

Student Learning Outcomes of Garden-Based Education: A Literature Review

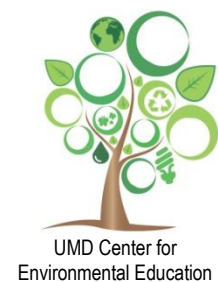


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The purpose of this project was to compile a summary of research surrounding student learning outcomes of school gardens and other garden-based education programs. A total of 40 articles are reviewed in this document, all of which were published in peer-reviewed journals from 1998-2013. These studies were conducted in both formal (school) and non-formal (i.e. community, summer, after-school) settings. Most studies were conducted within the United States, though several occurred internationally. This resource is not intended to be an exhaustive list, but rather a sampling of peer-reviewed research surrounding the wide variety of student learning outcomes of garden-based education programs.

Articles in this document are grouped under the following topics:

History of School Gardens: Discussion of the US school garden movement of eras past, in particular during the early 20th century

Perceptions and Use of School Gardens: Assessment of educators' perceptions and use of school gardens, as well as best practices and needs for improvement

Outcomes in Academic Performance and Engagement: Measurement of the impact of garden-based education programs on students' knowledge, test scores, and engagement in school

Outcomes in Environmental Education: Measurement of the impact of garden-based education programs on components of environmental literacy, particularly environmental attitudes

Outcomes in Nutrition: Measurement of the impact of garden-based education programs on students' nutrition knowledge, food preferences, and eating behaviors

Outcomes in Psycho-Social Skills: Measurement of the impact of garden-based education programs on students' life skills, such as developing interpersonal relationships and self-efficacy

Case Studies: Measurement of the impacts of an individual garden-based education program utilizing multiple data sources such as observations, interviews, and student work

Meta-Analyses: Compilation of information from many research articles condensed into generalizations and trends

Within each of the above topics, articles are listed in alphabetical order by author's last name. For each article presented in this document, the following information is provided:

Source: A full citation of the article's original publication

Purpose: The purpose statement, quoted directly or paraphrased, for the research article

Setting: The geographic location, academic setting, age/grade level of participants, and other relevant characteristics of the garden-based education program under study

Research Findings: A summary of the main findings from the research

Implications for Future: Suggestions for future research and/or considerations for future practitioners, as stated by the original authors

Salient Quotes: Prominent, direct quotations from the authors and/or study subjects, including page numbers linked to the direct quote in the original article

Additionally, Table 1 on page v. contains "Studies at a Glance" of the research reviewed in this document, including the study location (state, region, or country), educational setting (formal vs. non-formal), and student grade level, where specified.

- Page i. Using This Document
Page ii. Table of Contents
Page v. Table 1. Studies at a Glance

History of School Gardens

- Page 1. *“Soldiers of the Soil”: The Work of the United States School Garden Army during World War I*
Rose Hayden-Smith, 2007
Page 2. *“A Better Crop of Boys and Girls”: The School Gardening Movement, 1890-1920*
Sally Gregory Kohlstedt, 2008

Perceptions and Use of School Gardens

- Page 3. *Integrating Gardening into the Elementary School Curriculum*
Laurie W. DeMarco, Diane Relf, and Alan McDaniel, 1999.
Page 4. *Use of School Gardens in Academic Instruction*
Heather Graham, Deborah Lane Beall, Mary Lussier, Peggy McLaughlin, and Sheri Zindenberg-Cherr, 2005
Page 5. *California Teachers Perceive School Gardens as an Effective Nutritional Tool to Promote Healthful eating Habits*
Heather Graham and Sheri Zindenberg-Cherr, 2005
Page 6. *Best Practices Models for Implementing, Sustaining, and Using Instructional School Gardens in California*
Eric L. Hazzard, Elizabeth Moreno, Deborah L. Beall, and Sheri Zindenberg-Cherr, 2011
Page 7. *Creating a School Gardens Program in the Challenging Environment of Las Vegas, Nevada*
Angela M. O’Callaghan, 2005
Page 8. *The Importance of School Gardens as Perceived by Florida Elementary School Teachers*
Sonja M. Skelly and Jennifer C. Bradley, 2000

Outcomes in Academic Performance and Engagement

- Page 9. *An Evaluation of the Junior Master Gardener Program in Third Grade Classrooms*
Amy E. Dircks and Kathryn Orvis, 2005
Page 10. *Growing Minds: The Effect of a School Gardening Program on the Science Achievement of Elementary Students*
C.D. Klemmer, T.M. Waliczek, and J.M. Zajicek, 2005
Page 11. *Effects of a Gardening Program on the Academic Progress of Third, Fourth, and Fifth Grade Math and Science Students*
A.E. Pigg, T.M. Waliczek, and J.M. Zajicek, 2006
Page 12. *Intrinsic Motivation and Engagement as “Active Ingredients” in Garden-Based Education: Examining Models and Measures Derived From Self-Determination Theory*
Ellen A. Skinner, Una Chi, and The Learning-Gardens Educational Assessment Group, 2011
Page 13. *Impact of Hands-on Science through School Gardening in Louisiana Public Elementary Schools*
Leanna L. Smith and Carl E. Motsenbocker, 2005

Outcomes in Environmental Education

- Page 14. *Growing Environmental Stewards: The Overall Effect of a School Gardening Program on Environmental Attitudes and Environmental Locus of Control of Different Demographic Groups of Elementary School Children*
O.M. Aguilar, T.M. Waliczek, and J.M. Zajicek, 2008

Outcomes in Environmental Education (cont'd)

- Page 15. *The Green Brigade: The Educational Effects of a Community-Based Horticultural Program on the Horticultural Knowledge and Environmental Attitude of Juvenile Offenders*
Carol Cammack, Tina M. Waliczek, and Jayne M. Zajicek, 2002(a)
- Page 16. *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 and Jennifer Campbell Bradley, 2007
- Page 17. *The Effect of an Interdisciplinary Garden Program on the Environmental Attitudes of Elementary School Students*
Sonja M. Skelly and Jayne M. Zajicek, 1998
- Page 18. *School Gardening: Improving Environmental Attitudes of Children Through Hands-On Learning*
Tina M. Waliczek and Jayne M. Zajicek, 1999

Outcomes in Nutrition

- Page 19. *Expanding Children's Food Experiences: The Impact of a School-Based Kitchen Garden Program*
Lisa Gibbs, Petra K. Staiger, Britt Johnson, Karen Block, Susie Macfarlane, Lisa Gold, Jenny Kulas, Mardie Townsend, Caroline Long, and Obioha Ukoumunne, 2013
- Page 20. *Can a Community-based Intervention Improve the Home Food Environment? Parental Perspectives of the Influence of the Delicious and Nutritious Garden*
Stephanie Heim, Katherine W. Bauer, Jamie Stang, and Marjorie Ireland, 2011
- Page 21. *A Garden Pilot Project Enhances Fruit and Vegetable Consumption among Children*
Stephanie Heim, Jamie Stang, and Marjorie Ireland, 2009
- Page 22. *The Effect of a Summer Garden Program on the Nutritional Knowledge, Attitudes, and Behaviors of Children*
S. Koch, T.M. Waliczek, and J.M. Zajicek, 2006
- Page 23. *Understanding Gardening and Dietary Habits among Youth Garden Program Participants using the Theory of Planned Behavior*
Lauren Lautenschlager and Chery Smith, 2007
- Page 24. *An Evaluation of Inner-City Youth Garden Program Participants' Dietary Behavior and Garden and Nutrition Knowledge*
Lauren Lautenschlager Beckman and Chery Smith, 2008
- Page 25. *Garden-Based Nutrition Education Affects Fruit and Vegetable Consumption in Sixth-Grade Adolescents*
Jessica D. McAleese and Linda L. Rankin, 2007
- Page 26. *The Impact of Nutrition Education with and without a School Garden on Knowledge, Vegetable Intake and Preferences and Quality of School Life Among Primary-School Students*
Philip J. Morgan, Janet M. Warren, David R. Lubans, Kristen L. Saunders, Gabrielle I. Quick, and Clare E. Collins, 2010
- Page 27. *School Gardens: An Experiential Learning Approach for a Nutrition Education Program to Increase Fruit and Vegetable Knowledge, Preference, and Consumption among Second-grade Students*
Sondra M. Parmer, Jill Salisbury-Glennon, David Shannon, and Barbara Struempfer, 2009
- Page 28. *The Effects of School Garden Experiences on Middle School-Aged Students' Knowledge, Attitudes, and Behaviors Associated With Vegetable Consumption*
Michelle M. Ratcliffe, Kathleen A. Merrigan, Beatrice L. Rogers, and Jeanne P. Goldberg, 2011

Outcomes in Psycho-Social Skills

- Page 29. *The Green Brigade: The Psychological Effects of a Community-based Horticultural Program on the Self-development Characteristics of Juvenile Offenders*
Carol Cammack, Tina M. Waliczek, and Jayne M. Zajicek, 2002(b)
- Page 30. *Garden Affordances for Social Learning, Play, and for Building Nature-Child Relationship*
Taina Laaksoharju, Erja Rappe, and Taina Kaivola, 2012
- Page 31. *Growing Minds: The Effects of a One-Year School Garden Program on Six Constructs of Life Skills of Elementary School Children*
Carolyn W. Robinson and Jayne M. Zajicek, 2005
- Page 32. *Garden-Based Learning: An Experience with “At Risk” Secondary Education Students*
Jose-Reyes Ruiz-Gallardo, Alonso Verde, and Arturo Valdes, 2013
- Page 33. *The Effect of School Gardens on Children’s Interpersonal Relationships and Attitudes Toward School*
T.M. Waliczek, J.C. Bradley, and J.M. Zajicek, 2001

Case Studies

- Page 34. *Gardening as a Learning Environment: A Study of Children’s Perceptions and Understanding of School Gardens as Part of an International Project*
Rob Bowker and Penni Tearle, 2007
- Page 35. *Multicultural School Gardens: Creating Engaging Garden Spaces in Learning about Language, Culture, and Environment*
Amy Cutter-Mackenzie, 2009
- Page 36. *The Seeds of Learning: Young Children Develop Important Skills Through Their Gardening Activities at a Midwestern Early Education Program*
Dana L. Miller, 2007
- Page 37. *Environmental Education in Botanic Gardens: Exploring Brooklyn Botanic Garden’s Project Green Reach*
Susan Conlon Morgan, Susan L. Hamilton, Michael L. Bentley, and Sharon Myrie, 2009

Meta-Analyses

- Page 38. *The Child in the Garden: An Evaluative Review of the Benefits of School Gardening*
Dorothy Blair, 2009
- Page 39. *Impact of Garden-Based Youth Nutrition Intervention Programs: A Review*
Ramona Robinson-O’Brien, Mary Story, and Stephanie Heim, 2009
- Page 40. *Impact of Garden-Based Learning on Academic Outcomes in Schools: Synthesis of Research Between 1990 and 2010.*
Dilafuz R. Williams and P. Scott Dixon, 2013

