, 12*(2), 264–270.

Catsambis, S. (1995). Gender, race, ethnicity, and science education in the middle grades. *Journal of Research in Science Teaching, 32*(3), 243–257.

Chawla, L. (1994, July). Gardening as an initiation into environmental action. *American Horticulturist, 73*(7), 6–7.

Dalkey, N. (1969). *The Delphi method: An experimental study of group opinion.* RM-5888-PR. Santa Monica, CA: Rand Corporation.

DeMarco, L. (1999). *The factors affecting elementary school teachers' integration of school gardening into the curriculum.* Doctoral dissertation, Virginia Tech University, Blacksburg.

Dresner, M., & Gill, M. (1994). Environmental education at summer nature camp. *Journal of Environmental Education, 25*(3), 35–41.

Farenga, S. J., & Joyce, B. A. (1998). Science-related attitudes and science course selection: A study of high-ability boys and girls. *Roeper Review, 20*(4), 247–251.

Gwynn, M. (1988). A growing phenomenon. *Science and Children, 25*(7), 25–26.

Herd, M. (1997). *Learn and play in the garden.* Hauppauge: Barron's.

In Virginia, 500 years of gardening. (1992). *American Horticulturist, 71*(11/92), 10–12.

Jaus, H. (1982). The effect of environmental education instruction on children's attitudes toward the environment. *Science Education, 66*(5), 689–692.

Jaus, H. (1984). The development and retention of environmental attitudes in elementary school children. *Journal of Environmental Education, 15*(3), 33–36.

Lunneborg, C. (1994). *Modeling experimental and observational data.* Belmont, CA: Duxbury Press.

Neer, K. (1990). A children's garden. *The Herbarist, 56,* 69–76.

Peyser M., & Weingarten, T. (1998, April 13). A growing experience: Spring is here and children's gardens are in bloom. *Newsweek,* 65.

Pivnick, J. (1994). Sowing a school garden: Reaping an environmental ethic. *HortTechnology, 8*(3), 7–8.

Ramsey, C. E., & Rickson, R. E. (1976). Environmental knowledge and attitudes. *Journal of Environmental Education, 8*(1), 10–18.

Ramsey, J. M., Hungerford, H. R., & Volk, T. L. (1992). Environmental education in the K-12 curriculum: Finding a niche. *Journal of Environmental Education, 23*(2), 35–45.

Scales, P. & Leffert, N. (1999). *Developmental assets: A synthesis of scientific research on adolescent development.* Minneapolis, MN: Search Institute.

Simpson, R. D., & Oliver, J. S. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education, 74*(1), 1–18.

Sheffield, B. K. (1992). *The affective and cognitive effects of an interdisciplinary garden-based curriculum on underachieving elementary students.* Unpublished doctoral dissertation, University of South Carolina, Columbia.

Skelly, S. M., & Zajicek, J. M. (1998). The effect of Project GREEN, an interdisciplinary garden program, on the environmental attitudes of elementary school students. *HortTechnology, 8*(4), 579–583.

Skelly, S., & Bradley, J. (2000). The importance of school gardens as perceived by Florida elementary school teachers. *HortTechnology, 10*(1), 1–3.

Stetson, E. (1991). The big green schoolhouse. *Educational Leadership, 18*(1), 34–35.

Subramaniam, M. A. (2002). Garden-based learning in basic education: A historical review. Center for Youth Development, University of California. Retrieved from: http://ucce.ucdavis.edu/freeform/4hcyd/documents/CYD_Monograph_(Focus)2609.pdf.

Yager, R. E., & McCormack, A. J. (1989). Assessing teaching/learning successes in multiple domains of science and science education. *Science Education, 73*(1), 45–58.

Yager, R. E., & Yager, S. O. (1985). Changes in perceptions of science for third, seventh, and eleventh grade students. *Journal of Research in Science Teaching, 22*(4), 347–358.

Waliczek, T. M. (1997). *The effect of school gardens on self-esteem, interpersonal relationships, attitude toward school, and environmental attitude in populations of children.* Doctoral dissertation, Texas A&M University, College Station.

Wotowiec, P. J. (1975). Students' and parents' ratings of the tract garden program in the Cleveland Public Schools. *Dissertation Abstracts International, 36,* 3395-A.