

Improve Human Health through School Based Kitchen Gardens

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ENGN2226 Systems Engineering Analysis
Design Challenge Recommendations
Sustainable Cities - Improve Human Health

Executive Summary

This report takes a systems engineering approach to improve human health in a sustainable cities context. It focuses on school age children looking to increase the impact school based kitchen gardens have on their health and attitudes towards sustainability. Improving children's food choices is seen as an important step to improving children's long term health. The development of an appropriate research question, followed by surveys and investigative interviews, is used to facilitate research of the current state of school-based gardens in the Canberra region. The investigation focuses on schools with existing gardens and how their garden program can be integrated into the curriculum, how it can be maintained and how to improve production of fruit and vegetables for children to take home. It is hoped that a robust program is able to be achieved that in time can be rolled out to all schools within Australia, improving the health of our children.

Two recommendations are outlined to increase the student interaction with the garden projects:

Firstly, the gardens must be optimised to reduce ongoing maintenance requirements, whilst increasing the gardens production. The social and cultural perspectives are investigated, as well as the control theory perspectives of the recommended water tank and irrigation system.

Secondly, the creation of teacher resources are recommended to increase the role of the gardens in the curriculum, as well as increasing the cooperation of teachers in the supervision of garden maintenance.

Introduction

Improving human health is an important issue that Australia cities need to address if they are to remain sustainable into the future. One area of concern is the percentage of children that are overweight and the link between childhood and adult obesity (Alexander 2016). Research by the Journal of Nutrition Education suggests that children eating sufficient fruit and vegetables when young positively affects their food preferences as adults, however, Australian children aged 5-11 are consuming well below the recommended intake of fruit and vegetables per day (ABS 2013).

With this in mind analysis was conducted focusing on children as a means to address the proposed design challenge of improving human health. The major focus was on supporting existing school-based kitchen garden schemes to improve children's health directly by providing access to fresh vegetables, as well as improving their attitudes towards healthy eating through education and exposure. This report presents the findings of the analysis conducted and provides recommendations to further improve existing school based kitchen gardens. Although these recommendations in isolation will not completely address childhood obesity they play an important role in implementing change in children, which in turn will directly impact their health as adults.

Background

Schools around Australia are establishing school based kitchen gardens as a means to educate children on healthy living with the hope of improving their choices now and into the future. This is supported by the Australian Government who provided \$12.8 million in 2008, to roll-out a Victorian based program known as the Stephanie Alexander Kitchen Garden National Program (SAKGNP) to 177 schools across Australia.

The program focused on primary school aged children in years three to six, integrating the garden and kitchen into the school curriculum. A review of the program conducted in 2011 found that there was strong evidence that the children's food choices had improved by being involved; but at this stage there was no statistically significant evidence that their overall eating habits had changed (Yeatman et al. 2013). A survey of primary schools in Belconnen, Canberra was conducted and it was found that 24 out of 26 schools had functioning gardens. It is clear that creating a garden is not problematic, thus the focus of this report will be on how to improve functionality of the garden to increase student interaction and impact.



Figure 1: Bobbie's Garden The Stephanie Alexander project at Bondi Public school by wamblicious [CC BY-NA-SA 2.0 (<https://creativecommons.org/licenses/by-nc-sa/2.0/>)], via <https://www.flickr.com/photos/wamble/sets/72157622899252007>]

Improving Human Health

Before analysing the school based kitchen garden, it is important to take a step back to ensure the intended focus on schools is in fact the most appropriate to achieve the desire goal of improving human health. Research has identified that it is important to focus on children, but is it better to educate the children at home or within the school system. This was partially answered by estimating the available time parents have with their children during the working week compared to contact hours at school.

Based on 2009-10 statistics for children aged 5-14 the maximum number of families able to either pickup or be waiting for their children directly after school is around 66.5% (ABS 2011). Therefore, 66.5% of children are in theory able to be home by around 4pm. To determine the time for the remaining children along with children's normal bedtime the movements of working parents is required. Based on a likelihood of 95%, it can be showed that the average working parent arrives home with their children between 5:10 pm and 5:35 pm. In addition, the estimated time that an average child goes to bed is between 7:15 pm and 7:30 pm.