	Page & Source		Location	Setting		Grade			
				Form	NonF	Pre-K	K-5	6-8	9-12
History	1	Hayden-Smith (2007)	United States	x					
	2	Kohlstedt (2008)	United States	x					
Perceptions	3	DeMarco, et al. (1999)	United States	x			x		
	4	Graham, et al. (2005)	California	x			x	x	x
	5	Graham & Zindenberg-Cherr (2005)	California	x			4		
	6	Hazzard, et al. (2011)	California	x			x	x	x
	7	O'Callaghan (2005)	Nevada	x			x		
	8	Skelly & Bradley (2000)	Florida	x			x		
Academic Performance/Engagement	9	Dirks & Orvis (2005)	Indiana	x			3		
	10	Klemmer, et al. (2005)	Texas	x			3-5		
	11	Pigg, et al. (2006)	Texas	x			3-5		
	12	Skinner & Chi (2011)	Pacific NW	x				6-7	
	13	Smith & Motsenbocker (2005)	Louisiana	x			5		
Environmental Education	14	Aguilar, et al. (2008)	Texas	x			3-5		
	15	Cammack, Waliczek, & Zajicek (2002a)	Texas		x			x	x
	16	Skelly & Bradley (2007)	Florida	x			3		
	17	Skelly & Zajicek (1998)	Texas	x			2,4		
	18	Waliczek & Zajicek (1999)	Kansas, Texas	x			2-5	6-8	
Nutrition	19	Gibbs, et al. (2013)	Australia	x			3-5	6	
	20	Heim, et al. (2011)	Minnesota		x		4-5	6	
	21	Heim, et al. (2009)	Minnesota		x		4-5	6	
	22	Koch, et al. (2006)	Texas		x		2-5		
	23	Lautenshlager & Smith (2007)	Minnesota		x		x	x	
	24	Lautenshlager & Smith (2008)	Minnesota		x		x	x	
	25	McAleese & Rankin (2007)	Idaho	x				6	
	26	Morgan, et al. (2010)	Australia	x			5	6	
	27	Parmar, et al. (2009)	SE United States	x			2		
28	Ratcliffe, et al. (2011)	California	x				6		
Psycho-Social Skills	29	Cammack, Waliczek, & Zajicek (2002b)	Texas		x			x	x
	30	Laaksoharju, et al. (2012)	Finland		x		x		
	31	Robinson & Zajicek (2005)	Texas	x			3-5		
	32	Ruiz-Gallardo, et al. (2013)	Spain	x					x
	33	Waliczek, et al. (2001)	Kansas, Texas	x			2-5	6-8	
Case Studies	34	Bowker & Teale (2007)	England, India, Kenya	x			x	x	
	35	Cutter-Mackenzie (2009)	Australia	x			x		
	36	Miller (2007)	Nebraska	x		x	K		
	37	Morgan, et al. (2009)	New York		x		x	x	
Meta-Analyses	38	Blair (2009)	United States	x	x				
	39	Robinson-O'Brien, et al. (2009)	United States (1990-2007)	x	x				
	40	Williams & Dixon (2013)	United States (1990-2010)	x					

Table 1. Studies at a Glance. A summary of the studies reviewed in this document, organized by topic, page number, and source. Information includes study location (state, region, or country), educational setting (formal vs. non-formal), and grade level of participants (when specified).

“Soldiers of the Soil”: The Work of the United States School Garden Army during World War I

Rose Hayden-Smith (2007)

Source: Hayden-Smith, R. (2007). “Soldiers of the Soil”: The work of the United States School Garden Army during World War I. *Applied Environmental Education & Communication*, 6(1), 19-29.

Purpose: “This article charts a brief history of the U.S. School Garden Army (USSGA) and describes some elements of this youth gardening movement that may be relevant to the field today.”

Setting: Schools throughout the United States during World War I

Research Findings: During World War I, the United States School Garden Army (USSGA) and National War Garden Commission encouraged gardens at school and home, transforming the American food system in the process. Youth were seen as vital to achieving national security during the wartime era. The USSGA was one of the first attempts to nationalize a curriculum by the Federal Bureau of Education, integrating gardening across school curriculum and encouraging linkages to home and community life. Many also saw the USSGA as a cure to “urban ills,” bringing “country values to the city.”

Gardening was celebrated during this era as a national priority. The USSGA was extremely effective, with several million youth enlisted by war’s end. They were so productive that their efforts actually depressed local agricultural markets in some parts of the country.

No longer a national priority, the USSGA dismantled shortly after armistice. A version of the USSGA resurfaced during World War II. The author suggests that the success of the WWII Victory Garden campaign was due in part to many adults having participated in the USSGA as children during the First World War.

Implications for the future: The author draws a connection between the USSGA and the current school garden movement, highlighting the importance of transition from an “exception” to and “expectation”.

Salient Quotes: “We must teach children how to make good choices as consumers, good decisions as policymakers, and how to lead a healthy lifestyle that is sustainable. ... Sometimes to move forward, we must look back. ... The period around World War I is one of the most relevant to understanding and informing our current work.” (pg. 20)

Official taglines of the USSGA included, “A garden for every child. Every child in a garden.” and “He who produces is a patriot – a good citizen.”(pg. 21)

“A Better Crop of Boys and Girls”: The School Garden Movement, 1890-1920

Sally Gregory Kohlstedt (2008)

Source: Kohlstedt, S.G. (2008). “A better crop of boys and girls”: The school gardening movement, 1890-1920. *History of Education Quarterly*, 48(1), 58-93.

Purpose: To investigate the use of school gardens during 1890-1920

Setting: Schools throughout the United States between 1890-1920

Research Findings: At the end of the 19th century, potential for school gardens were abound with widespread usage abroad. School gardens were initially a part of the nature study movement which brought science into public schools. They were seen as a mechanism for moral, aesthetic, or civic uplift and as vocational/skills training. However, school gardens were met with some skepticism, claiming gardens ought to be grown at home so students could focus on learning basic literary and other skills at school.

School gardens were used for different purposes in different settings. Gardens in Indians schools were used to provide food and “build character” rather than as a nature study educational tool. African American school gardens were used primarily to teach agricultural practices, as students were likely to remain in rural life as adults.

It is estimated that over 75,000 school gardens were in production by 1906. However, federal oversight was sporadic until the WWI home front efforts began. President Woodrow Wilson supported the School Garden Army, suggesting “every boy and girl... would like to feel that they are in fact fighting in France by joining the home garden army.” By 1918, the national School Garden Association had members in every state and Canadian province, and school gardening had become so prevalent it was often indistinguishable from nature study. The movement reached its apex during the war, and was significantly scaled back in the war’s aftermath.

Implications for the future: None identified.

Salient Quotes: “The gardening movement is a particularly striking example of a widely accepted program that nonetheless flourished for just one generation before largely disappearing.” (pg. 60)

“School gardens began as expressions of progressive pedagogy at the turn of the century. ... Inevitably, the garden movement could not fulfill all the expectations, and sponsorship faltered in the postwar years, nonetheless leaving a modest legacy of bean sprouts and window boxes in classrooms.” (pg. 92-93)

Integrating Gardening into the Elementary School Curriculum

Laurie W. DeMarco, Diane Relf, and Alan McDaniel (1999)

- Source:** DeMarco, L.W., Relf, D., & McDaniel, A. (1999). Integrating gardening into the elementary school curriculum. *HortTechnology*, 9(2), 276-281.
- Purpose:** “To determine those factors that promote the successful use of gardening within an elementary school curriculum from teachers who are experienced in its use” and “to describe the current application of gardening”
- Setting:** Teachers from 322 elementary schools in the United States (survey); teachers from 28 elementary schools in Virginia (interviews)
- Research Findings:** Of surveyed and interviewed teachers, the top-valued factors deemed essential for school garden success primarily fell into three categories: 1) student and faculty commitment to integrate gardening into curriculum, 2) availability of physical resources such as garden site materials, and 3) faculty knowledge and skill in gardening.
- School gardens were incorporated into most educational subject areas across the curriculum, the most common being science (92.4%), environmental education (83.1%), mathematics (68.6%), and language arts (67.8%). Teachers’ goals of school gardens included academic (91.5%) and social development (83.1%). Surveyed teachers overwhelmingly perceived school gardens as very successful (60.6%) or somewhat successful (35.2%) as a teaching tool in elementary classrooms.
- Implications for the future:** The authors recommend training courses and teaching tools are needed to strengthen teachers’ commitments to school gardening. Additionally, the authors urge for research that measures student learning outcomes of school garden programs.
- Salient Quotes:** “Gardening provides students with opportunities to interact with nature on a personal level that promotes positive behavior changes.” (pg. 277)
- “Responses indicated that teachers experienced in using gardening as part of their curriculum saw student learning enhanced through its use.” (pg. 280)
- “To promote and support the use of school gardening by educators and educational institutions, it is imperative research be conducted that quantifies the student learning that occurs when gardening is used in the curriculum. Research tools and supporting documentation describing the cost effectiveness of school gardening needs to be developed.” (pg. 280)

Use of School Gardens in Academic Instruction

Heather Graham, Deborah Lane Beall, Mary Lussier, Peggy McLaughlin, and Sheri Zindenberg-Cherr (2005)

- Source:** Graham, H., Beall, D.L., Lussier, M., McLaughlin, P., & Zindenberg-Cherr, S. (2005). Use of school gardens in academic instruction. *Journal of Nutrition Education & Behavior*, 37, 147-151.
- Purpose:** "To determine the current status of gardens in public schools in California," specifically in three areas: current practices, attitudes, and barriers
- Setting:** 4194 of 9805 California public school principals
- Research Findings:** The number of school gardens in California has increased from 13% in 1996 to at least 24% in 2005, and were most common at the elementary level.
- Practice: The most frequently cited reasons for school gardening included academic instruction (89%), extracurricular activities (60%), and edible produce (39%). Gardens were used to teach many subjects, most frequently science (95%), environmental studies (70%), and nutrition (66%).
- Attitudes: Most principals perceived school gardens as "moderately" to "very effective" at enhancing science (69%). Most principals, however found the garden as being "not effective" or only "slightly effective" at enhancing the school meal program (55%). Principals strongly believed teaching materials and other resources were needed to increase school garden use.
- Barriers: Perceived barriers included time (88%), lack of curricular materials linked to standards (74%), and a lack of teacher interest, knowledge, experience, and training (70%). For schools currently without gardens, the biggest barriers were funding (60%), time (57%), and lack of supplies (49%).
- Implications for the future:** The authors note that the link between school gardens and school meal programs requires attention. There is a need for strategies to incorporate volunteers in the garden to lessen the time barrier, as well as a need for curriculum materials & training for teachers.
- Salient Quotes:** "Engaging, hands-on learning activities incorporated into subject matter are key components of experiential education in which environment-based education programs have been employed, emphasizing the development of lifelong learning skills, such as problem solving and critical thinking." (pg. 149-150)

California Teachers Perceive School Gardens as an Effective Nutritional Tool to Promote Healthful Eating Habits

Heather Graham and Sheri Zindenberg-Cherr (2005)

