

GARDENING ACTIVITIES AT SCHOOL AND THEIR IMPACT ON CHILDREN'S KNOWLEDGE AND ATTITUDES TO THE CONSUMPTION OF GARDEN VEGETABLES

Marjanca Kos, Janez Jerman

University of Ljubljana, Slovenia

E-mail: Marjanca.Kos@pef.uni-lj.si, Janez.Jerman@pef.uni-lj.si

Abstract

Learning through gardening is known to be an educational strategy in which a garden is used as a teaching tool. Systemic reviews of the impact of school gardening on academic performance and dietary habits foreground the need for additional quantitative studies that would use strong experimental designs. The aim of the present research was to establish the impact of school gardening on children's knowledge of and attitude to the consumption of garden vegetables. A quasi-experiment was conducted including one control and one experimental group, with each group consisting of 15 children aged 6–7 years. The children's prior knowledge and attitude toward the consumption of garden vegetables was identified through individual interviews. Participants in the experimental group then carried out their activities in a school garden that was built in co-operation with an organic farm located in close vicinity of the school. Following these activities, interviews were repeated in both groups to establish any newly acquired knowledge of and changes in the children's attitude to garden vegetables. The results revealed that the children in both groups had poor general knowledge about garden vegetables at the beginning of the experiment. After their work in the garden was concluded, the knowledge of garden vegetables in the experimental group of children improved to a statistically significant degree. The children's attitude to consuming garden vegetables also became more positive than before they engaged in the gardening activities. The results of this research indicated that school gardening activities improved academic outcomes and the children's attitude to the consumption of vegetables. Therefore, the research suggests that gardening should be considered a vital part of school education.

Keywords: active learning, garden-based learning, organic gardening, outdoor education, school garden.

Introduction

It is the fact of modern life that children only have little contact with nature. With obesity becoming a problem even in early childhood, it is all the more important that they are offered opportunities to become actively involved with nature. Not only can the forest, meadow, stream or marshland provide such environments, but the garden can also be a place that enables children to experience nature in its diversity and changeability. In many cases a garden is more readily accessible than other natural environments, and can offer children infinite possibilities for experiential learning, even in early childhood. This is why gardening has become a popular activity in preschools and schools, giving children the opportunity to gain direct experience, efficiently face challenges, acquire knowledge and strengthen their self-confidence (Bowker & Tearle, 2007; Dirks & Orvis, 2005; Miller, 2007; O'Brien & Shoemaker, 2006; Robinson & Zajicek, 2005). Children build knowledge based on hands-on experience of the environment, which they integrate, adapt and give meaning to in the frameworks of their existing knowledge

that itself is thus changed and enriched (Labinowicz, 2010). That gardening enables children to acquire knowledge has been shown in numerous studies. For example, children who participated in plant growing projects showed better achievements in scientific knowledge than those who did not participate in such projects, with this found in school children (Almon & Agaiston, 2010; Graham, Lussier, McLaughlin, & Zidenberg-Cherr, 2005; Davids, 2008; Hollar, Lombardo, Lopez-Mitnik, Hollar, Ratcliffe, Merrigan, Rogers, & Goldberg, 2011; Klemmer, Waliczek, & Zajicek, 2005; Mohrmann, 1999; Nolan, McFarland, Zajicek, & Waliczek 2012; Robinson - O'Brien, Story, & Heim, 2009; Smith & Motsenbocker, 2005; Zidenberg-Cherr, 2005;), as well as preschool children (Adams, 2006; Hutchinson, Christian, Evans, Nykjaer, Hanock, & Cade, 2015; Kirby, 2008; Kos, 2014; Kos & Jerman, 2012; 2013; Leuven, Rutefrans, Dolfing, & Leuven, 2018; Trepanier-Street, 2000).

Preschool or school gardening combines meaningful work and motivating activities with three key elements of education in science: content, process skills and attitude (Hachey & Butler, 2009). Gardening activities enable children to improve their knowledge of scientific processes (Rickinson et al., 2004), and encourage the use of their sense organs (Miller, 2007). The scientific contents which children become acquainted with during gardening activities involve the knowledge of plants and their importance for a healthy diet, knowledge of animals, rocks and soil, the life needs and life cycles of organisms, knowledge of hibernation, migration, metamorphosis, the weather and seasons. The scientific processes include observation, asking research questions and making hypotheses, developing knowledge about the relationship between a cause and consequence, and experimenting (Jaffe & Appel, 2007; Miller, 2007).

Positive early experiences with nature encourage children's understanding of their natural environment, and are the precondition for children to be able to develop a responsible attitude to the environment, as well as long-term respect for nature, and thus its preservation and protection (Chawla, 1994; Miller, 2007; Skelly & Zajicek, 1998; Waliczek & Zajicek, 1999; Wilson, 2008). This is what makes activities in nature the key element and basis of any efficient environmental education programme (Chawla, 1998; Rivkin, 1995; Torkar, 2014; Wilson, 2008).

Although much is known and has been said about the positive effects of early learning in nature in connection with environmental consciousness, the over-organisation of life, the culture of fear about children being left to play outside and power of technology that encourage children to remain seated indoors, all mean that today's young people are more and more alienated from the natural environment (Clements, 2004; Louv, 2005; Waller, Sandseter, Wyver, Årlemalm-Hagsér, & Maynard, 2010). Gardening is also an opportunity for children to develop a responsible and caring attitude to living beings (Berenguer, 2007; Dirks & Orvis, 2005; Fisher-Maltese & Zimmerman, 2015; Rivkin, 1995; Skelly & Zajicek, 1998; Waliczek & Zajicek, 1999; Williams & Brown, 2012), while at the same time experiencing satisfaction in doing something meaningful and useful (Rivkin, 1995). Moreover, it encourages their emotional development and nurtures their "sense of wonder" (Miller, 2007; Wilson, 2008).