Once bath time and other tasks are taking into consideration, children with all parents working full-time have a maximum of ½ to 1 hour per day to interact with their parents after school. Other children would have 2 to 2 ¼ hours, but this may be further reduced by any out-of-school activities. This shows that schools have a greater or at least an equivalent opportunity to educate children to improve their health if they are able to integrate the garden into the daily curriculum, approximately 2 out of 5 hours per day.

Analysis of an Existing School Based Kitchen Garden

A local Canberra primary school with an existing school based kitchen garden was contacted to gain a greater understanding of the gardens role within the community. Interviews were conducted with three people involved with the garden: the garden designer (a local volunteer); a key staff member involved with the garden (a Learning Support Assistant); and the school principal. This provided valuable information on the benefits and challenges faced by schools that have or intend on implementing a school based garden program.

Some of the benefits seen since the introduction of the garden were:

- engagement of students and the community, with parents showing a great interest in the continuation of the program;
- educational and social student development along with a sense of pride for the garden; and
- improved students' willingness to try new foods.

As stated earlier, although the garden has benefits it also has challenges that, if not addressed, may affect the future of the program. In order for the garden program to be continued, it must:

- be fully integrated into the curriculum;
- have trained staff that are able to use and maintain the garden as required;
- have sufficient funding for upkeep and implementation; and
- produce adequate quantities of vegetables.

Note: The majority of these challenges were also identified in the Stephanie Alexander Kitchen Garden National Program review conducted in 2011 (Yeatman et al. 2013).

This highlights three main points that need to be considered for gardens within the school environment to assist in ensuring the garden program continues to impact children and improve education.

1. Ongoing maintenance and size of the garden's harvest;
2. Integrating the garden into the school curriculum;
3. Funding and training for support staff and teachers

Based on the knowledge gained through analysing the existing school based kitchen garden and further desktop research, the design idea objective was defined considering the theme: Sustainable Cities; the topic: Improve Human Health; and the focus: School Based Kitchen Gardens.

The defined design idea objective was:

What can be done to improve the success of school based kitchen gardens?

Improving Ongoing Maintenance and Size of the Garden's Harvest

Irrigation System

To address the issue of ongoing maintenance and the size of the gardens harvest, it is recommended that a controlled automated irrigation system be implemented for all new and existing gardens. In addition, all irrigation systems should incorporate water tanks to promote sustainability within the local community removing the reliance on mains water. Using an automated irrigation system will help reduce the responsibilities of staff and volunteers, particularly during the holiday periods, but also ensure the garden is operating optimally. Important factors that prevent schools from producing adequate quantities of fruit and vegetables is the lack of control and monitoring presently conducted.

A low cost irrigation system has the potential to improve efficiency, save time and provide data for evaluation of the garden. A drip irrigation system, in conjunction with a controlled hose timer and a moisture sensor is recommended to ensure a constant soil moisture content and low evaporative losses (Karlberg, Jansson and Gustafsson, 2006). After conducting a control perspectives analysis, it was identified that an irrigation system would work well combined with either an open loop or closed loop control system.

The main point was that the designed irrigation system should be automated to reduce ongoing maintenance as well as have the ability to monitor the system over time allowing integration into future lesson plans. As a result it is suggested that the irrigation system be designed with a digitally controlled hose that is independent of the moisture sensors. This design ensures that student input is still required, via management of the digital timers and monitoring of the sensor data, which will be further detailed in the following section.

The gardens should be set up in a similar fashion to Figure 1 in the introduction, using the garden beds to separate the types of vegetables into particular zones, e.g. one for high yield, thirsty crops, another is for beds and berries and another may be for fruit trees. Using these garden beds, the design can utilise multiple drip-irrigation systems based on how much water each plant needs, minimising wasted water (Carnevale, 2013). With an increase in efficiency via control and monitoring, the design hopes to increase the producing capacity of the gardens harvest. The intention is to provide more children with more vegetables to take home or purchase from the school, so as to make it staple in the student's diets.

One social and cultural impact that needs to be addressed in the design of the garden includes the types of fruit and vegetables that are grown. Although children and adults with fruit and vegetable allergies are the minority of the population, it is important to consider any allergies that identify with particular students or teachers at the school. Children identified with fruit or vegetable allergies commonly reacted to more than one fruit/vegetables (MA, 2004). To ensure an inclusive garden design, specific fruits and vegetables that are known to be an issue should be avoided to minimise the risk of allergic reactions and allow all students and teachers to be involved. Additionally, vegetables that may pose health risks at any point in their growth (ie, green potatoes) must either be closely monitored or reconsidered.