- Source:** Graham, H. & Zindenberg-Cherr, S. (2005). California teachers perceive school gardens as an effective nutritional tool to promote healthful eating habits. *Journal of the American Dietetic Association*, 105, 1797-1800.
- Purpose:** "To assess teachers' use of gardens in academic instruction as well as their attitudes and perceived barriers associated with the integration of school gardens within the school system"
- Setting:** 4th grade teachers at schools with gardens in California
- Research Findings:** Practice: The most frequent reason teachers cited using the school garden was academic instruction (72%). The most frequently taught subject areas included science (65%), nutrition (43%), environmental studies (43%), language arts (42%), and math (40%).
- Attitudes: Most teachers believed school gardening was "moderately" to "very effective" at enhancing science (53%) and social skills (41%). Other areas with perceived improvement include academic performance, physical activity, language arts, and healthful eating habits. 46% of teachers, however, said the garden was "not effective" or "slightly effective" at enhancing school meal programs. Teachers expressed a strong need for training and curriculum.
- Barriers: The greatest barrier noted by teachers was time (67%), followed by lack of teacher interest (63%), lack of experience (61%), lack of curricular materials aligned with standards (60%), lack of teacher knowledge (60%), and lack of relevant training (58%)
- Implications for the future:** There is a need for relevant training and curricular resources that meet the pressure of standards-based education. The link between the school meal program, the garden, and healthful eating also needs attention. Dietetics ought to work more closely with schools to support nutrition education.
- Salient Quotes:** One teacher stated, "It's a great way to tie in nutrition, math, science, and language arts skills." Another noted, "The garden has provided a valuable context for student learning." (pg. 1798)

Best Practices Models for Implementing, Sustaining, and Using Instructional School Gardens in California

Eric L. Hazzard, Elizabeth Moreno, Deborah L. Beall, and Sheri Zindenberg-Cherr (2011)

Source:	Hazzard, E.L., Moreno, E., Beall, D.L., & Zindenberg-Cherr, S. (2011). Best practices models for implementing, sustaining, and using instructional school gardens in California. <i>Journal of Nutrition Education and Behavior</i> , 43 (5), 409-413.
Purpose:	“To ascertain and report best practices to provide models for schools implementing or sustaining instructional school gardens”
Setting:	Interviews with key players in 10 California schools with “exemplary” garden programs
Research Findings:	<p>The interviews yielded four areas that are crucial to garden success:</p> <ol style="list-style-type: none"> 1) <u>People</u>: Regular collaboration between a variety of people committed to sustaining the garden program, including administrators, teachers, parent/community volunteers, and garden coordinators, is essential. 2) <u>Funds</u>: Grants are the most common sources of funds, and support from multiple stakeholders is needed to search and apply for grants. Other common sources of funding include fundraisers (sponsored by foundations, booster clubs, or PTO) and corporate sponsorship. 3) <u>Materials</u>: Common sources of materials, aside from grants and other funding sources, include donations from seed companies, nurseries, local businesses, and parent and community volunteers. 4) <u>Instruction</u>: Use of a part-time or full-time garden coordinator who spends his/her time tending and teaching in the garden was common among schools. Collaboration is needed between the coordinator and teachers to incorporate lessons that meet state standards. <p>Barriers noted include time, funding, uncooperative administration, burned out teachers, and a lack of a full-time garden coordinator or volunteers.</p>
Implications for the future:	Sustaining a garden program requires key players who contribute time and energy. Establish a committee and work with many partners (i.e. Cooperative Extension and Master Gardeners) to overcome barriers.
Salient Quotes:	<p>“You really need to develop a partnership between the person who is going to be in the garden with classes and the teachers and the support of the administration... and involving parents is really helpful.” (pg. 411)</p> <p>“We use it as a hands-on method of teaching kids. Any concept that you can [find] in the textbook [you can] bring... to life with the hands-on approach in the school gardens.” (pg. 411)</p>

Creating a School Gardens Program in the Challenging Environment of Las Vegas, Nevada

Angela M. O'Callaghan (2005)

Source: O'Callaghan, A.M. (2005). Creating a school gardens program in the challenging environment of Las Vegas, Nevada. *HortTechnology*, 15(3), 429-433.

Purpose: To report on efforts "to create a school gardens program in the Las Vegas area and empower teachers"

Setting: Las Vegas, NV elementary schools which face rapid population growth in the difficult growing environment of the Mojave Desert

Research Findings: Focus Groups: Focus group interviews were conducted with community stakeholders. The majority viewed school gardens as "highly important" and saw a need in the community for youth and career information related to horticulture.

Principal Surveys: An initial survey found most elementary school principals desired school gardens, especially if coupled with relevant teacher training. Common barriers listed to establishing a school garden included cost and vandalism. Maintenance was the biggest barrier to sustaining a school garden, and the most common reason for failure was if the driving teacher left the school. Interestingly, cost was not viewed as prohibitive to maintenance once a school garden was established. In a follow-up survey, all principals with school gardens perceived benefits to student learning, though none had taken steps to evaluate outcomes. Principals also expressed interest in partnering with Master Gardener mentors.

Trainings and Field Experiences: As a result of curriculum trainings, one Nevada Master Gardener began correlating the Junior Master Gardener curriculum with Nevada state education standards. Teachers expressed an overall satisfaction and perceived usefulness of garden trainings and agriculture-related field trips.

Implications for the future: To continue to build a school garden culture in Las Vegas, it is essential that teachers are trained as both educators and gardeners.

Salient Quotes: "This [finding that failure often resulted from the departure of one driving individual] emphasized the need for participation by many members of the school community." (pg. 431)

"Students can be involved in seeing how native plants survive a harsh environment as well as learning about edible plant species from other parts of the world. For many children, school gardens offer their first encounters with fruits or vegetables that have not been processed." (pg. 432)

The Importance of School Gardens as Perceived by Florida Elementary School Teachers

Sonja M. Skelly and Jennifer C. Bradley (2000)

Source:	Skelly, S.M., & Bradley, J.C. (2000). The importance of school gardens as perceived by Florida elementary school teachers. <i>HortTechnology</i> , 10(1), 229-231.
Purpose:	To explore teachers' perceptions of the benefits of school gardens to students
Setting:	71 elementary school teachers in Florida utilizing school gardens
Research Findings:	<p>The most common garden types reported were flower (84.3%) and vegetable (71.4%). Vegetable and butterfly gardens were commonly used to supplement science lessons, while flower gardens were most often used to enhance the schoolyard and building. The majority of teachers indicated their students spend an average of one hour/week in the garden, and that the garden is used for 10% or less of total class time.</p> <p>The majority of teachers reported using the garden for environmental education (97.1%) and for experiential learning (42%), and most indicated they perceived the garden as helping students better learn (84.3%). 42% of the gardens had been established for less than six months, while only 31% had been established for two or more years. Gardens were most commonly funded by donations (69.9%), teachers' personal funds (52.1%), and grants (49.3%).</p>
Implications for the future:	Teachers need to be made aware of school garden resources, especially curricula for integrating the garden into lessons and funding opportunities.
Salient Quotes:	<p>"Findings reveal that, for this group of teachers, gardens were used minimally for classroom instruction." (pg. 231)</p> <p>"Integrating the garden and garden activities into classroom lessons will not only enable the teacher and the students to use the garden more, but may also enhance students' learning. It is apparent that many teachers understand the usefulness of the garden and the impact it may have on student learning." (pg. 231).</p>

An Evaluation of the Junior Master Gardener Program in Third Grade Classrooms

Amy E. Dircks and Kathryn Orvis (2005)

Source: Dircks, A.E. & Orvis, K. (2005). An evaluation of the Junior Master Gardener Program in third grade classrooms. *HortTechnology*, 15(3), 443-447.

Purpose: To evaluate the Junior Master Gardener (JMG) program in a formal classroom setting, utilizing qualitative and quantitative measurements of science achievement and attitudes toward science, horticulture, and the environment

Setting: 3rd grade classrooms in 11 elementary schools throughout Indiana

Research Findings: Measures of both science knowledge (science achievement) and attitudes towards science, horticulture, and the environment significantly increased as a result of the JMG program. There was no significant effect of gender, geographic region, age, or race in either the knowledge or attitude measure. However, individual differences in classrooms had a significant effect on both knowledge and attitude scores, and whether or not the school had access to a garden during the program had a significant effect on attitude scores. By the end of the program, 5 of the 7 schools without gardens had established an area for a new garden on school grounds.

Observations yielded the following trends: 1) many factors affected the way the JMG program was presented, 2) the use of school gardens increased with the use of the JMG program, 3) JMG was adapted into current curriculum, 4) JMG was valued by teachers and students, and 5) student interest in JMG was high.

Implications for the future: These results indicate the JMG program has academic merit for interdisciplinary use in classrooms. The scope of this study was, however, limited to a single program with little diversity among participants. Future studies should target a broader audience.

Salient Quotes: “An interesting finding was that students learned that they could not live without plants. This contradicts previous research where Relf et al. (1992) found that despite environmental education, less than 50% of the respondents believed that the natural world is essential to their well-being.” (pg. 445)

“Teachers reported that students were excited and interested in learning when utilizing the JMG program.” (pg. 446)

Growing Minds: The Effect of a School Gardening Program on the Science Achievement of Elementary Students

C.D. Klemmer, T.M. Waliczek, and J.M. Zajicek (2005)

- Source:** Klemmer, C.D., Waliczek, T.M., & Zajicek, J.M. (2005). Growing minds: The effect of a school gardening program on the science achievement of elementary students. *HortTechnology*, 15(3), 448-452.
- Purpose:** "To assess the effectiveness of school gardens for enhancing the science achievement of elementary students in the third, fourth, and fifth grades"
- Setting:** 3rd-5th grade classrooms at 7 schools in Temple, TX
- Research Findings:** In a post-test only measure of science achievement, students involved in the school garden program scored an average of 5.6 points higher than students in the control group ($p=.001$).
- Additionally, 5th grade students in the garden program scored 14.9 points higher ($p<.001$) than 5th grade students in the control group. There was no difference, however, between groups in either 3rd or 4th grades; this suggests that the garden program was more effective for 5th grade students than it was for younger students.
- There was no significant difference in scores between males and females involved in the garden program, suggesting the program was equally effective for both sexes.
- Implications for the future:** Hands-on learning activities, such as school gardens, should be used to increase student learning, achievement, and science literacy.
- Salient Quotes:** "These findings indicate that students who participated in hands-on gardening activities had higher science achievement scores versus those who did not. This is in accord with research indicating that students' knowledge levels are increased through the use of hands-on, experiential activities." (pg. 450)
- "Hands-on, constructivist learning serves as the main idea behind school garden programs. Gardens can serve as living laboratories in which students can see what they are learning and in turn, apply that knowledge to real world situations." (pg. 452)

Effects of a Gardening Program on the Academic Progress of Third, Fourth, and Fifth Grade Math and Science Students

A.E. Pigg, T.M. Waliczek, and J.M. Zajicek (2006)