Dietary education and healthcare are other two areas that need more attention due to our modern, mainly sedentary lifestyles, with obesity increasing even among children. Since dietary patterns start to form in early childhood (Sandeno, Wolf, Drake, & Reicks, 2000; McAleese & Rankin, 2007), it is during this time that efforts at raising awareness of healthy food and the importance of getting enough movement need to take place. Research showed that children who participated in gardening had a more positive attitude to the consumption of fruit and vegetables, which thus made up a greater part of their diet (Cavaliere, 1987; Cotugna, Manning, & DiDomenico, 2012; Hutchinson et al., 2015; Koch, Waliczek & Zajicek, 2006; Langelotto & Gupta, 2012; Lautenschlager & Smith, 2007; Lineberger & Zajicek, 2000; Morgan, Warren, Luban, Saunders, Quick, & Collins, 2010; Meinen, Friese, Wright, & Carrel, 2012; Morris, Neustadter, & Zidenberg-Cherr, 2001; Morris & Zidenberg - Cherr, 2002; Nolan, McFarland,

Zajicek, & Waliczek, 2012; Nury, Sarti, Dijkstra, Seidell, & Dedding, 2017; Parmer, Salisbury-Glennon, Shannon, & Struempfer, 2009; Pothukuchi, 2004; Sarti, Dijkstra, Nury, Seidell, & Dedding, 2017; Wang, Rauzon, & Studer, 2010). They also knew better, what were the benefits of eating fresh fruits and vegetables (Ratcliffe et al., 2011). The beneficial influence of such experiences on the development of dietary patterns in childhood continued in later periods of children's lives (Moris & Ziderberg-Cherr, 2002). Moreover, gardening encourages physical activity and improves children's general well-being (Rickinson et al., 2004, Rees-Punia et al., 2017; Storz & Heymann, 2017).

Garden-based education also encourages progress in numerous other developmental fields: in language (Bang-Jensen, 2012; Hollar et al., 2010; Miller, 2007), mathematics (Hollar et al., 2010; Lyon & Bragg, 2011; Miller, 2007;), the arts (Lovejoy, 1998; Miller, 2007; Wilson, 2008), as well as in interpersonal relationships and social development (Black et al., 2012; Cutter-MacKenzie, 2009; Miller, 2007; Moore, Wilson, Kelly-Richards & Marston, 2015; Robinson & Zajicek, 2005; Waliczek et al., 2001;) and physical development (Rees-Punia, Holloway, Knauft, & Schmidt, 2017; Wells, Myers & Henderson, 2014;).

Furthermore, gardening has been shown by several studies to benefit the development of children with special needs (Hutchinson – Harmon, 2009; Rye, Selmer, Pennington, Vanhorn, Fox, & Kane, 2012). In terms of social benefits, a school garden can be a good place for making inter-generational connections (Latimer, 1995; Ruby, Kenner, Jessel, Gregory & Arju, 2007; Mayer-Smith, Bartosh & Peterat, 2009), strengthening ties with the local community (Brink & Yost, 2004; Cutter-Mackenzie, 2009; Nimmo & Hallet, 2008; Starbuck & Olthof, 2008), and acquiring and developing a positive attitude to the professions involved in the food chain (Dillon, Rickinson, Sanders, & Teamey, 2005).

Williams and Dixon (2013), Berezowitz, Bontrager Yoder and Schoeller (2015), and Ohly, Gentry, Wiggelsworth, Bethel, Lovell and Garside (2016) carried out systemic reviews on how gardening as part of the educational process influenced both academic performance and dietary outcomes. While all these researchers found numerous positive influences of gardening, they pointed to the need for further quantitative research to persuasively back the qualitative evidence that indicates far-reaching benefits from school gardens. In keeping with this, the present research aimed to carry out quantitative research, exploring how gardening activities impacted the children's knowledge of and attitude to garden vegetables, including some other plants, such as some cereals, fruit and herbs, were explored.

The research questions examined in this research were as follows:

- How much knowledge about the variety of garden vegetables can children aged 6 and 7 years acquire through activities in the school garden?
- What is the impact of school gardening on their attitude to the eating of garden vegetables?

The following hypotheses were examined in this research:

- Through school gardening, children aged 6 and 7 can improve their knowledge of garden vegetables to a significant degree.
- The teaching activities carried out in the school garden with children aged 6 and 7 encourage better attitudes toward consuming garden vegetables.

Research Methodology

Research Approach

The research aimed to establish the impact of gardening activities at school on children's acquisition of the knowledge of garden vegetables and their attitude to the consumption of fruit and vegetables. Following the need for more quantitative studies a quasi-experiment was carried out with children aged 6–7 years in the period between March and October of 2017. The

quasi-experiment included 15 children in the control group and 15 children in the experimental group. Before the learning activities in the garden started in March 2017, semi-structured individual interviews were conducted with children in both groups, which were then repeated after the conclusion of the gardening intervention in October 2017.

Sample

The research sample was composed of 30 children, six and seven years old. The relatively small number of children in each group enabled a more individualised approach to each young child, more quality work in the experimental group that participated in the gardening project, and better assessment of the children's progress. The school that was chosen was selected because it had the facilities to organise the school garden, and because it had never had a garden before. The first grade children were randomly selected and put in the control and experimental groups. Each of the two groups included 15 children (seven girls and eight boys). The children attended a school in a suburban area in Slovenia. Before the intervention none of the children had taken part in gardening at school.

Ethics

The parents gave their written, signed consent prior to starting the research. The consent form provided an explanation of the purpose of the research. The researchers also presented its purpose to the children when they asked them to participate. The children and the parents had the opportunity of refusing participation.

Procedure and Setting

Initially, all children from both groups participated in individual semi-structured interviews, so that it was determined how much they knew about garden vegetables, and their attitude to consuming them was established. They were asked questions while various specimens of vegetables, most of them unprocessed and some cooked (beans, potatoes, Brussels sprouts, grains), were positioned in front of them and the children could taste them. The children were asked to identify and name of each vegetable, then were specifically asked to explain how the beans and tomatoes were grown, and finally to say whether they liked the taste of these vegetables or not. All interviews were video recorded.