Integration into School Curriculum

Create Teacher Resources

Providing teachers with learning resources will help to integrate the garden into the school curriculum, which will increase the student's interaction with the garden in an educational setting. The resources may take the form of lesson plans, classroom posters or hands-on gardening and cooking lessons. In order to create an inclusive design, there should be an emphasis put on the social and cultural perspectives of the primary school students. An important social perspective that should be addressed when designing the teacher resources, is any disabilities amongst the student population. In the interview conducted with a Canberra school, and from past studies evaluating the effects of school based gardens, it was found that students with learning disabilities responded positively and excelled in hands on gardening activities (Block et al., 2011).

It is important to consider all of the learning techniques, as a means to address both the majority and minority of students. It is recommended that the school uses both hands on lessons in the garden and kitchen, where they address subjects like mathematics when taking measurements in the garden and operating the timing device on the irrigation system. In addition, there should also be a focus on students who excel in classroom activities. Lesson plans for in class activities should be developed, which incorporate science into the curriculum using topics like "Plants", "Recycling" and "Weather" (Collins et al., 2015). The irrigation system may also be used in science and math classes by recording and analysing the sensor data within the classroom. For example, assessing the recorded moisture content of the soil to determine whether the water flow needs to be increased or decreased for each garden bed. Using the open loop control system will increase the interaction of students with the garden by providing them with real feedback in the form of both moisture sensor data and larger harvests.

It is important to ensure safety is taken into consideration when introducing the irrigation system. Therefore, a safety and risk assessment was conducted to ensure that all risks were identified and eliminated or controlled. It is recommended that this safety and risk assessment is utilised as a teacher resource for students. When dealing with primary school students it is important to reiterate the risks involved with the garden and the safety measures that should be taken. In the teacher resources some of the risks to be addressed include:

- Associated dangers of pesticides and fertilisers; it is recommended that these are excluded from the garden environment.
- Risks of cuts and infections; it is important to inform students that gloves should be worn and shovels should be handled carefully in the garden.
- Risks involved when drinking the water from the rainwater tanks

Safety and risks should also be incorporated into health and physical education and cooking classes, by promoting healthy habits, such as washing hands, preparing foods and the risk of living unhealthy lifestyles. To encourage safe practices and good behaviour in the garden the students should be awarded garden access badges after completing the lessons on safety, risk and how to use the recommended irrigation system.

Funding and Training for Support Staff and Teachers

The survey results highlighted that funding for dedicated staff and teachers was not seen as a viable option moving forward. It is proposed that by installing the irrigation system and integrating the garden into the school curriculum as stated above that the reliance on dedicated staff will no longer be a major requirement. In addition, additional funds could be raised by selling the additional harvest resulting from a better management of the garden.

As such, attention needs to be shifted to ensuring that the teachers have adequate support to not only meet their existing requirements, but also incorporate the garden as a whole and ongoing maintenance into their lessons. Creating the teacher resource will go a long way to achieving this, but further training for qualified teachers as well as students presently training to be teachers will be required. It is recommended that this be the focus of further analysis into how to improve school based kitchen gardens.

Recommendations

In summary, in order to improve the health of children it is recommended that primary schools with existing school based gardens invest in a semi automated water drip irrigation system, in conjunction with rain water tanks. These systems should be facilitated by teacher resources, which incorporate the garden into the curriculum. This will ensure children have the opportunity to not only have access to fresh vegetables, but continue to have exposure to the garden to hopefully improve their long term food choices.

Secondly, it is recommended that further work be done to provide resources and integrate school based gardens into the main stream school curriculum to reduce the reliance on specialised staff for the garden and ensure that teachers are not overloaded. This is to ensure that the gardens do not become too burdensome on the teachers and school system.

Conclusion

School based gardens are a way forward, to increase the sustainability of fruit and vegetable gardens in local communities. The design idea of introducing irrigation systems and teacher resources is a promising development to improve human health, by promoting healthy habits at a young age. This analysis should be evaluated and trialled to determine the validity and potential of school garden programs.

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