- Source:** Pigg, A.E., Waliczek, T.M., & Zajicek, J.M. (2006). Effects of a gardening program on the academic progress of third, fourth, and fifth grade math and science students. *HortTechnology*, 16(2), 262-264.
- Purpose:** Address “whether a school gardening program would have an effect on the science and math achievement scores of third, fourth, and fifth grade students”
- Setting:** 3rd-5th grade classrooms at an elementary school in McAllen, TX
- Research Findings:** Overall, there was no statistically significant difference between experimental (gardening) and control groups with respect to science achievement scores. However, the control group scored an average of 4.13 points higher ($p=.000$) than the experimental group on the math achievement test. Researchers note that the curriculum used by the experimental groups was developed to teach horticulture, health, nutrition, environmental science, and leadership, but didn’t include math.
- Analysis showed that males and female benefited from the program equally, with no significant differences on either science or math scores based on gender. At specific grade levels, 4th grade science scores were significantly higher among the experimental group ($p=.012$). 5th grade math and science scores were both significantly higher in the control group ($p=.000$ and $.006$, respectively). No differences were noted among 3rd grade students.
- Implications for the future:** Further research is needed on the impact of garden-based learning on student academic performance, based on discrepancies between this and other studies (i.e. Klemmer, et al., 2005).
- Salient Quotes:** “Results from this study support the idea that for some students, gardening may be an effective tool to supplement, enhance or complement existing traditional curricula. However, these results also indicate that garden curriculum activities may need more development of particular subject areas if they are intended to improve achievement scores such as math and science.” (pg. 264)

Intrinsic Motivation and Engagement as “Active Ingredients” in Garden-Based Education: Examining Models and Measures Derived from Self-Determination Theory

Ellen A. Skinner, Una Chi, and The Learning-Gardens Educational Assessment Group (2011)

- Source:** Skinner, E. A., Chi, U., and The Learning-Gardens Educational Assessment Group (2011). Intrinsic motivation and engagement as “active ingredients” in garden-based education: Examining models and measures derived from self-determination theory. *Journal of Environmental Education*, 43(1), 16-36.
- Purpose:** 1) to present a theoretical model of motivation as an explanation for why garden-based education influences achievement, and 2) construct a set of quantitative indicators of student engagement in garden-based activities
- Setting:** A middle school (6th and 7th grades) in the Pacific Northwest, USA
- Research Findings:** Student garden engagement, as rated by both students and teachers, was significantly and positively correlated with student perceptions of how much they learned in the garden, students’ actual grades (GPA) in core subjects, and students’ self-perceptions of their competence, autonomy, and intrinsic motivation in the garden. Additionally, engagement in the garden was significantly and positively correlated with both student and teacher reports of students’ academic engagement and students’ self-perceptions of their sense of relatedness, competence, intrinsic motivation, and autonomy in school.
- These findings were consistent with the motivational explanation of the effects of garden-based education provided by self-determination theory.
- Implications for the future:** Future studies on student motivation in garden-based education should include additional constructs of self-determination theory, qualitative measures of students, and measures from multiple time points throughout the school year to get a clearer picture of the motivational model.
- Salient Quotes:** “Several decades of research have demonstrated that students’ engagement predicts their learning, grades, achievement, retention, and graduation. ... Unfortunately, however, no measures of student engagement in garden programs have been published to date.” (pg. 17)
- “The defining features of garden-based programs, which offer holistic, integrated, hands-on, project-based, cooperative, experiential learning activities, are intrinsically motivating and have the potential to meet fundamental needs of children and youth, thereby fostering engagement.” (pg. 19)

Impact of Hands-on Science through School Gardening in Louisiana Public Elementary Schools

Leanna L. Smith and Carl E. Motsenbocker (2005)

- Source:** Smith, L.L. & Motsenbocker, C.E. (2005). Impact of hands-on science through school gardening in Louisiana public elementary schools. *HortTechnology*, 15(3), 439-443.
- Purpose:** To determine if participation in the Junior Master Gardener (JMG) curriculum improved science achievement scores
- Setting:** 5th grade classrooms at urban elementary schools in East Baton Rouge, LA
- Research Findings:** The JMG curriculum was introduced to three schools in East Baton Rouge, LA. Science achievement tests were developed specifically for the JMG program and were given to students before and after gardening activities.
- Science achievement scores of the experimental groups significantly improved between pre- and post-test, while there was no significant difference between pre- and post-test scores in the control group. There was no effect of gender on science achievement test scores.
- Implications for the future:** More research needs to be conducted before researchers can definitively say that garden-based education positively affects student achievement scores.
- Salient Quotes:** “Organization and support of school gardening will hopefully be realized sometime in the future in many states; until then, more research into the benefits and effects of gardening is needed.” (pg. 439)
- “Our study focused on a predominantly African-American student population in low-income, inner-city public schools, with some of the students being from disadvantaged backgrounds. These are the students who truly need educators to find new ways of engaging their students in science learning activities.” (pg. 442)

Growing Environmental Stewards: The Overall Effect of a School Gardening Program on Environmental Attitudes and Environmental Locus of Control of Different Demographic Groups of Elementary School Children

O.M. Aguilar, T.M. Waliczek, and J.M. Zajicek (2008)

- Source:** Aguilar, O.M., Waliczek, T.M., & Zajicek, J.M. (2008). Growing environmental stewards: The overall effect of a school gardening program on environmental attitudes and environmental locus of control of different demographic groups of elementary school children. *HortTechnology*, 18(2), 243-249.
- Purpose:** "To examine an interdisciplinary and experiential approach to environmental education by use of a youth gardening program for third through fifth grade students and to evaluate the gardening program's effectiveness on promoting positive environmental attitudes and a high environmental locus of control with children"
- Setting:** 3rd-5th grade classrooms in elementary schools in Temple, TX
- Research Findings:** Although both experimental and control groups had positive environmental attitudes, there was no significant difference between the two groups. Additionally, there were no significant differences in environmental locus of control between the experimental and control groups.
- However, significant differences were noticed between different demographic groups. Girls scored significantly higher than boys and Caucasians scored significantly higher than African-American or Hispanic students with respect to both environmental attitude and environmental locus of control.
- Students with previous gardening experience had higher environmental attitudes and environmental locus of control when compared with students with no previous gardening experience, indicating that any gardening experience, regardless of whether or not it is in an educational setting, can have positive effects on children's environmental outlook.
- Implications for the future:** Future research should focus on developing garden curricula that specifically target boys and minorities.
- Salient Quotes:** "More than 80% of children in the study were involved in gardening to some extent, ...these past experiences appeared to have an effect on children's environmental attitudes and environmental locus of control." (pg. 247)

The Green Brigade: The Educational Effects of a Community-Based Horticultural Program on the Horticultural Knowledge and Environmental Attitude of Juvenile Offenders

Carol Cammack, Tina M. Waliczek, and Jayne M. Zajicek (2002a)

Source:	Cammack, C., Waliczek, T.M., & Zajicek, J.M. (2002a). The Green Brigade: The educational effects of a community-based horticultural program on the horticultural knowledge and environmental attitude of juvenile offenders. <i>HortTechnology</i> , 12(1), 77-81.
Purpose:	To determine if participation in the Green Brigade program improved horticultural knowledge and environmental attitude of juvenile offenders
Setting:	Juvenile offenders, primarily male and Hispanic with a mean age of 15, in a community-based horticultural program in Bexar Co., TX
Research Findings:	<p>Researchers found a significant improvement in the horticultural knowledge of participants after the 16-week program when compared with the pre-test ($p=.048$). No differences in horticultural knowledge were found due to gender, ethnicity, age, grade, or the Green Brigade session in which they participated. This finding indicates that the program was effective for all participants, regardless of demographics, at enhancing horticultural knowledge.</p> <p>Researchers also found a significant improvement in environmental attitude of participants following the 16-week program when compared with the pre-test ($p=.019$). Again, there were no differences in environmental attitude based on gender, ethnicity, age, grade, or Green Brigade session. However, there was a significant difference in environmental attitude based on the frequency of participation; those who participated in less than 60% of the session had significantly lower environmental attitude than those who participated more frequently ($p=.047$). This is likely a result of less exposure to topics and activities covered throughout the program.</p>
Implications for the future:	None identified.
Salient Quotes:	<p>“In the criminal justice system, horticulture programs are commonly used in the vocational training and rehabilitation of adult offenders, and are becoming more common in juvenile probation programs.” (pg. 77)</p> <p>“Findings from the Green Brigade study indicated that, while participants in the program lived in an urban setting, they had environmentally friendly attitudes towards animals and plants that became even more positive by the end of the project.” (pg. 80)</p>

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 and Jennifer Campbell Bradley (2007)

Source: Skelly, S.M., & Bradley, J.C. (2007). The growing phenomenon of school gardens: Measuring their variation and their affect on students' sense of responsibility and attitudes towards science and the environment. *Applied Environmental Education and Communication*, 6, 97-104.

Purpose: Assess the variation in school garden programs and examine what, if any, impacts the variation has on student's responsibility and attitudes toward science and the environment

Setting: 3rd grade students at elementary schools in Florida

Research Findings: Variation was calculated based on two constructs, 1) intensity (high, medium, or low) as a reflection of the total number of garden activities conducted by the classroom, and 2) form of the garden (vegetable, flower, or combination). Thus, there were nine possible typologies: high intensity-vegetable garden, high-intensity-flower garden, etc. Overall, no real trends emerged as to which type was most or least effective.

Responsibility: Responsibility scores were high across the board and did not vary significantly by typology. Over half the teachers reported using the garden to teach ethics, such as responsibility and nurturing.

Science Attitudes: There was a significant difference in science attitude scores based on typology ($p=.000$). The garden types with the highest scores were medium intensity-vegetable, and low- and high intensity-flower. Those with the lowest scores were low- and high intensity-vegetable. Individual differences in schools and classrooms, such as the teaching style and content, have a large influence on students' attitudes toward science.

Environmental Attitudes: Attitudes toward the environment were also high across the board, with no significant difference based on typology. About 67% of teachers reported using the garden to teach environmental education. A comparison between gardening and non-gardening students is needed to attribute environmental attitudes directly to the garden.

Implications for the future: Variation in garden programs exists, and therefore needs to be accounted for when conducting comparative studies.

Salient Quotes: "School gardens offer an ideal place to teach environmental education and to inform students about the environment and related issues." (pg. 103)

The Effect of an Interdisciplinary Garden Program on the Environmental Attitudes of Elementary School Students

Sonja M. Skelly and Jayne M. Zajicek (1998)

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

Purpose: "To evaluate whether students developed positive environmental attitudes by participating in gardening activities"

Setting: Project GREEN (Garden Resources for Environmental Education Now) program in 2nd and 4th grade classrooms at elementary schools in Texas

Research Findings: Students who participated in the Project GREEN program had significantly more positive overall environmental attitude scores when compared with the control group. Additionally, participants scored significantly higher than the control group on 30 of the 45 specific items of the survey instrument.

There was no effect of gender, ethnicity, or place of residence on environmental attitude scores. There was, however, a significant difference in with respect to age, with 2nd grade students exhibiting significantly more positive environmental attitudes than 4th grade students.

There was also a significant effect of the number of outdoor related activities on students' environmental attitudes; the more outdoor related activities students experienced during the program, the higher students' environmental attitude scores. However, no significant differences were found between students who had previous gardening experience and those who were gardening for the first time.

Implications for the future: Environmental education programs should start in early grades and be hands-on in order to have the biggest effect on students' environmental attitudes.