The experimental group then carried out their work in the school garden in which the children actively cultivated land and weeded the vegetable beds, grew vegetables, acquired knowledge about them, their growth and development, and in particular their development from the bud and flower to the fruit. They talked about how useful these vegetables were, and consumed them either raw or cooked in different forms (salads, spreads, soups, juices). The activities were performed from the beginning of March to the middle of October, and the children grew the plants according to the principles of organic farming. The school garden activity was structured so as to allow children a maximum of direct experience, with all activities being based on approaches of experiential and explorative learning and involving a high degree of children's participation. Table 1 presents all the children's activities. The children were given the opportunity to get to know all the plants before being asked about them in individual interviews. The control group of children carried out their daily school routine that did not include gardening.

The school garden was made in cooperation with the family of the Porta organic farm located in the immediate vicinity of the school. The farm gave the school a piece of land for the garden, donated the seeds and seedlings, and their staff worked along with the children in the garden. They also gave presentations about life on the farm and farming as an occupation.

Table 1. Descriptions of the various activities performed in the school garden.

Month	Activity	Description
March	Introductory instructions and preparation of beds, planting the seedlings	The children were presented with the goals of the project. We agreed with them about the rules to be observed when working in the garden. We presented hand tools for working the land and how to use them. Children prepared the beds in small groups, made a woven composter and built a little fence from hazel sticks around the edge of the bed. Finally, they planted the strawberry seedlings.
March	Acquiring knowledge about machines for working the land	At the farm the children repeated the names of the tools that they had learned the previous time. They took a look at the potato combine harvester, the plow, seedbed cultivator, rotary tiller, cultivator, disc harrow, water tank, grass harrow, sowing machine, hoeing machines and potato planter. At each machine the children were told what it is designed for, and in the class they were shown video clips of how the machines work.
March	Making the sowing design	The children made drawings of vegetables on pieces of paper. With the help of a book about permaculture that presented good and bad neighbours, they laid pieces of paper on the ground to make a sowing design.
April	Sowing and planting	In the garden the children sowed radish and carrot seeds, they planted onion and lettuce and kohlrabi seedlings. They visited the greenhouse at the farm, where they tasted rocket that already grew there.
April	Sowing and planting, Preparation of beds	The children planted green peas, potatoes and seedlings of cauliflower, lettuce, cabbage and chard. They prepared and weeded the beds in which they would plant and sow next time.
April	Sowing and getting to know herbs and consuming them in a spread	The children sowed swede, beetroot, flax, buckwheat, millet and parsley seeds. They acquired knowledge about the herbs in the vegetable garden of the farm. They made a spread with cottage cheese and herbs, and they tasted it.
May	Weeding and sowing in pots to grow seedlings	The children weeded and prepared seedlings: they put cauliflower, broccoli, Brussels sprouts, cucumber, courgette, tomato and leek seeds in pots.
May	Observing the growth and development of plants in pots and in the garden, picking of lettuce and radishes, and eating them	The children observed plants in the pots. In the garden they sowed millet, radicchio, basil and beetroot that did not sprout on a previous occasion. They picked lettuce and radishes. They prepared mixed salad from lettuce, radishes, young garlic, rocket, chard leaves and flowers of common comfrey, and ate the salad.
May	Sowing of seeds and seedlings	The children planted beans around six high poles erected in the shape of a wigwam, and corn along the edge of the garden. The children worked the soil and planted the tomato and sweet pepper seedlings.
May	Getting to know the animals in the garden	In the garden the children looked for bugs and collected them in little pots. Later they exchanged them with each other and observed them. For each animal we talked about whether it is useful or not in the garden, and why. The children made "bug hotels" from different natural materials.
June	Planting of seedlings and observing the development and growth of plants, preparation and drinking of juice made from herbs	The children observed the growth and development of plants. They tasted sweet fennel and radishes. They observed, smelled and tasted mint, lemon balm and elderflowers, from which they made juices for each other, guessing which juice they tasted. The children planted their own seedlings in the garden.

June	Monitoring the development and growth of plants, eating the vegetables	The children monitored the growth and development of cauliflower, broccoli, chard, cabbage, cucumbers, beetroot, carrots, kohlrabi and onion, and picked them. After returning to the school playground the children washed the vegetables, cut them and put the pieces on skewers, which they ate.
June	Getting to know the animals on the farm, and the farmer's profession	The children visited an ecological farm, where they observed different domestic animals and listened to the farmer who explained his work. The children listened about how grain is produced and processed to make flour, and then ground some grain to make flour. In the garden the children observed different phases in the development of tomatoes, bean seeds and strawberries. They also ate those strawberries that were ripe.
September	Harvesting the crops and preparation and eating of vegetable soup, getting to know the animals in the garden	The children collected swede, cauliflower, broccoli, leek, runner beans, sweet fennel, celery, tomatoes, garlic, sweet peppers and Brussels sprouts, and dug up the potatoes. They then cleaned and cut up the vegetables. They tried the tomatoes, red peppers and garlic, then made a delicious soup from the rest of the vegetables and ate it for a snack. The children were asked to pay attention to how the different vegetables tasted. We took a look at which animals inhabited the "insect hotels".
September	Picking the vegetables and tasting them in a salad	In the school garden we picked radicchio, cucumbers and chard. The children cleaned and cut up the vegetables and used them in salads: one was made of radicchio and the other from boiled potatoes and cucumbers. The children tasted boiled chard.
September	Picking and eating vegetables from the garden, pickling beetroot	The children observed the development of the plants in the garden. They picked, peeled and cut the beetroot, and put slices in little glass jars. They then poured vinegar solution over the beetroot and pasteurised the jars. The children tasted the beetroot salad, and the salad from the runner beans that they picked in the garden. They picked ripe bean pods, shelled the beans and tasted them cooked.
September	Observing the development of grains and eating the seeds and porridge, extracting seeds from black radish pods	The children devoted their attention to cereals that were grown in the garden. They tasted flax seeds and picked buckwheat and millet from which they cooked porridge and then tasted it. They also picked corn and tasted it cooked. The children were given worksheets, on which they glued seeds alongside the corresponding photographs of the plants. Later they divided the plants in two groups, grains in one and (garden vegetables in the other. They shelled radish pods, and collected the seeds in a bag.
October	Eating cabbage, preparation of cabbage for pickling, end of the project	We picked two cabbages in the garden. The children cleaned the cabbage and tasted it, they observed the grating process, and pressed the grated cabbage in a bucket. They were able to taste the sauerkraut that was already pickled. They also ate raw fennel, raw celery and ground flax. The project was concluded with children receiving diplomas for their good work.