Salient Quotes: "The results from these analyses illustrate that a gardening program which provides hands-on experience with the environment may provide a means to foster positive environmental attitudes." (pg. 581)

"These results indicate that gardening alone does not have a significant impact on students' environmental attitudes and that some formal educational structure may be necessary to affect student's environmental attitudes." (pg. 582)

School Gardening: Improving Environmental Attitudes of Children Through Hands-On Learning

Tina M. Waliczek and Jayne M. Zajicek (1999)

- Source:** Waliczek, T.M., & Zajicek, J.M. (1999). School gardening: Improving environmental attitudes of children through hands-on learning. *Journal of Environmental Horticulture*, 17(4), 180-184.
- Purpose:** "1) Develop a garden activity guide and 2) evaluate whether students were developing positive environmental attitudes by participating in the school garden program"
- Setting:** 7 schools in TX and KS, with participants spanning grades 2-8, utilizing the Project GREEN (Garden Resources for Environmental Education Now) program
- Research Findings:** Using a 13-item environmental attitude survey, researchers found an overall significant increase in students' environmental attitudes from pre-test to post-test ($p=.087$). This change was noted in spite of the fact that children's environmental attitudes were already high at pre-test. Individual items on the survey that saw significant improvements included statements about endangered species ($p=.023$), littering ($p=.009$), and pollution ($p=.001$). However, attitudes towards one item, "We should use weed killer to kill the weeds on the roadsides of highways," were significantly worse at post-test ($p=.074$). The researchers attribute this to students learning that weeds in the garden are "bad plants" but not having discussions about the potential effects of chemicals on the environment.
- Though both were well above the "neutral" score at post-test, females saw significantly more positive environmental attitudes than did males ($p=.022$). Additionally, Caucasians' scores were significantly more positive than Hispanic students and African-American students ($p=.004$). Again, students of all ethnicities exhibited positive environmental attitudes. There were no significant effects of place of residence (urban vs. rural) or age of participants.
- Implications for the future:** Programs should discuss the difference between chemical and organic methods. Programs should also be developed to specifically target males and minority groups.
- Salient Quotes:** "Children's outdoor experiences are important in the long-term development of children because they impact career choices and conservation efforts. Findings from the Project GREEN school gardening research study indicated that gardening activities, accompanied by educational lessons, positively influenced children's environmental attitudes." (pg. 180)

Expanding Children's Food Experiences: The Impact of a School-Based Kitchen Garden Program

Lisa Gibbs, Petra K. Staiger, Britt Johnson, Karen Block, Susie Macfarlane, Lisa Gold, Jenny Kulas, Mardie Townsend, Caroline Long, and Obioha Ukoumunne (2013)

- Source:** Gibbs, L., Staiger, P.K., Johnson, B., Block, K., Macfarlane, S., Gold, L., ... Ukoumunne, O. (2013). Expanding children's food experiences: The impact of a school-based kitchen garden program. *Journal of Nutrition Education Behavior*, 45(2), 137-146.
- Purpose:** "Evaluate achievement of the *Stephanie Alexander Kitchen Garden [SAKG] Program* in increasing child appreciation of diverse, healthy foods"
- Setting:** Students in 3rd-6th grade, their teacher, and parents in 6 program and 6 comparison schools in Victoria, Australia
- Research Findings:** Qualitative: Four themes emerged from qualitative interviews, focus groups, and observations: 1) children eating and appreciating new foods, 2) impact on student engagement and learning, 3) social impacts on the broader school community, and 4) transfer of impacts to the home environment. Teachers and students perceived and increase in consumption of healthy foods. There was little impact on the students' ability to describe foods.
- Quantitative: Students increased their willingness to try new food if they had never tried it ($p=.03$), had cooked it ($p=.001$), and had grown it ($p<.001$). However, a parent survey found no significant difference in the children's willingness to try new foods ($p=.09$). Children's complexity of favorite foods and description of foods did not improve. A parent survey also indicated no significant difference in children's intake of fruits and vegetables, contrary to qualitative observations made at school.
- Implications for the future:** Further research is needed to explore the impact of garden programs on the home food environment and the long-term effects of garden programs on nutritional behaviors.
- Salient Quotes:** "The strength of the findings in terms of children's increased willingness to try new foods provides preliminary evidence of the success of the SAKG Program in achieving its primary objective... Nevertheless, the link between increased willingness to try new foods and increased fruit and vegetable intake is inconclusive." (pg. 145)
- "One principal reported how a young boy in a kitchen class had exclaimed in amazement: 'This tastes better than Maccas [McDonalds]!'" (pg.142)

Can a Community-based Intervention Improve the Home Food Environment?
Parental Perspectives of the Influence of the Delicious and Nutritious Garden
Stephanie Heim, Katherine W. Bauer, Jamie Stang, and Marjorie Ireland (2011)

Source: Heim, S., Bauer, K.W., Stag, J., & Ireland, M. (2011). Can a community-based intervention improve the home food environment? Parental perspectives of the influence of the Delicious and Nutritious Garden. *Journal of Nutrition Education and Behavior*, 43(2), 130-134.

Purpose: "To examine changes in parental report of the home food environment during the course of a garden-based fruit and vegetable intervention for grade school children"

Setting: 12-week YMCA summer camp in SE Minnesota for children entering grades 4-6

Research Findings: 99% of parents reported that their child enjoyed the garden program, and 88% said their child shared information about the garden with their family at least once/week.

Parents reported a significant increase in their child asking for fruits and vegetables at home, and home availability of fruits and vegetables significantly increased after the garden program. Parental encouragement of fruits and vegetables increased, though not significantly, and parental value of fruit and vegetable consumption significantly increased after the garden program. These data indicate that children's home food environments became increasingly supportive with respect to fruit and vegetable consumption.

Implications for the future: Interventions that target both children and parents could provide additional benefits, and professionals should consider programs that actively engage parents to promote changes in the home food environment.

Salient Quotes: Parent responses to open-ended questions included, "[My child] enjoyed tasting the fruits and vegetables and learned to like new vegetables. [She] now loves cucumbers and lettuce and snap peas. I am still working on tomatoes." and "I saw them [children] be more flexible and eat fruits and veggies more, try new things. I made more of an effort to make fruits and veggies accessible by cutting them up and keeping them in the fridge so they could just grab slices versus trying to eat the whole fruit or veggies." (pg. 132)

"A strength of the current pilot study was its ability to reach and engage parents through a child-focused intervention. To the best of the authors' knowledge, this is the first garden-based nutrition intervention that has examined outcomes from the parent perspective." (pg. 133)

A Garden Pilot Project Enhances Fruit and Vegetable Consumption among Children

Stephanie Heim, Jamie Stang, and Marjorie Ireland (2009)

Source: Heim, S., Stang, J., & Ireland, M. (2009). A garden pilot project enhances fruit and vegetable consumption among children. *Journal of the American Dietetic Association*, 109, 1220-1226.

Purpose: Evaluate Delicious and Nutritious Garden program participant satisfaction and determine whether participation increased fruit and vegetable exposure, preferences, self-efficacy, asking behavior, and home availability of vegetables among school-age children

Setting: 12-week YMCA summer camp in Minnesota for children entering grades 4-6

Research Findings: 97.8% of children enjoyed taste-testing fruits and vegetables, 93.4% enjoyed preparing fruits and vegetables as snacks, 95.6% enjoyed working in their garden, and 91.3% enjoyed learning about fruits and vegetables. Most children expressed interest in participating next year.

Children reported significant increases in the number of fruits and vegetables ever eaten, specifically cucumbers, spinach, snap peas, radishes, peppers, zucchini, beets, and cantaloupe. Children also reported a significant increase in vegetable preference. However, fruit preferences, which were high prior to the start of the program, remained unchanged.

Children's asking behavior for fruits and vegetables significantly increased, while their snack preferences, self-efficacy related to fruit and vegetable consumption, and home availability of fruits and vegetables did not change.

Implications for the future: Rigorous garden-based nutrition intervention research is needed with larger sample sizes and comparison groups. Professionals should consider nutrition education programs that connect children with healthy foods in fun, hands-on activities.

Salient Quotes: When asked what they like most about the program, student responses included: "Being able to pick fruits and vegetables and eat the same ones," "We got to make snacks that were really really good," "Trying different fruits and vegetables," "We learned about worldwide recipes!," and "I liked that we did it ourselves and we have the pride for it." (pg. 1223)

"These results support previous findings that increased fruit and vegetable exposure may influence preferences for and, subsequently, intake of fruits and vegetables." (pg. 1224)

The Effect of a Summer Garden Program on the Nutritional Knowledge, Attitudes, and Behaviors of Children

S. Koch, T.M. Waliczek, and J.M. Zajicek (2006)

Source: Koch, S., Waliczek, T.M., & Zajicek, J.M. (2006). The effect of a summer garden program on the nutritional knowledge, attitudes, and behaviors of children. *HortTechnology*, 16(4), 620-625.

Purpose: To evaluate the effect of a nutrition education garden program on nutritional knowledge, attitudes, and eating behaviors of children

Setting: 2nd-5th grade participants across four counties in Texas (non-school settings)

Research Findings: Knowledge scores improved significantly during and after the program ($p < .001$). Each age level and gender saw significant increases in knowledge, and there were no significant differences between students of different age levels, gender, ethnicities, or counties of residence.

There were no significant changes in fruit or vegetable preferences during or after the program. However, fruit preference scores were consistently high among participants.

Researchers used a 5-question interview to better assess students' perceptions of healthy eating. Overall, there was a significant increase in interview scores after the program ($p < .001$). Specifically, students were better able to place foods in the correct food groups ($p < .001$) and reported eating significantly healthier snacks ($p = .001$).

Implications for the future: Healthy eating habits are formed early in life, and improvements in eating habits among America's youth are needed.

Salient Quotes: "These results indicate that the *Health and Nutrition in the Garden* curriculum is effective for younger as well as older children, and for both males and females." (pg. 623)

"All of the preference test scores were high, indicating that children had a positive attitude toward fruit and vegetables before, during, and after participating in the program. This was an encouraging finding since food preference, or nutritional attitudes, have a strong relationship to food consumption." (pg. 623)

"These results indicated that students had a better understanding of the food groups after participating in the *Health and Nutrition in the Garden* program. However, often there is a gap between the understanding and awareness and the actual consumption of fruit and vegetables." (pg. 624)

Understanding Gardening and Dietary Habits among Youth Garden Program Participants using the Theory of Planned Behavior

Lauren Lautenschlager and Chery Smith (2007)

Source: Lautenschlager, L. & Smith, C. (2007). Understanding gardening and dietary habits among youth garden program participants using the Theory of Planned Behavior. *Appetite*, 49, 122-130.

Purpose: "To evaluate whether a garden project could change eating or gardening behavior among urban youth using the Theory of Planned Behavior model."

Setting: A multi-cultural garden education program in Minneapolis/St. Paul, MN, participants aged 8-15

Research Findings: The Theory of Planned Behavior model was successful in explaining the variance in intention and behavior in this group of students.

There was an overall significant increase in the consumption of fruits and vegetables by the end of the program. When broken down by gender, however, only boys, and not girls, showed significant increases in consumption patterns.

No association was found between intention and behavior among boys. Subjective norm (i.e. peer pressure) and attitude were both significantly correlated with boys' intention to change.

Among girls, however, a significant association was found between intention and behavior on the pre-survey, but not on the post-survey. Again, attitude and subjective norm were both significant indicators for intention to change, and behavior was significantly correlated to girls' perceived behavioral control (PBC).

A high level of intention among boys marginally predicted some post-survey behavior, as those who indicated the intention to learn more about planting or weeding a garden did follow through with these post-survey behaviors. However, girls' high level of pre-survey intention did not result in positive post-survey behavioral changes.

Implications for the future: Practitioners must bear in mind the multiple factors that influence gardening and dietary behavior in youth when developing future garden programs that promote gardening and healthy eating among youth.

Salient Quotes: "In order for garden programs to play a role in improving gardening and dietary habits, an understanding of youth attitudes, subjective norms, and PBC is needed." (pg. 129)

An Evaluation of Inner-City Youth Garden Program Participants' Dietary Behavior and Garden and Nutrition Knowledge

Lauren Lautenshlager Beckman and Chery Smith (2008)

- Source:** Lautenshlager Beckman, L. & Smith, C. (2008). An evaluation of inner-city youth garden program participants' dietary behavior and garden and nutrition knowledge. *Journal of Agricultural Education*, 49(4), 11-24.
- Purpose:** To investigate whether participation in a youth inner-city garden program affects garden and nutrition knowledge or dietary behavior
- Setting:** A 10-week garden program for inner-city, multi-ethnic youth ages 8-15 in Minneapolis, MN
- Research Findings:** Boys: Nutrition/gardening knowledge score significantly increased from pre- to post-test. Additionally, consumption of both fruits and vegetables significantly increased by the end of the program. No significant changes were found in the consumption of other food groups.
- Girls: Nutrition/gardening knowledge scores did not significantly increase between pre- and post-tests. One individual question, however, did show a significant improvement ("protein is found in cheese and soy"). Consumption of meat, but no other food groups, significantly increased after the program.
- Implications for the future:** Long-term behavior change is unknown and future research is warranted. Age and gender differences in regards to learning styles also require attention.
- Salient Quotes:** "An inappropriate nutrition and/or garden curriculum for the younger age group (e.g., 8 to 10 years) may also explain the limited change in knowledge at post-survey." (pg. 19)
- "No U.S. research to date has evaluated changes in knowledge, nutrients, or other food groups after garden program participation, particularly with inner-city youth." (pg. 21)
- "Garden programs have the potential to positively impact inner-city youth nutrition and gardening knowledge, and dietary behaviors. Most importantly, youth appeared to be empowered to try new behaviors (e.g., cooking, gardening, eating new and healthy foods) as a result of participation in this program." (pg. 22)

Garden-Based Nutrition Education Affects Fruit and Vegetable Consumption in Sixth-Grade Adolescents

Jessica D. McAleese and Linda L. Rankin (2007)

- Source:** McAleese, J.D., & Rankin, L.L. (2007). Garden-based nutrition education affects fruit and vegetable consumption in sixth-grade adolescents. *Journal of the American Dietetic Association*, 107, 662-665.
- Purpose:** “To measure the effects of garden-based education on fruit and vegetable consumption”
- Setting:** 6th grade classrooms at elementary schools in SE Idaho
- Research Findings:** Three groups were used: one with no intervention (control group), one with 12 weeks of nutrition education only, and one with 12 weeks of nutrition education and complementing garden activities.
- No significant differences in fruit, vegetable, or nutrient intake were found based on sex or age. No significant changes occurred at the control school or the non-garden nutrition education school.
- Fruit servings, vegetable servings, vitamin A intake, vitamin C intake, and fiber intake all significantly increased after the intervention for students who received the garden-based nutrition intervention. Combined fruit and vegetable servings more than doubled among students after receiving the garden-based nutrition intervention.
- Implications for the future:** Effective nutrition education programs should include hands-on exposure to fruits and vegetables through the use of gardens
- Salient Quotes:** “Our study’s findings show that garden-based nutrition education did have a significant effect on adolescents’ consumption of fruits and vegetables and selected nutrient intake.” (pg. 663)
- “These results help to show the importance of hands-on activities when attempting to change nutrition-related behavior such as fruit and vegetable consumption.” (pg. 664)

The Impact of Nutrition Education with and without a School Garden on Knowledge, Vegetable Intake and Preferences and Quality of School Life Among Primary-School Students

Philip J. Morgan, Janet M. Warren, David R. Lubans, Kristen L. Saunders, Gabrielle I. Quick, and Clare E. Collins (2010)

- Source:** Morgan, P.J., Warren, J.M., Lubans, D. R., Saunders, K.L., Quick, G.I., & Collins, C.E. (2010). The impact of nutrition education with and without a school garden on knowledge, vegetable intake, and preferences and quality of school life among primary-school students. *Public Health Nutrition*, 13(11), 1931-1940.
- Purpose:** To measure the effects of a garden-based nutrition program on fruit and vegetable knowledge, preference, and intake, as well as quality of school life
- Setting:** 5th and 6th grade students in New South Wales, Australia
- Research Findings:** Three groups were used in this study, one receiving 10 weeks of classroom nutrition education (NE), one receiving the same nutrition education plus work in a school garden (NE+G), and a control group receiving no treatment (CG).
- At post-test, NE+G and NE groups were significantly more willing to taste vegetables ($p < .001$) and had higher vegetable preference ratings ($p < .001$) when compared with CG. No overall between-group differences were noted for vegetable knowledge or ability to identify vegetables. However, among students with the lowest pre-test scores, NE+G made significant gains in vegetable knowledge ($p = .02$) and ability to identify vegetables ($p < .001$) when compared with NE and CG. This finding indicates the school garden is most effective for students who are most in need of a nutrition intervention. No between-group differences were found for vegetable intake, fruit intake, or quality of school life.
- Interestingly, many of the individual vegetables in the survey were not grown in the school garden, yet NE+G were more willing to eat many vegetables as snack when compared with NE and CG. This indicates that garden exposure to certain vegetables may potentially increase outlook toward vegetables in general.
- Implications for the future:** Research is needed to explore the sustainability of school gardens over long periods of time, as well as effective nutrition behavior intervention methods.
- Salient Quotes:** "Increasing vegetable intake is difficult due to the complex nature of children's eating behaviour, which is also substantially influenced by adults, and can be particularly difficult to change in short-term interventions." (pg. 1937)
- "These findings have implications for the targeting of programmes to those students who may benefit the most." (pg. 1938-1939)

School Gardens: An Experiential Learning Approach for a Nutrition Education Program to Increase Fruit and Vegetable Knowledge, Preference, and Consumption among Second-grade Students

Sondra M. Parmer, Jill Salisbury-Glennon, David Shannon, and Barbara Struempler (2009)

- Source:** Parmer, S.M., Salisbury-Glennon, J., Shannon, D., & Struempler, B. (2009). School gardens: An experiential learning approach for a nutrition education program to increase fruit and vegetable knowledge, preference, and consumption among second-grade students. *Journal of Nutrition Education & Behavior*, 41, 212-217.
- Purpose:** “To examine the effects of a school garden on children’s fruit and vegetable knowledge, preference, and consumption”
- Setting:** 2nd grade students at an elementary school in Southeastern United States
- Research Findings:** Three treatment groups were used: nutrition education and gardening (NE+G), nutrition education only (NE), and a control group with no intervention (CG).
- Nutrition Knowledge: There was a significant increase in food group knowledge from pre- to post-test, but this increase could not be attributed to group assignment. However, both treatment groups (NE and NE+G) had significantly greater knowledge gains in nutrient-food association, nutrient-job association, and fruit and vegetable identification over time than did the CG. The NE+G group was significantly better able to identify certain fruits and vegetables.
- Preference: Though all three groups experienced an increase in willingness to try new fruits and vegetables over time, treatment groups (NE and NE+G) exhibited a greater willingness than did CG. NE and NE+G both rated fruits and vegetables significantly better tasting than did CG, with the NE+G group showing greater changes than the NE group.
- Consumption: NE+G group was significantly more willing to choose vegetables during school lunch at post-test vs. pre-test than was NE or CG. NE+G ate significantly more vegetables at post-test, NE had no significant changes, and CG ate significantly fewer vegetables at post-test.
- Implications for the future:** Future research should consider using a variety of fruits, as the only fruits specifically addressed in this study was blueberries. Future research is also needed in more diverse populations.
- Salient Quotes:** “Although nutrition education alone does seem to improve fruit and vegetable knowledge and preference in children, adding the gardening component appears to strengthen the likelihood that children will increase vegetable intake.” (pg. 216)

The Effects of School Garden Experiences on Middle School-Aged Students' Knowledge, Attitudes, and Behaviors Associated with Vegetable Consumption
Michelle M. Ratcliffe, Kathleen A. Merrigan, Beatrice L. Rogers, and Jeanne P. Goldberg (2011)

- Source:** Ratcliffe, M.M., Merrigan, K.A., Rogers, B.L., & Goldberg, J.P. (2011). The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health Promotion Practice*, 12(1), 36-43.
- Purpose:** Investigate "the impact of participating in a school garden program on low-income, racially and ethnically diverse urban middle school-aged students' ability to identify, willingness to try, preference for, and overall consumption of vegetables"
- Setting:** 6th grade classrooms in the San Francisco Unified School District, California; participants were predominantly low-income and students of color
- Research Findings:** A taste test measured students' ability to identify, willingness to taste, preference for, and consumption of five specific vegetables. Garden students could identify significantly more vegetables and significantly increased their consumption of vegetables at school compared with the control group. However, there was no significant difference between groups with respect to willingness to taste, preference for, or at home consumption of vegetables.
- A self-report questionnaire measured students' preference, willingness to taste, and consumption of vegetables. By the end of the program, garden students had significantly higher preferences, were significantly more willing to taste, and consumed significantly more varieties of vegetables compared with the control group.
- Implications for the future:** School gardens can substantially contribute to federally mandated school wellness policies. Nutrition interventions should be coupled with hands-on experience. Garden education programs should engage home and community to affect students' consumption patterns outside of school. Research is needed to gauge the long-term impacts of garden programs.
- Salient Quotes:** "Results from this study indicate that hands-on garden-based learning experiences can increase low-income urban middle school-aged students' ability to identify vegetables correctly, increase the variety that they eat, and increase their consumption of different vegetable varieties at school." (pg. 41)
- "Because interest in evidence-based school garden interventions is relatively recent, a more coordinated effort among academics and advocates would strengthen programs, practices, and policies." (pg. 42)

The Green Brigade: The Psychological Effects of a Community-Based Horticultural Program on the Self-Development Characteristics of Juvenile Offenders

Carol Cammack, Tina M. Waliczek, and Jayne M. Zajicek (2002b)

Source: Cammack, C., Waliczek, T.M., & Zajicek, J.M. (2002). The Green Brigade: The psychological effects of a community-based horticultural program on the self-development characteristics of juvenile offenders. *HortTechnology*, 12(1), 82-86.