Semi-structured interviews with the children in both groups were carried out once again after the experiment. The children were again shown real examples of garden vegetables, and at this point their knowledge about these and their attitudes toward consuming them were re-examined. The results were then compared to those obtained in the first interviews. Some conclusions were then derived with regard to how the children's previous knowledge and attitude toward garden vegetables were influenced by the activities.

Data Analysis

After the recordings were analysed, the children's answers were categorised in various ways according to children's tasks. In the task of identifying and naming the vegetables the children's answers were classified and scored as follows: (1 point) has no idea of and is unable to name the vegetable; (2 points) the child's answer implies that he or she has some knowledge of the vegetable, because they describe their contact with it (e.g. where and when they consumed it), but cannot name it; and (3 points) correctly names the vegetable. The answers to the question of how the tomato and bean develop were grouped under three headings: (1 point) the child has no knowledge about fruit development or their idea is incorrect; (2 points) the child has only an unclear, vague idea of fruit development; and (3 points) the child knows and understands precisely how the fruit develops. With regard to the attitude to the consumption of each vegetable the answers were categorised and scored as follows: (1 point) expresses a negative attitude to the consumption of the vegetable; (2 points) has a neutral attitude to the consumption of the vegetable; and (3 points) likes to consume the vegetable.

The following descriptive statistics were first calculated: means and standard deviations, and absolute frequency and percentage share for each answer category. The data were controlled according to the assumptions of a normal distribution (Shapiro-Wilk test) and homogeneity of variance (Levene test). Prior to conducting the experiment, differences in answers for both groups of children were examined by applying the Mann-Whitney U test. After the experiment had been carried out, differences in answers were examined for the experimental and control groups by using Wilcoxon signed-rank tests. As a measure of effect size Cohen's r was applied (Coolican, 2014). Descriptive statistics were calculated using the IBM SPSS Statistics.

Research Results

Knowledge and Naming of Vegetables

The results of the knowledge and naming of the vegetables before and after the experiment are given in Table 2. At the beginning knowledge about most of the vegetables in both groups was generally poor. Although the children had good knowledge about those that they most often saw in their diet (potatoes, tomatoes, corn, lettuce, carrots, strawberries), many were unknown to them.

Table 2. Means and standard deviations of the answers regarding the children's knowledge of vegetables for both the control and experimental groups before and after the experiment.

Vegetables	Before experiment				After experiment			
	Control Group		Experimental group		Control group		Experimental group	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Rocket	1.13	.35	1.20	.41	1.60	.63	1.87	.35
Brussels sprouts	1.67	.72	2.13	.83	1.53	.64	1.80	.86
Leek	1.93	.70	2.00	.85	2.20	.68	2.80	.41
Courgette	2.33	.49	2.33	.62	2.67	.49	2.73	.59
Bean seed	2.87	.35	3.00	.00	2.87	.35	2.93	.26
Potato	3.00	.00	3.00	.00	3.00	.00	3.00	.00
Parsley	2.93	.26	2.27	.59	2.80	.41	2.47	.64
Swede	1.47	.64	1.33	.49	1.80	.41	2.73	.59
Green bean	2.27	.59	2.47	.74	2.93	.26	3.00	.00
Onion	2.87	.35	2.73	.46	3.00	.00	3.00	.00
Cauliflower	2.13	.64	2.53	.52	2.60	.51	2.67	.49
Tomato	3.00	.00	3.00	.00	3.00	.00	2.93	.26
Sweet fennel	1.13	.35	1.13	.35	2.00	.93	2.27	.88
Radish	2.47	.64	2.40	.63	2.87	.35	2.60	.63
Chard	1.40	.51	1.67	.72	1.60	.74	2.20	.68
Millet	1.47	.52	1.67	.49	1.67	.49	2.53	.64
Beetroot	2.07	.26	2.13	.52	2.13	.35	2.87	.35
Red radicchio	2.00	.54	2.00	.38	2.13	.35	2.60	.63
Flax	1.80	.41	1.80	.41	1.73	.59	2.53	.52
Celery	1.73	.46	1.33	.49	1.67	.49	2.07	.80
Cabbage	2.53	.64	2.67	.62	2.73	.46	2.87	.35
Corn	3.00	.00	3.00	.00	3.00	.00	3.00	.00
Lettuce	3.00	.00	3.00	.00	3.00	.00	3.00	.00
Broccoli	2.67	.49	2.47	.74	2.40	.63	2.53	.64
Cucumber	2.87	.35	2.40	.51	2.93	.26	2.87	.35
Buckwheat	1.87	.35	1.73	.46	2.00	.38	2.73	.46
Sweet pepper	2.80	.41	2.80	.41	2.87	.35	2.87	.35
Garlic	2.93	.26	2.73	.46	2.80	.41	3.00	.00
Carrot	3.00	.00	3.00	.00	3.00	.00	3.00	.00
Strawberry	3.00	.00	3.00	.00	3.00	.00	3.00	.00

Table 2 presents descriptive statistics. In accordance with this data inferential statistics is continued in Table 3.

Table 3. Mann-Whitney U test for both groups before and after the experiment.