Purpose: "To determine if participation in the Green Brigade horticultural program resulted in the improved self-esteem, attitude toward school, locus of control, and/or interpersonal relationships of juvenile offenders"

Setting: Juvenile offenders, primarily male and Hispanic with a mean age of 15, in a horticultural treatment and diversion program in San Antonio, TX

Research Findings: Participants scored significantly worse than a comparative group on interpersonal relationships, attitudes towards school, and self-esteem prior to the program. After the program, participants' self-esteem scores were no longer significantly worse than the comparative group, though this was not the case for interpersonal relationships and attitudes towards school. No pre- or post-test differences in locus of control between the two groups were noted.

Among the participants, there was no significant improvement in any of the variables measured from pre- to post-test. Additionally, no differences were found based on gender, ethnicity, age, or grade-level. However, significant differences in participants' interpersonal relationships were found based on which session of the program youth attended, which could be attributed to the types of horticultural projects the different sessions focused on. Lastly, there were no significant differences on rates of repeated offense after the program when compared to a traditional probationary program.

Implications for the future: Research needs to be done to determine the optimal program length and to test which components of horticultural, community-based programs are more effective at improving psychological characteristics of juvenile offenders.

Salient Quotes: "In terms of benefits to the San Antonio community, the program was just as effective as traditional probationary programming in the reduction of crimes, and the program provided a service to the city residents by cleaning and beautifying areas through landscaping." (pg. 86)

"Since the Green Brigade program was a short-term probationary program, it may not have been long enough to influence complex psychological variables, especially when the program focused on only a few facets of the participants' lives, such as job training." (pg. 86)

Garden Affordances for Social Learning, Play, and for Building Nature-Child Relationship

Taina Laaksoharju, Erja Rappe, and Taina Kaivola (2012)

- Source:** Laaksoharju, T., Rappe, E., & Kaivola, T. (2012). Garden affordances for social learning, play, and for building nature-child relationship. *Urban Forestry & Urban Greening*, 11, 195-203.
- Purpose:** To examine what kind of affordances a garden camp provides children and how children act upon those affordances
- Setting:** A summer garden camp in Helsinki, Finland for students aged 7-12
- Research Findings:** Students were excited about garden work. Instructors described participants as enthusiastic, persistent, peaceful, and helpful. Instructors noted that students began to initiate projects toward the end of camp. Some students exhibited dissatisfaction, but these tapered off as camp duration progressed.
- The garden provided opportunities for enriched social interaction. Students learned life skills such as social manners, affection, trust, and work ethic through many garden affordances, such as access to natural materials, peer-gardening, diverse wildlife, and open spaces for running, hiding, and climbing.
- Children diversified their play, which fell into two main categories: child-initiated (non-structured) play and adult-initiated (structured) play. Non-structured play tended to focus on imaginary games, role-playing, mud play, garden play, climbing trees, and water play. Many affordances enabled non-structured play, including plants, trees, soil, wildlife, running space, open air, and friends. Structured play tended to focus on educational, physically active, calming, and competitive games. Even during garden work times, children “were masters in turning work into fun.”
- Implications for the future:** When planning garden activities, adults should adopt a flexible, child-centered attitude with opportunities for encountering natural environments. Future researchers should develop a methodology that enables trustworthy relationships with children to better gain the child’s perspective.
- Salient Quotes:** “Along with the growth in a garden, friendships deepened and children expressed pride of their work. In addition, they were often helpful to each other: ‘Children [. . .] often weed each other’s plots and this kind of reciprocity is truly gratifying’ (Group leader, 2008).” (pg. 199)
- “Gardening in a naturally rich environment can have a positive influence on the learning of social skills, work ethics and engagement with nature...When given the time and the place, [the children] willingly seized the affordances and created their own social and individual worlds within the context. (pg. 202)

Growing Minds: The Effects of a One-Year School Garden Program on Six Constructs of Life Skills of Elementary School Children

Carolyn W. Robinson and Jayne M. Zajicek (2005)

Source: Robinson, C.W., & Zajicek, J.M. (2005). Growing Minds: The effects of a one-year school garden program on six constructs of life skills of elementary school children. *HortTechnology*, 15(3), 453-457.

Purpose: "To assess changes in the life skill development of elementary school students participating in a 1-year school garden program"

Setting: 3rd-5th grade elementary classrooms in Fort Worth, TX and Temple, TX

Research Findings: Program participants experienced a significant increase in overall life skills from pre- to post-test, while there was no difference among the control group students. Grade, gender, and ethnicity showed no bearing on overall life skills scores for program participants.

When comparing specific components of participants' pre- and post-test scores, there was a significant increase in the working with groups and self-understanding constructs. No differences were found in the leadership, decision-making, communication, or volunteerism constructs.

Implications for the future: School garden programs have the potential to aid in the development of life skills among elementary students.

Salient Quotes: "It would appear that this program had a positive influence on the students' overall life skills development regardless of age, gender, or ethnicity." (pg. 455)

"The youth that participated in the year-long garden program increased their overall life skills as well as improved teamwork skills and self-understanding. These skills are extremely important to ensure socially responsible and productive citizens." (pg. 456)

Garden-Based Learning: An Experience with “At Risk” Secondary Education Students

Jose-Reyes Ruiz-Gallardo, Alonso Verde, and Arturo Valdes (2013)

- Source:** Ruiz-Gallardo, J.-R., Verde, A., & Valdes, A. (2013). Garden-based learning: An experience with “at risk” secondary education students. *Journal of Environmental Education*, 44(4), 252-270.
- Purpose:** To determine the influence of a GBL [garden-based learning] program on “disruptive and low-performance secondary school students”
- Setting:** 63 students aged 15-18 in Spain, each with disruptive behavior disorders (DBDs) and/or low-performance in school
- Research Findings:** Academic Success: Participants passed a significantly higher number of school subjects after the GBL program than they had the previous year ($p < .001$). Over the six years of the GBL program, graduation rates progressively increased, while dropout and failure rates progressively decreased.
- Disruptive Behavior Disorders: The GBL program significantly improved all measures of DBDs ($p < .001$ for each measure), which include failure to comply with teacher request within 5 seconds, use of obscene vocabulary, disturbance of peers, taking a different direction from that of teacher or assignment, and number of class expulsions.
- Qualitative Observations: Teachers and parents noticed many changes in participants after participating in the GBL program. Attitudes toward school improved, as noted by a more regular attendance, increased participation in class, and formerly disruptive students discouraging their peers’ disruptive behaviors. Student responsibility increased as students showed a commitment to and ownership of their work. Self-esteem and confidence also improved and students expressed pride and satisfaction in completing activities. Finally, students developed many skills, from the practical skills of garden maintenance to life skills such as critical thinking.
- Implications for the future:** Research should focus on students’ behaviors outside of school. Research is also needed to assess medium- and long-term effects of GBL programs, as well as to determine which portion of success is directly attributed to GBL.
- Salient Quotes:** “Explanations for these changes are neither singular nor simplistic. The reality is that GBL provides these types of young people with opportunities to demonstrate their competence, overcoming a continuous sense of failure that has been generated in the traditional school system.” (pg. 264)

The Effect of School Gardens on Children's Interpersonal Relationships and Attitudes Toward school

T.M. Waliczek, J.C. Bradley, and J.M. Zajicek (2001)

Source: Waliczek, T.M., Bradley, J.C., & Zajicek, J.M. (2001). The effect of school gardens on children's interpersonal relationships and attitudes toward school. *HortTechnology*, 11(3), 466-468.

Purpose: To determine if a school garden program influences students' interpersonal relationships and attitudes toward school

Setting: 2nd-8th grade classrooms in seven schools throughout TX and KS

Research Findings: There were no statistically significant differences found in comparison between gardening and control groups with respect to interpersonal relationships or attitude toward school. However, some demographic differences were noted.

Gender: At post-test, females had significantly more positive attitudes toward school than males ($p < .001$). No differences were noted in interpersonal relationships based on gender.

Grade: There was a significant difference in interpersonal relationship scores with respect to grade level ($p < .001$), with 7th grade students having the highest scores. Researchers speculate this could be due to older students being allowed more independence in the garden. No differences were found in attitude toward school with respect to grade level.

School: There was a significant difference in attitudes toward school based on individual school ($p = .029$), with students in schools allowing for more individual participation in the garden reporting overall higher attitudes toward school. No differences were found in interpersonal relationships based on school.

Implications for the future: None identified.

Salient Quotes: "Results from this study show that school gardening can not only give children important interactions with the natural world, but may impact the psychological factors of particular groups of children." (pg. 468)

Gardening as a Learning Environment: A Study of Children's Perceptions and Understanding of School Gardens as Part of an International Project

Rob Bowker and Penni Tearle (2007)

Source: Bowker, R., & Tearle, P. (2007). Gardening as a learning environment: A study of children's perceptions and understanding of school gardens as part of an international project. *Learning Environments Research*, 10(2), 83-100.

Purpose: Consider the impact of Gardens for Life (GfL), an international project, on children's perceptions of school gardening and on their learning

Setting: Students aged 7-14 in six GfL schools in England, Kenya, and India

Research Findings: Qualitative methods were used to gauge students' perceptions, including concept maps, interviews, observations, and drawings.

The most frequent concepts to appear in students' concept maps were "garden features & design" and "fruit & vegetables" (England), "gardening activity & knowledge" and "curriculum & community links" (India), and "gardening activity & knowledge" and "fruit and vegetables" (Kenya). When comparing the depth of students' accuracy and understanding expressed in concept maps, Kenyan students scored highest (3.3 out of 5), followed by India (2.8), then England (2.2). Students' drawings were supportive of concept map findings.

English students perceived the garden as a place for pleasure, leisure, play, and enjoyment, while Indian and Kenyan students perceived the garden as being a place of learning, community, security, and peace. Kenyan gardens were large and grew staple crops, Indian schools tended toward container gardening, and English schools grew vegetables and flowers but not in large quantities. Kenyan students had high understanding of tools, soil types, and ecology, while Indian students were very aware of weather and ecology. English students showed no awareness of agriculture or health related to school gardening.

Many students expressed a positive impact of the garden on school experiences and learning. All students expressed positive attitudes towards school gardening, and the "feel good factor" was strong across all three countries.

Implications for the future: Further research is need to address how school gardening affects children's academic and emotional learning

Salient Quotes: Selected quotes from participating students:
 "We use jembes to dig and we usually plant cabbages, kale, spinach, carrots and many others." – [Kenyan student] (pg. 96)
 "We must care for plants to care for the world." – [Indian student] (pg. 96)
 "English children used words such as 'enjoyable' and also talked in terms of the garden being 'fun', 'colourful' and 'a place to get messy'." (pg. 96)

Multicultural School Gardens: Creating Engaging Garden Spaces in Learning about Language, Culture, and Environment

Amy Cutter-Mackenzie (2009)

Source: Cutter-Mackenzie, A. (2009). Multicultural school gardens: Creating engaging garden spaces in learning about language, culture, and environment. *Canadian Journal of Environmental Education*, 14, 122-135.

Purpose: Gauge the impact of a multicultural school garden program on language, culture, and the environment

Setting: The multicultural school gardens program (Afghani and Sudanese refugees, ages 6-12) at Dalem Primary School in the Dandenog region of Melbourne, Australia, “one of the most multicultural cities in the world”

Research Findings: The garden provided a sense of belonging among participants and enhanced teachers’ cultural awareness. The garden also engaged students in learning English through reading instructions and recipes, writing, and talking. Students enjoyed the garden as it provided a chance to “slow down” and get outside of the classroom.

Students helped design and construct their garden spaces, an opportunity missing from most youth garden programs. Children’s actual knowledge of plants was lacking, though the focus of the school garden was on the experience. Students tended to view gardening as positive environmental behavior and made students feel empowered. However, the researcher noted a deep environmental interconnectedness was not evident.

Implications for the future: Longer-term gardening programs may strengthen students’ environmental connection.

Salient Quotes: The garden led to “a sense of belonging for students newly arrived to the country that was an ongoing challenge for the school previously.” – [ESL teacher] (pg. 129)

“The garden’s primary aim is to foster a good rounded education on the environment through real life learning.” – [EE coordinator] (pg. 130)

“The garden is definitely good for the school. Obviously there is the healthy eating, and we will have somewhere to relax and somewhere to “slow down” a bit. It is so enjoyable being in the garden, we should have done this a long time ago!” – [Student] (pg. 131)

“Children’s gardening [has the potential] to transcend language and cultural differences, therein providing authentic learning opportunities that extend well beyond previous expectations of school gardening programs.” (pg. 134)

The Seeds of Learning: Young Children Develop Important Skills through their Gardening Activities at a Midwestern Early Education Program

Dana L. Miller (2007)

Source: Miller, D.L. (2007). The seeds of learning: Young children develop important skills through their gardening activities at a Midwestern early education program. *Applied Environmental Education and Communication*, 6, 49-66.

Purpose: To examine the benefits of garden-based learning for preschool and kindergarten children

Setting: Early Education Program in Lincoln, NE

Research Findings: Three broad themes emerged from the data: 1) students were able to communicate about their world, through verbalization, showing, drawing, and/or writing, 2) children were showing emotions related to garden experiences, including feeling more connected, taking risks, developing self-confidence, and mastering their fears, and 3) many important skills were developed, such as visual-spatial, language, science, math, body awareness, interpersonal, and intrapersonal skills.

Art elements, such as pattern, shape, color, and texture, were included throughout students' work and exploration. In creating representations of the garden through words or drawings, children used fine motor skills, classification, and visual memory. One student collected "smell samples" of certain leaves to share with the group. Two girls, who were initially afraid of bees, left their colorful drawings among the flowers to attempt to attract bees.

Implications for the future: Research should focus on garden-based learning in early education programs and the potential benefits of young children's connection to nature.

Salient Quotes: "Our findings suggest that important personal growth, skill development, academic learning, and environmental awareness are occurring at the preschool and kindergarten level through children's experiences in the garden/greenhouse." (pg. 64)

Emotions conveyed by children included, "tomatoes are yummy," and "feel sorta bad – tomatoes got squished." (Table 5, pg. 59)

"Teachers described how much 'richer' children's conversations are because they are developing an 'incredible vocabulary'." (pg. 63)

Environmental Education in Botanic Gardens: Exploring Brooklyn Botanic Garden's Project Green Reach

Susan Conlon Morgan, Susan L. Hamilton, Michael L. Bentley, and Sharon Myrie (2009)

- Source:** Morgan, S.C., Hamilton, S.L, Bentley, M.L., and Myrie, S. (2009). Environmental education in botanic gardens: Exploring Brooklyn Botanic Garden's Project Green Reach. *Journal of Environmental Education*, 40(4), 35-52.
- Purpose:** "To investigate the long-term influence of a hands-on gardening program on urban youth" and "to document the PGR program as a model for informal science and plant-based education"
- Setting:** Project Green Reach (PGR), an after-school and summer program for students in K-8 Title I schools at the Brooklyn Botanic Garden in Brooklyn, New York
- Research Findings:** Seven themes emerged from participant observations and alumni interviews:
- 1) Challenging home and school environments: PGR reaches out to high-needs, inner city youth by targeting Title I schools and offering free transportation.
 - 2) Academic and interdisciplinary skills: Participants developed science, reasoning, writing, speaking, geography, art, and cooking skills. Student work included poems, songs, art, and family history projects related to gardening.
 - 3) Understanding of science concepts and gardening skills: Participants conducted experiments with plants while at PGR. Participants expressed a competence to garden and expressed a desire to do so in the future.
 - 4) Environmental awareness and appreciation: PGR changed students' consciousness toward nature. Students were aware of their outdoor environment and engaged in caring for crops and observing wildlife.
 - 5) Social development and growth: Participants appreciated the opportunity to make new friends and work with partners in their garden plots. Some students returned for a second summer as mentors to new students.
 - 6) Positive life experience: Students describe PGR as "fun," "productive," and "meaningful." Students were "excited and proud" to receive their certificate and would recommend the program to others. Parents described how PGR helped keep their children "off the streets" and perform better in school.
 - 7) Culturally significant to the participants' community: The central location of the Botanic Gardens made it visible and relevant to participants' everyday lives. The diversity of the staff mirrored the diversity of participants, and projects focused on cultural and family history related to food and gardening.
- Implications for the future:** There is a need for Brooklyn Botanic Gardens to better maintain alumni records for more well-rounded research. Future studies should include focus groups and longitudinal tracking of students through the program and beyond.
- Salient Quotes:** One mother said the program "turned around her daughter's life; she now loves science; whereas she had been doing very poorly in science she now is top in her class, takes care of the principal's plants and helps the teacher with plant information; she love science." (pg. 47)

The Child in the Garden: An Evaluative Review of the Benefits of School Gardening
Dorothy Blair (2009)

- Source:** Blair, D. (2009). The child in the garden: An evaluative review of the benefits of school gardening. *Journal of Environmental Education*, 40(2), 15-38.
- Purpose:** To address whether a school garden can cause “measureable and observable changes in student achievement and behavior”
- Setting:** U.S. literature on children’s gardening programs
- Research Findings:** Rationales for school gardening include broadening children’s experience of ecosystem complexity, place-based learning, teaching food system ecology, shaping environmental attitudes and values, and developing cognitive skills.
- Quantitative studies have most frequently measured science achievement, nutrition knowledge, and food behavior changes. 9 of 12 quasi-experimental, pre-test/post-test studies revealed significant, positive effects on the outcomes measured. Qualitative studies, on the other hand, have most often researched agricultural education and have a wide variety of research methods. Out of 7 qualitative studies reviewed, some emergent themes included all studies reporting student enjoyment of the garden and improved attitude toward school and all studies reporting the use of team-building efforts and a variety of learning opportunities. Another common approach was to evaluate principals’ and teacher’s perceptions of the effectiveness of school gardens.
- Methodological problems were noted in many of the studies reviewed, suffering from bias, a lack of rigor, and the use of invalid, unreliable test instruments. This review also found that teachers are lacking in support and training with respect to school gardens. More needs to be done to help educators remove barriers.
- Implications for the future:** Researchers should focus on conducting longitudinal studies, using valid instruments, and controlling for variables such as teacher effects and demographics. More qualitative studies of high-functioning school gardens, studies of reasons for garden failure, and studies examining ways to eliminate teacher barriers are also needed.
- Salient Quotes:** “The results of qualitative, quantitative, and survey research have supported the conclusion that school gardening can improve students’ test scores and school behavior. Teachers believe that gardens promote academic instruction. However, methodological shortcomings of the quantitative studies have reduced faith in these results.” (pg. 35)

Impact of Garden-Based Youth Nutrition Intervention Programs: A Review
 Ramona Robinson-O'Brien, Mary Story, and Stephanie Heim (2009)

- Source:** Robinson-O'Brien, R., Story, M. & Heim, S. (2009). Impact of garden-based youth nutrition intervention programs: A review. *Journal of the American Dietetic Association*, 109(2), 273-280.
- Purpose:** Evaluate existing peer-reviewed literature regarding youth nutrition intervention programs
- Setting:** 11 articles published from 1990-2007 in peer-reviewed literature evaluating youth garden programs' impacts on nutrition-related outcomes
- Research Findings:** Of four studies evaluating fruit and vegetable intake, three reported an increase in consumption while one saw no significant improvements. Of six studies evaluating fruit and vegetable preferences, two reported improvements in preferences and four reported no changes. Of three studies on willingness to taste fruits and vegetables, only two reported an increase.
- Four studies found an association with nutrition knowledge while two found no improvement after the intervention. Other outcomes included self-efficacy to consume fruits and vegetables, intake of certain nutrients, increased likelihood to cook, and an increased appreciation for others' cultures.
- Methodological concerns arose, as most researchers used different evaluation tools and were limited by small sample sizes, lack of long-term data, lack of control groups, and convenience samples which may invoke self-selection bias.
- Implications for the future:** Investigating creative and effective healthful eating initiatives is imperative in light of high obesity rates. Statistically rigorous research is needed, and professionals should convene a workgroup to address these concerns.
- Salient Quotes:** "The evidence for the effectiveness of garden-based nutrition education is promising. ... However, it is difficult to make conclusions based on the limited number of well-designed, methodologically peer-reviewed research studies available." (pg. 279)

Impact of Garden-Based Learning on Academic Outcomes in Schools: Synthesis of Research Between 1990 and 2010

Dilafruz R. Williams and P. Scott Dixon (2013)

Source: Williams, D.R. & P.S. Dixon (2013). Impact of garden-based learning on academic outcomes in schools: Synthesis of research between 1990 and 2010. *Review of Educational Research*, 83(2), 211-235.

Purpose: To “determine what the landscape of research indicates about the impact of garden-based learning on academic outcomes”

Setting: Studies from 1990-2010, both published and unpublished, that reported on academic outcomes of garden-based learning connected with schools for a minimum of one hour every two weeks

Research Findings: Garden-based learning in the U.S. is a convergence of obesity, health, and food insecurity concerns and the No Child Left Inside movement. School gardens have multiple purposes, including personal development, environmental learning, nutrition and food literacy, and formation of community ties.

Of the academic outcomes addressed, science was most common, followed closely by language arts and math. Moreover, science had the highest proportion (93%) of positive effects, followed by math (80%) and language arts (72%). Two of three measures of writing were positive, as was the only study to examine social studies. Across all direct academic outcomes measured, 82% were positive, 3% negative, and 15% no impact. Of studies that measured indirect academic outcomes (i.e. environmental attitudes), 80% were positive, 1% negative, and 19% neutral.

Of the studies reviewed, 50% were quantitative, 27% mixed-methods, and 23% qualitative. Descriptions of sample characteristics such as gender, ethnicity, socioeconomic status, and school setting were often limited, and few used equivalent control groups. Nearly half of studies focused on 3rd-5th grade students and very few appeared at the high school level.

Implications for the future: The authors call for well-designed studies and offer a template to serve as a framework for future research on garden-based learning.

Salient Quotes: “These findings speak to the potential of garden programs in benefitting academic and academic-related outcomes.” (pg. 225)

“In general, the body of research on garden-based education lacked focus and clarity given the myriad outcomes reported. ...The movement falls short in that there has not been a parallel focus on rigorous research to understand the academic learning outcomes in a systematic manner.” (pg. 226)