Vegetables	Before the experiment			After the experiment		
	Z	p	r	Z	p	r
Rocket	-0.482	.775	.088	-1.562	.059	.285
Brussels sprouts	-1.567	.148	.286	-0.795	.214	.145
Leek	-0.222	.838	.041	-2.625	.005	.479
Courgette	-0.121	.935	.022	-0.673	.251	.123
Bean seed	-1.439	.539	.263	-0.598	.275	.109
Potato	0.000	1.000	.000	0.000	1.000	.000
Parsley	-3.348	.004	.611	-1.587	.056	.290
Swede	-0.492	.683	.090	-3.954	.001	.722
Green bean	-1.056	.345	.193	-1.000	.159	.183
Onion	-0.898	.539	.164	0.000	1.000	.000
Cauliflower	-1.732	.126	.316	-0.372	.355	.068
Tomato	0.000	1.000	.000	-1.000	.159	.183
Sweet fennel	0.000	1.000	.000	-0.808	.210	.148
Radish	-0.326	.775	.060	-1.324	.093	.242
Chard	-0.983	.389	.179	-2.201	.014	.402
Millet	-1.087	.367	.198	-3.392	.001	.619
Beetroot	-0.512	.744	.093	-3.949	.001	.721
Red radicchio	0.000	1.000	.000	-2.554	.006	.466
Flax	0.000	1.000	.000	-3.211	.001	.586
Celery	-2.159	.061	.394	-1.491	.068	.272
Cabbage	-0.702	.567	.128	-0.898	.185	.164
Corn	0.000	1.000	.000	0.000	1.000	.000
Lettuce	0.000	1.000	.000	0.000	1.000	.000
Broccoli	-0.611	.624	.112	-0.655	.256	.120
Cucumber	-2.607	.029	.476	-0.598	.275	.109
Buckwheat	-0.898	.539	.164	-3.676	.001	.671
Sweet pepper	0.000	1.000	.000	0.000	1.000	.000
Garlic	-1.445	.367	.264	-1.795	.037	.328
Carrot	0.000	1.000	.000	0.000	1.000	.000
Strawberry	0.000	1.000	.000	0.000	1.000	.000

The Mann-Whitney U test mainly revealed no statistically significant differences between both groups before the experiment with regard to the knowledge of vegetables. The effect sizes were small and medium ($r < 0.3$ and $r < 0.5$). This reveals that before the experiment the knowledge and understanding of garden vegetables in the two groups of children were equal (Table 3).

On the other hand the results also indicated many statistically significant differences between the two groups after the experiment with regard to the knowledge of vegetables. Some effect sizes were small ($r < 0.3$) and medium ($r > 0.3$), but some were large ($r > 0.5$). After the experiment, differences were seen between the two groups. Therefore, the gardening activities partly improved the children's knowledge of vegetables (Table 3).

Table 4. Wilcoxon signed-rank tests of both groups after the experiment.

Vegetables	Control group			Experimental group		
	Z	p	r	Z	p	r
Rocket	-2.646	.008	.483	-3.162	.002	.577
Brussels sprouts	-1.414	.157	.258	-2.236	.025	.408
Leek	-2.000	.046	.365	-2.585	.010	.472
Courgette	-1.890	.059	.345	-1.732	.083	.316
Bean seed	0.000	1.000	.000	-1.000	.317	.183
Potato	0.000	1.000	.000	0.000	1.000	.000
Parsley	-1.414	.157	.258	-1.732	.083	.316
Swede	-1.508	.132	.275	-3.391	.001	.619
Green bean	-2.887	.004	.527	-2.271	.023	.415
Onion	-1.414	.157	.258	-2.000	.046	.365
Cauliflower	-2.333	.020	.426	-1.000	.317	.183
Tomato	0.000	1.000	.000	-1.000	.317	.183
Sweet fennel	-2.739	.006	.500	-2.919	.004	.533
Radish	-2.121	.034	.387	-1.134	.257	.207
Chard	-0.966	.334	.176	-2.309	.021	.422
Millet	-1.732	.083	.316	-2.968	.003	.542
Beetroot	-1.000	.317	.183	-3.317	.001	.606
Red radicchio	-1.414	.157	.258	-2.324	.020	.424
Flax	-0.577	.564	.105	-2.810	.005	.513
Celery	-0.577	.564	.105	-2.495	.013	.456
Cabbage	-1.732	.083	.316	-1.134	.257	.207
Corn	0.000	1.000	.000	0.000	1.000	.000
Lettuce	0.000	1.000	.000	0.000	1.000	.000
Broccoli	-1.633	.102	.298	-0.333	.739	.061
Cucumber	-0.577	.564	.105	-2.646	.008	.483
Buckwheat	-1.414	.157	.258	-3.419	.001	.624
Sweet pepper	-1.000	.317	.183	-1.000	.317	.183
Garlic	-1.414	.157	.258	-2.000	.046	.365
Carrot	0.000	1.000	.000	0.000	1.000	.000
Strawberry	0.000	1.000	.000	0.000	1.000	.000

The Wilcoxon signed-rank test for the control group did not show any statistically significant differences with regard to the knowledge of vegetables, as observed, before and after the experiment. The effect sizes were small ($r < 0.3$) and medium ($r > 0.3$), and some were large ($r < 0.5$) (Table 4).

However, for the experimental group the results did show some statistically significant differences in the children's knowledge of vegetables, as observed before the experiment and after. The effect sizes were small ($r < 0.3$) and medium ($r > 0.3$), although some were large ($r < 0.5$) (Table 4). The gardening activities were thus seen to have substantially enhanced the children's knowledge of vegetables (Table 4).

The Concept of Fruit Development

Before the experiment the majority of children in both groups did not know how the tomato fruit and bean seed developed – they either did not know at all or had a wrong or imprecise idea about it. After the experiment the children’s knowledge about fruit development in the experimental group improved (Tables 5 and 6).

Table 5. The structure of the answers about tomato fruit before and after the experiment for both groups.

Answers	Control group		Experimental group		
	Before	After	Before	After	
No knowledge or the wrong idea	f	6	1	2	1
	%	40.0	6.7	13.3	6.7
Superficial, imprecise concept	f	8	12	9	1
	%	53.3	80.0	60.0	6.7
Correct, precise concept	f	1	2	4	13
	%	6.7	13.3	26.7	86.7
Total	f	15	15	15	15
	%	100.0	100.0	100.0	100.0

Table 6. The structure of the answers about bean seed before and after the experiment for both groups.

Answers	Control group		Experimental group		
	Before	After	Before	After	
No knowledge or the wrong idea	f	6	3	3	1
	%	40.0	20.0	20.0	67
Superficial, imprecise concept	f	8	9	11	2
	%	53.3	60.0	73.3	13.3
Correct, precise concept	f	1	3	1	12
	%	6.7	20.0	6.7	80.0
Total	f	15	15	15	15
	%	100.0	100.0	100.0	100.0

Table 7. Mann-Whitney U test between both groups before and after the experiment.

Vegetables	Before the experiment			After the experiment		
	Z	p	r	Z	p	r
Tomato fruit	-1.052	.293	.192	-3.584	.001	.654
Bean seed	-1.027	.389	.188	-3.015	.002	.550

With respect to the concept of fruit development, the Mann-Whitney U test revealed no statistically significant differences between both groups before the experiment. The effect sizes were small ($r < 0.3$) and the concept of fruit development was equally understood by the children of both groups. (Table 7). After the experiment statistically significant differences were seen between the two groups, with effect sizes being large ($r > 0.5$). As such, the conclusion can be drawn that the children's understanding of fruit development was much improved by practical activities in the garden (Table 7).

Table 8. Wilcoxon signed-rank tests of both after the experiment.

Vegetables	Control group			Experimental group		
	Z	p	r	Z	p	r
Tomato fruit	-1.414	.157	.258	-3.162	.002	.577
Bean seed	-1.518	.129	.277	-3.357	.001	.613

The Wilcoxon signed-rank test for the control group did not show statistically significant differences in the knowledge and idea of fruit development as observed before and after the experiment, and the effect sizes were also small ($r < 0.3$) (Table 8).

Conversely, for the experimental group the results revealed statistically significant differences in the children's idea of fruit development before and after the experiment, with the effect sizes being large ($r > 0.5$), thus showing that the children's idea of fruit development was substantially enhanced by practical activities in the garden (Table 8).

Attitude to the Consumption of Garden Vegetables

Table 9 shows the results of the children's answers regarding their attitude to the consumption of vegetables. Before the experiment most of the children mainly showed a positive attitude to eating potatoes, carrots and strawberries.

Table 9. Means and standard deviations in answers about the attitude to the consumption of vegetables for both groups before and after the experiment.

Vegetables	Before the experiment				After the experiment			
	Control group		Experimental group		Control Group		Experimental Group	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Rocket	1.27	.70	1.33	.72	1.93	.96	2.53	.74
Brussels sprouts	2.00	1.00	2.07	.88	1.73	.88	1.80	.86
Leek	2.47	.92	1.93	.80	2.53	.74	2.73	.46
Courgette	2.67	.49	2.87	.35	2.73	.46	2.60	.63
Bean seed	3.00	.00	2.93	.26	3.00	.00	2.73	.46
Potato	3.00	.00	3.00	.00	3.00	.00	3.00	.00
Parsley	3.00	.00	2.67	.62	3.00	.00	2.80	.56
Swede	1.80	1.01	1.60	.91	2.47	.83	2.60	.74
Green bean	2.87	.52	2.47	.83	3.00	.00	2.53	.74
Onion	2.80	.41	2.53	.52	2.73	.46	2.80	.41
Cauliflower	2.53	.74	2.93	.26	2.87	.35	2.93	.26
Tomato	2.73	.46	2.67	.49	2.80	.41	2.80	.41
Sweet fennel	1.27	.70	1.20	.56	1.80	.94	1.67	.90
Radish	2.80	.56	2.40	.74	2.67	.62	2.40	.74
Chard	1.80	1.01	1.80	.86	1.67	.90	2.27	.88
Millet	1.93	1.03	2.27	.96	2.27	.96	2.53	.74
Beetroot	2.93	.26	2.73	.59	2.80	.41	2.93	.26
Red radicchio	2.53	.74	2.60	.63	2.60	.63	2.73	.59
Flax	2.60	.83	2.60	.83	2.27	.96	2.67	.72
Celery	2.27	.88	1.60	.91	2.27	.96	2.00	1.00
Cabbage	2.73	.59	2.73	.59	2.87	.35	2.93	.26
Corn	2.93	.26	2.87	.35	2.93	.26	2.93	.26
Lettuce	2.87	.35	2.93	.26	2.93	.26	3.00	.00
Broccoli	2.87	.35	2.60	.83	2.67	.62	2.67	.72
Cucumber	2.80	.41	2.80	.41	2.87	.35	2.80	.41
Buckwheat	2.53	.83	2.27	.96	2.73	.59	2.60	.74
Sweet pepper	2.80	.41	2.67	.49	2.87	.35	2.67	.49
Garlic	2.53	.52	2.40	.63	2.80	.41	2.40	.51
Carrot	3.00	.00	3.00	.00	3.00	.00	3.00	.00
Strawberry	3.00	.00	3.00	.00	3.00	.00	3.00	.00

Table 10. Mann-Whitney U test of the differences between both groups before and after the experiment.

Vegetables	Before the experiment			After the experiment		
	Z	p	r	Z	p	r
Rocket	-0.416	.806	.076	-1.766	.039	.322
Brussels sprouts	-0.180	.870	.033	-0.248	.402	.045
Leek	-1.832	.098	.334	-0.594	.276	.108
Courgette	-1.273	.367	.232	-0.493	.311	.090
Bean seed	-1.000	.775	.183	-2.112	.018	.386
Potato	0.000	1.000	.000	0.000	1.000	.000
Parsley	-2.108	.217	.385	-1.438	.075	.263
Swede	-0.517	.683	.094	-0.437	.331	.080
Green bean	-1.726	.233	.315	-2.399	.008	.438
Onion	-1.523	.217	.278	-0.424	.336	.077
Cauliflower	-1.845	.202	.337	-0.598	.275	.109
Tomato	-0.392	.775	.072	0.000	1.000	.000
Sweet fennel	-0.070	.967	.013	-0.397	.346	.072
Radish	-1.854	.137	.338	-1.119	.132	.204
Chard	-0.138	.902	.025	-1.776	.038	.324
Millet	-0.899	.436	.164	-0.679	.249	.124
Beetroot	-1.089	.539	.199	-1.056	.146	.193
Red radicchio	-0.125	.935	.023	-0.751	.227	.137
Flax	0.000	1.000	.000	-1.240	.108	.226
Celery	-1.954	.074	.357	-0.749	.227	.137
Cabbage	0.000	1.000	.000	-0.598	.275	.109
Corn	-0.598	.775	.109	0.000	1.000	.000
Lettuce	-0.598	.775	.109	-1.000	.159	.183
Broccoli	-0.672	.683	.123	-0.281	.390	.051
Cucumber	0.000	1.000	.000	-0.482	.315	.088
Buckwheat	-0.802	.512	.146	-0.477	.317	.087
Sweet pepper	-0.812	.539	.148	-1.273	.102	.232
Garlic	-0.519	.653	.095	-2.198	.014	.401
Carrot	0.000	1.000	.000	0.000	1.000	.000
Strawberry	0.000	1.000	.000	0.000	1.000	.000

The Mann-Whitney U test did not reveal any statistically significant differences between both groups before the experiment regarding the attitude to the consumption of vegetables. The effect sizes were small ($r < 0.3$) and medium ($r < 0.5$). Before the experiment the groups were equal in their attitude to the consumption of vegetables (Table 10).

After the experiment, some statistically significant differences between both groups were detected by the test, with small ($r < 0.3$) and medium ($r > 0.3$) effect sizes. It can be concluded that gardening activities at school partly improved the children's attitude to the consumption of vegetables (Table 10).

Table 11. Wilcoxon signed-rank tests for both groups after the experiment.

Vegetables	Control group			Experimental group		
	Z	p	r	Z	P	r
Rocket	-2.197	.028	.401	-2.985	.003	.545
Brussels sprouts	-1.633	.102	.298	-1.265	.206	.231
Leek	-0.414	.679	.076	-2.585	.010	.472
Courgette	-1.000	.317	.183	-1.633	.102	.298
Bean seed	0.000	1.000	.000	-1.732	.083	.316
Potato	0.000	1.000	.000	0.000	1.000	.000
Parsley	0.000	1.000	.000	-1.414	.157	.258
Swede	-1.873	.061	.342	-2.758	.006	.504
Green bean	-1.000	.317	.183	-0.276	.783	.050
Onion	-0.577	.564	.105	-1.633	.102	.298
Cauliflower	-1.518	.129	.277	0.000	1.000	.000
Tomato	-0.577	.564	.105	-1.414	.157	.258
Sweet fennel	-2.070	.038	.378	-1.890	.059	.345
Radish	-0.816	.414	.149	0.000	1.000	.000
Chard	-0.552	.581	.101	-1.823	.068	.333
Millet	-1.512	.131	.276	-0.730	.465	.133
Beetroot	-1.414	.157	.258	-1.342	.180	.245
Red radicchio	-0.264	.792	.048	-0.816	.414	.149
Flax	-1.633	.102	.298	-0.378	.705	.069
Celery	0.000	1.000	.000	-1.622	.105	.296
Cabbage	-1.000	.317	.183	-1.342	.180	.245
Corn	0.000	1.000	.000	-1.000	.317	.183
Lettuce	-1.000	.317	.183	-1.000	.317	.183
Broccoli	-1.134	.257	.207	-0.333	.739	.061
Cucumber	-0.577	.564	.105	0.000	1.000	.000
Buckwheat	-1.134	.257	.207	-1.155	.248	.211
Sweet pepper	-0.577	.564	.105	0.000	1.000	.000
Garlic	-2.000	.046	.365	0.000	1.000	.000
Carrot	0.000	1.000	.000	0.000	1.000	.000
Strawberry	0.000	1.000	.000	0.000	1.000	.000

For the control group the Wilcoxon signed-rank test showed no statistically significant differences in the attitude to the consumption of vegetables. The effect sizes were small ($r < 0.3$) and medium ($r > 0.3$) (Table 11).

For the experimental group, however, statistically significant differences were revealed in the children's "attitude to the consumption of vegetables". The effect sizes were small ($r < 0.3$), medium ($r > 0.3$) and large ($r < 0.5$) (Table 10). The children's attitude to the consumption of vegetables was thus substantially enhanced by the practical activities (Table 11).

Discussion

This research examined the impact that gardening activities at school had on children's knowledge of garden vegetables. "Garden-based learning is an instructional strategy that utilizes a garden as an instructional resource, a teaching tool. It encompasses programs, activities and projects in which the garden is the foundation for integrated learning, in and across disciplines, through active, engaging, real-world experiences" (Desmond, Grieshop, & Subramaniam, 2002, p.7). At the beginning of our study the knowledge of garden vegetables among the six- and seven-year old children was generally poor. Most of the vegetables were unfamiliar to the students, who mainly knew only those that most commonly appeared in their diet. The results of this research indicate that the children had little previous contact with gardening, although they lived in a suburban environment where most families have their own gardens. This indicates that parents and other adults are not taking the opportunity to allow children to participate in gardening, and thus acquire numerous positive experiences. With gardening being a fairly common practice in Slovenian schools (Pogačnik, Žnidarčič, & Strgar, 2012) and preschools (Kos, 2014), its potential should be explored to the maximum degree to enhance children's progress in all developmental areas.

After participating in the activities presented in this study, the experimental group showed significant improvements with regard to their knowledge about garden vegetables. They were capable of identifying and naming various vegetables based on real specimens, and showed good understanding of the process of fruit development. Improving children's ability to recognise objects (Sloutsky, 2010) and name them is considered important in learning about garden vegetables. Moreover, our results corroborated the findings of numerous other studies (Adams, 2006; Davids, 2008; Graham et al., 2005; Hollar et al., 2010; Hutchinson et al., 2015; Kirby, 2008; Klemmer et al., 2005; Kos & Jerman, 2012; 2013; Kos, 2014; Leuven et al., 2018; Mohrmann, 1999; Nolan et al., 2012; Ratcliffe et al., 2011; Rickinson et al., 2004; Robinson - O'Brien et al., 2009; Smith & Motsenbocker, 2005; Trepanier - Street, 2000; Zidenberg-Cherr, 2005;) that found substantially improved academic outcomes in children that were included in gardening programmes. Experiential learning has also been found to promote higher-level learning (Waliczek et al., 2003).

In their systematic review of such research, in which they examined the unique impact of school-based gardening interventions, Williams and Dixon (2013) found that gardening positively affects children's academic outcomes in as much as 83% of studies. The highest proportion of positive effects was noticed in science achievements. The systemic review performed by Berezowitz et al. (2015) indicated that all research studies that measured academic outcomes in relation to participating in school gardening found that gardening students showed improved academic performance compared to non-gardening students. These results support Klemmer et al.'s suggestion that "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" (Klemmer et al., 2005, p.452). However, the researchers of both systemic reviews, that is, Williams and Dixon, (2013) and Berezowitz et al. (2015), noted some methodological deficiencies in the studies they examined, and a lack of quantitative research, in particular a lack of control groups. They thus recommended more systematic and rigorous research using strong experimental designs, including a detailed presentation of the contents of the intervention. The present research is considered to be an answer to this call, and thus to have made a contribution to the research of the impact of school gardening on children's knowledge acquisition.

In looking for an answer to the question of how school gardening improves academic outcomes, it needs to be noted that this is an activity that promotes direct inclusion of children in the process of experiential learning. Encouraged by this type of learning through active participation, students have been seen to become more positively engaged in their studies

(Christenson, 2012; Klemmer et al., 2005b) and experience more satisfaction in doing something meaningful and useful (Rivkin, 1995). While gardening, the children in the current study's experimental group developed a positive attitude to consuming vegetables. Many studies have examined the question of the impact of the direct experience of gardening on this, with positive impacts reported by the following studies: Cavaliere, 1987; Cotugna et al., 2012; Hutchinson et al., 2015; Koch et al., 2006; Langellotto and Gupta, 2012; Lautenschlager and Smith, 2007; Leuven et al., 2018; Lineberger and Zajicek, 2000; Meinen et al., 2012; Morgan et al., 2010; Morris et al., 2001; Morris and Zidenberg-Cherr, 2002; Nolan et al., 2012; Nury et al., 2017; Parmer et al., 2009; Pothukuchi, 2004; Sarti et al., 2017; Waliczek and Zajicek, 2006; Wang, et al., 2010. Ohly et al. (2016) noted the need to establish the impact of school gardening in terms of children's health and well-being by using more systematic and robust mixed methods of review. Their review examined 40 articles and found that in most cases children who engaged in gardening at school benefited from this activity as regards their health and well-being. However, as they point out, most of the studies described in these articles are qualitative, and currently there is limited quantitative evidence of school gardening having benefits on health and well-being for students. Therefore, new evidence is called for that would allow for subgroup analysis of the beneficial impacts of school gardening activities on the students' health and well-being. By including experimental and control groups, the present quantitative research can be considered as making a clear contribution to the knowledge of these benefits in the literature.

The activities in the school garden were developing throughout the growing season. During school holidays farmers from the organic farm which donated soil for the project started to participate in caring for the garden. The school and farm co-operated closely throughout the project. This relationship strengthened the inclusion of children in the local community, as well as intergenerational participation. The children thus had the opportunity to acquire knowledge about farming professions and develop a positive attitude to them. Nimmo and Hallet (2008), Starbuck and Olthof (2008), and Brink and Yost (2004) also showed that gardening presents an opportunity to strengthen the ties between a local community and its children. Similarly, the findings of Latimer (1995), Ruby et al. (2007), and Mayer-Smith, Bartosh and Peterat (2009) showed that school gardens can be places that foster intergenerational connections.

Conclusions

The present research fills the gap exposed by the researchers of the related review articles about the importance of gardening for the knowledge of garden vegetables and attitude to their consumption, which highlight the current lack of quantitative research that would include a strong experimental design, a control group and a detailed description of the gardening intervention. The results of this research lead to two main conclusions. First, hands-on activities in the school garden encouraged a significant improvement in knowledge about garden vegetables in the children aged 6 and 7 who took part in the school garden project. At first, the children's knowledge of garden vegetables was generally poor, and they mainly knew those that they most often saw in their diet. After the gardening interventions, they were able to recognise and name most of the 30 specimens of garden vegetables, with which they were in direct contact in the project. Second, the school gardening intervention was seen as having a positive impact on the children's attitude towards eating vegetables. The results of this research have important educational implications. Since a garden has been shown to be a pleasant, creative and highly motivating learning space for acquiring knowledge and improving the attitude to vegetable consumption, school gardening should become a vital part of school educative practice in order to foster good habits that will benefit children throughout their lives.

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Marjanca Kos
(Corresponding author)

Ph.D., Assistant Professor, Faculty of Education, University of Ljubljana, Kardeljeva ploščad 16, SI-1000 Ljubljana, Slovenia.
E-mail: Marjanca.Kos@pef.uni-lj.si
Website: <http://www.pef.uni-lj.si>

Janez Jerman

Ph.D., Associate Professor, Faculty of Education, University of Ljubljana, Kardeljeva ploščad 16, SI-1000 Ljubljana, Slovenia.
E-mail: Janez.Jerman@pef.uni-lj.si
Website: <http://www.pef.uni-lj.si>